GENDER PERSPECTIVE IN INTEGRATED FARMING SYSTEM

समन्वित कृषि प्रणाली में महिलाओं की भूमिका

MODEL TRAINING COURSE: 2012-13

(Sponsored by Directorate of Extension, DAC, Ministry of Agriculture, New Delhi)

(17-24 January, 2013)

A Training Manual by:

M S Meena, K M Singh, B P Bhatt, Ujjwal Kumar

Organized by

ICAR Research Complex for Eastern Region

(Indian Council of Agricultural Research)

ICAR Parisar (P.O.: BVC) Patna-800 014 (Bihar) India

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FOREWORD

The diverse challenges, increasing food, feed and fodder needs, natural resource degradation, small and scattered land holdings, climate change, slow growth in farm income and new global trade regulations demand a paradigm shift in formulating and implementing the agricultural research and capacity building programmes for women, particularly in Eastern region.

ICAR Research Complex for Eastern Region, Patna is working to understand the roles and problems being faced by women in agriculture and its implications for overall agricultural development. Strengthening gender research in agriculture would make women as a vibrant partner in agricultural growth. Keeping this fact in view, National Level Model Training Course on ***"Gender Perspective in Integrated Framing System"*** has been designed and training has been imparted to 26 stakeholders w.e.f 17-24 January 2013.

It is expected that the analytical approach and forward looking concepts presented during 'Model Training Course' in the form of Training Manual shall prove usefulness for state level extension functionaries, researchers, policymakers and stakeholders to address the future challenges for growth and development of the women in agricultural sector and ensure food and income security with a human touch.

Dated the 17th January, 2013
Patna

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Introduction

Over the years, there is a gradual realization of the key role of women in the field of agricultural development Aside from raising children, women are expected to prepare all meals, maintain the homestead, and assist in crop and animal production system besides taking care of children. Rural women form the most important productive work force in the economy of majority of the developing nations including India. Agriculture--the single largest production endeavour in India, contributing about 18% of GDP, is increasingly becoming a female activity. Agriculture sector employs 4/5th of all economically active women in the country. On an average 48% of India's self-employed farmers are women. There are 75 million women engaged in dairying as against 15 million men. Likewise 20 million women folk are associated with animal husbandry as compared to 1.5 million male population. Beyond the conventional market-oriented narrower definition of 'productive workers', almost all women in rural India today can be considered as 'farmers' in some sense, working as agricultural labour, unpaid workers in the family farm enterprise, or combination of the two. Moreover, several farm activities traditionally carried out by men are also being undertaken by women as men are pulled away into higher paying employment. Thus, rural India is witnessing a process which could be described as "Feminization of Agriculture".

Closing "gender gap" in agriculture–or increasing women's contribution to food production and enterprise by providing equal access to resources and opportunities–could reduce the number of hungry people in the world by 12-17%, or by 100 to 150 million people (FAO, 2011). The world community today sincerely recognized the role of women in agriculture and the constraints that they face in earning a decent and sustainable livelihood. There is growing evidence suggesting that women's underdevelopment has adverse bearing on growth and development of agriculture. Therefore, time has come for us to make concerted efforts to address gender issues and provide support for social, technological and economic empowerment of women. One of the important steps in this direction is integration of gender perspective in agricultural research, extension and policies so as to make women an important partner in sustainable agricultural development.

Gender Perspective in Agriculture

In order to mainstream gender concerns in agriculture, the Department of Agriculture and Cooperation is making conscious efforts to 'engender the agricultural development process' for which appropriate measures are being initiated. Currently, there are no specific allocations earmarked for women farmers under most of the schemes of the department, however, an attempt has been made almost under each scheme to identify and promote the involvement of women in areas having better potential and scope so as to ensure women's full and equitable participation under these components/areas.

The salient gender specific interventions are as follows:

1. **Cooperation Division:** The National Cooperative Union of India (NCUI) is implementing a "Cooperative Education and Development programme for women' through its 45 Cooperative Education Field Projects and 4 exclusive Cooperative Education and Development Projects for women located at Shimoga (Karnataka); Berhampur (Orissa); Bhopal (MP) and Imphal (Manipur). The focus of these programmes besides promoting literacy; generating awareness and educating women to be organized into cooperatives is to advance loans to members for production and consumer purposes. The NCUI also monitors, guides and supervises the Cooperative Education Programme being implemented by State Cooperative Unions under which 16 state cooperative unions are providing cooperative education to women with the help of 60 cooperative education instructors.

2. **Crops Division:** The schemes namely 'Technology Mission on Cotton and On Farm Water Management for increasing Crop Production in Eastern India' are neither gender specific nor have any specific allocations for women, however, to enable women to take full benefits of the scheme, the States/Implementing Agencies are being encouraged to give preference to women farmers who head the household/have land holdings in components like distribution of agriculture inputs, trainings and demonstrations.

3. **Plant Protection Division:** Under the scheme 'strengthening and Modernization of Pest Management Approach in India', there are no separate provision/budget allocated for women. However, under the sub-component 'Integrated Pest Management', the Farmers' Field Schools are organized in collaboration and support of the State Government on different crops in which women farmers actively participate in the training activities/programmes.

4. **Horticulture Division:** Women as a work force contribute to the coconut cultivation and industry especially in the making of coir which is widely used. Keeping this in view, under the scheme 'Expansion of Area under Coconut' being implemented by Coconut Development Board, conscious efforts are made to extend the benefits of the scheme to women farmers. During 2004-05, in Kerala state, out of a total of 945, numbers of beneficiaries, 228 were women (24.9%). In the year 2005-06, 22.3% of women folk were benefitted out of a total of 1036 stakeholders. Under the schemes of National Horticulture Board namely 'Development of Commercial Horticulture through Production and Post-Harvest Management' and Technology, Development and Transfer for Promotion of Horticulture', 174 and 107 women have been benefited during 2004-05 and 2005-06, respectively.

5. **Seeds Division:** Specific financial targets have been fixed for women farmers under the Central Sector Scheme titles 'Development and Strengthening of Infrastructure facilities for Production and Distribution of Quality seeds under its following components:
   - Seed Village Scheme
   - Human Resource Development
   - National Seeds Research and Training Centre (Varanasi)
   - Use of Bio Technology in Agriculture and Public Awareness Campaign

The implementing agencies have been advised to allocate specific amount for women farmers.

6. **Machinery & Technology Division:** A number of agricultural implements and hand tools suitable for farm women have been developed by Research and Development Organizations under ICAR. These gender friendly tools are being promoted through Macro Management Scheme. The feedback from the state governments indicates that 20,380 women farmers have been benefited under this scheme during the year 2004-05. Under the Central Sector Scheme 'Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration', the skill development aspect among women farmers has been adequately taken care of by earmarking 10% of the funds and fixing up of separate physical targets for women. Under the 'Training and Testing component', Farm Machinery, Training and Testing Institutes have organized short duration training and testing programmes–both institutional and on-site for farmers in the areas of selection, operation, maintenance and management of agricultural implements. A total of 309 women have been trained against the target of 400 during 2004-05 and 217 against a target of 500 during 2005-06. Though, there are no specific targets for women farmers under 'Demonstrations', however, the women farmers have been actively made to participate in the demonstrations organized during 2004-05. During 2005-06, 961 demonstrations have been organized in the farmers' fields including the fields of women farmers. The State Governments have been requested to earmark 10% of the funds for women and furnish their reports separately on gender disaggregated basis. Under a new component 'outsourcing of training', the State Governments have been requested to earmark 10% of the funds for training of women farmers during the 10th Plan period.

7. **Integrated Nutrient Management (INM) Division:** As per the guidelines of 'National Project on Organic Farming (NPOF)', there is no gender specific activities/allocation. However, 25% seats for training of farmers on organic farming have been reserved for women farmers.

8. **Technology Mission on Oilseeds & Pulses (TMOP) Division:** There is no separate provision for gender based budgeting. However, under the NOVOD Board's schemes on 'Integrated Development of Tree Borne Oilseeds', the implementing agencies have been advised to ensure maximum participation of women in the programme.

9. **Natural Resource Management (NRM) Division:** Under the 'Watershed Development Project in Shifting Cultivation Areas (WDPSCA)', there is no specific component exclusively allocated for women farmers, however, under the scheme, 17.5% of the total allocation is earmarked for rehabilitation component which enable the beneficiaries to take up agriculture and allied activities such as Production of short duration crops like banana, papaya, etc.; animal Husbandry/Piggery/Poultry/Duckery/Purchase of milch cows; Pisiculture; Sericulture–Plantation of Mulberry, Supply of silk worm; and household activities–Basket/rope/Mats making, Tailoring, embroidery, carpentry, black smithy, small house hold food processing units, cottage industries and many other activities suitable to the locality with the approval of the DWDC. These activities are mainly carried out by women.

10. **Rainfed Farming System Division:** Under the 'National Watershed Development Project for Rainfed Areas (NWDPRA)' which has been subsumed with Macro Management scheme for funds, there is an active participation of women in different activities. In a Watershed Development Team (WDT), one out of four members is a woman; Each Watershed Committee has two women members to facilitate active participation of women in the programme. The women oriented users groups (UGs) are formed at each watershed. Also, for income generating activities, exclusive women SHGs as well as general SHGs with adequate participation of women are formed.

11. **Extension Division:**

(i) Support to States for Extension Reports: A centrally sponsored scheme "Support to States for Extension Reforms" based on Agricultural Technology Management Agency (ATMA) Model, which was successfully pilot tested under the National Agricultural Technology Project (NATP) has been launched during 2005. The Scheme aims at providing decentralized and demand driven extension services through active involvement of Farmers/ Women Farmers/Subject Matter Specialists/NGOs/Krishi Vigyan Kendras etc. The gender concerns are being mainstreamed by mandating that 30% of resources on programmes and activities are allocated for Women Farmers and Women Extension Functionaries.

(ii) National Agriculture Technology Project (NATP): There has been a focused participation of women under the Innovations in Technology Dissemination (ITD) component of National Agriculture Technology Project (NATP). A total of 1.27 lakh of women farmers have been benefited in seven states, implementing the programme through demonstrations; exposure visits; farm women training, FAC meetings and other such activities.

(iii) National Agricultural Innovation Project (NAIP) and Gender Concern: The NAIP was launched on July 26, 2006 to facilitate accelerated and sustainable transformation of Indian agriculture in support of poverty alleviation and income generation by collaborative development and application of agricultural innovation by the public research organizations in partnership with the farmer's groups, the private sector, the civil society organizations and other stakeholders. Gender issue has been adequately addressed under the NAIP component-1 and 3.

Component 1: This component aims at bringing in the organizational changes in the NARS so that it becomes a dynamic innovation system capable of responding to the present as well as the future needs of Indian agriculture research and development. The role of the ICAR as the leader of the NARS (Funds allocated: approximately US$ 46 million) is to act as a catalyzing agent to bring the changes in the agricultural universities being the main partners where all other stakeholders are involved. Under this component, one of the objectives is policy analysis including that for gender concerns, visioning and market intelligence analysis for supporting the policy makers on one hand and the farmer on the other.

- Gender Work Participation Disparity Index (GWPDI) was developed to characterize the gender work participation scenario at regional and all India basis. The value of GWPDI varies between 0 and 1 (greater the index value more will be the disparity). The GWPDI value for India was found to be 0.397 in 1991 and 0.338 in 2001 indicating that the disparity in work participation between men and women has narrowed down over the years.

- Gender Work Participation Index (GWPI) has been developed to characterize the gender work participation scenario in a state or a country. The GWPI value which was 0.234 in 1991 increased to 0.272 in the year 2001 indicating improvement in work participation scenario. Mizoram (0.559), Sikkim (0.454) and D&NH (0.492) are the states with high gender work participation status based on figures in 2001 census. Some of the states–Odisha, West Bengal, Bihar, Punjab, Haryana are having low level of gender work participation. There seems to be an inverse relationship between GWPDI and GWPI.

- A gender sensitive Rural ICT website model was created and implemented for women SHGs in Aipur village in Nalgonda district of AP in collaboration with two NGOs.

Component-3: It refers to Research on Sustainable Rural Livelihood Security **(**Funds allocated: approximately US $ 73 million) and the emphasis is on research, on-farm, for improving and developing the most suitable farming systems and allied off-farm activities, in the less favourable environments, regions and groups so that the livelihood of the rural poor improves through assured food, nutrition, employment and income. The sustainability of socio-economic and natural resources has to be ensured. Particular attention has been given to the rainfed, hill, mountain, coastal and island eco-regions. Partnerships is built among all the stakeholders, be the farm men and women, the farm labourer, the input supplier, the rural industry entrepreneur or the researcher, who will share their resources and knowledge and own the changes brought in.

During previous years of trials, some of the major interventions resulting into high impact in the respective areas were identified and documented in ICAR-NAIP publication 'Selected livelihood options for disadvantaged regions of India'. Some important interventions for livelihood improvement of men/women are as:

- Rice–fish–poultry farming system-a success story from Tamil Nadu
- Integrated rice–fish–vegetable system for enhanced livelihood in selected backward districts of Assam
- Integrated fish–vegetable–poultry/pig system
  - Enhanced livelihood through pig-fish-vegetable system in Assam
  - Enhanced livelihood through fish-livestock-horti system in Dhalai
  - Fish–duck–pig based farming system in South Garo Hills, Meghalaya
  - Fish–duck–pig based farming system in Dhemaji, Assam
  - Integrated poultry- fish–vegetable farming system, Meghalaya
- Improvement of livelihood through integration of fish with makhana (*Euryale ferox* Salisb.) & Water Chestnut (*Trapa bispinosa* Natans.) in flood prone ecosystem of Darbhanga (Bihar).
- Utilization of upland fallows for cultivation of maize for increased income, food and nutritional security in Bastar region.
- Income enhancement through intercropping in maize-Jhabua.
- SRI and ICM method of paddy cultivation-a great success in Dhalai, Tripura and South Garo Hills, Meghalya.

- Redgram transplanting–success story from Bidar, Karnataka
- Rice cultivation: A Community Enterprise in a Remote Tribal Village of Dhule

Main Obstacles in Women Growth in Agriculture Sector (Source: Lal and Khurana, 2011). The main obstacle are depicted below are as;

- Very few land holdings, animals, and machineries are under the control of womenfolk.
- Women absence from decision making process, either inside or outside the home.
- Women perform all un-mechanized agricultural tasks and perform multiple tasks, which add more burden to them.
- Women workers in agriculture suffer from high illiteracy rate and school drop-outs.
- Women earn less wages, especially in joint, informal and private sector.
- Women do not know their legal rights.
- Miss applying of some laws and regulations in favour of women such as heritage legislation.

(iv) UNDP National Food Security Programme: The agreement for UNDP-GOI Food Security programme was signed in 1998. The sub-programmes included maize based cropping system; promotion of hybrid rice; sustainable dry-land agriculture, natural resource management along with supplementary programme for cyclone affected districts and management support for food security. Under the women specific programmes implemented in the States of Orissa, Andhra Pradesh and Uttar Pradesh, 2206 Farm Women Groups (FWGs) have been directly benefited and 49,976 Women Farmers have been directly trained.

(v) Extension Support to Central Institutes/DOE: Out of 11 components of scheme, 'Support to Central Institutions / DOE' the budget for gender purposes is allocated only under one component viz. 'National Gender Resource Center in Agriculture (NGRCA)' wherein the expenditure is made on women specific activities mainly–undertaking macro/micro level studies; action research on critical thrust areas related to Women in Agriculture; developing Gender Sensitization Modules for programme implementers; arranging exposure visits of extension functionaries to women specific/pro women programmes and developing a separate portal for this Centre. The NGRCA is also housing a Gender Budgeting Cell of the DAC. The Cell has sensitized the subject matter Divisions of DAC to have Divisional Gender Coordinators identified in each division. In remaining components of the scheme, consistent efforts are being made to promote both– organization of specific training programmes for women in agriculture and also improving their participation in all the training programmes.

(vi) Mass Media Support to Agriculture Extension: The Central Sector Scheme "Mass Media Support to Agriculture Extension" envisages utilization of existing infrastructure of Doordarshan and All India Radio to produce and transmit latest information and knowledge to the farming community viz. farmers/women farmers. Special programmes are being produced and telecast under the Doordarshan–Narrow Casting programmes to transfer information and technology in areas in which women farmers are pre-dominantly engaged such as vermicompost, nursery–raising, seed treatment, floriculture, kitchen garden, gender friendly tools etc. Also under the Doordarshan–National/Regional Agricultural Programmes, the areas of women interest such as organic farming, vermi compost, nursery–raising, seed treatment, floriculture, kitchen gardening as well as their success stories are included. The existing infrastructure of FM Transmitters of All India Radio is being used to broadcast half an hour Kisan Vani Programme daily, six days a week from Monday to Saturday, from 96 rural areas FM Stations. These FM Stations are also producing special programmes to transfer information and technology in areas of women's involvement.

(vii) Establishment of Agri-Clinics and Agri–Business Centres (ACABC): The scheme is open to all eligible Agriculture Graduates including women. As an outcome of the special efforts, 845 women have been trained as against the total of 14300 (5.90%). Also, 157 trained women candidates have taken up enterprises against 4800 (3.27%) ventures set up across the country.

12. **International Cooperation Division:** FAO Regional Office for Asia and Pacific also honoured a model female farmer (who had done an exemplary work in the field of 'Heritage/Conservation Agriculture') on the occasion of World Food Day 2005.

13. **Agricultural Marketing Division:** Under the scheme 'National Institute of Agricultural Marketing', the provision have been made to organize training programmes for women in the field of modern marketing system, export of horticulture produce from north-east, orientation of SHGs for women during 2005-06 and 2006-07. While, it is not possible to make women specific allocations in view of the scheme being demand driven, however, as and when the project proposals from women entrepreneurs are received, they are processed on priority basis.

14. **Agriculture Census Division:** The 'Centrally sponsored Scheme for Agriculture Census' is not a development oriented programme and involves only statistical operations. As such, it has not been possible to fix any target/allocation for women in the scheme. However, the Division has collected, collated and documented the data on 'operational land holdings and land use pattern' on gender disaggregated basis in its Agricultural Census conducted during 1995-96.

15. **Macro Management Division:** The Centrally sponsored Scheme: Supplementation/ Complementation of States efforts through work plans (Macro Management) is a step towards achieving decentralization in pursuance of restoring primacy of states in agricultural development planning. Since, the scheme is being implemented through the work plan being prepared by the states themselves; there is no separate allocation of funds from DAC. However, some states themselves have provided funds for the benefits of women.

16. **IT Division:** The IT Division's scheme 'strengthening/promoting agricultural information systems' is inherently gender neutral. However, it is anticipated that proportionate benefits accrue to women employees/users. The following benefits accrue to women through the scheme:
    - Women employees at the headquarters as well as in the field offices of the Department get computer facilities in proportion to their strength among all employees, which is about 15 per cent.
    - Similarly, the benefits from websites/portals, Kisan Call Centers etc. flow to the women farmers. Further, to encourage flow of benefits of this scheme to women farmers/beneficiaries, women participation is encouraged. It is also endured that they are represented in training courses relating to IT at least in proportion to their number among employees.

The Need for Different Strategies

The involvement of women in crop production varies according to the type of crop grown, the cropping systems and the socio-economic status of the family. There is also a need to make distinctions between the involvement of women as agricultural labourers and involvement of women in agricultural operations on their own farm. In relatively prosperous areas where land holdings are large and most of the agricultural operations are mechanized, women play only a marginal role. The women from poor families work as agricultural labourers, irrespective of the community to which they belong. Keeping milch animals, small ruminants and backyard poultry is an important source of income for poor farm families and agricultural labourers.

The problems of tribal women are different from other rural women and they need a totally different approach. For instance, the majority of workers involved in collection of non-timber forest produce (NTFP) are women, particularly tribal women. However, approximately 70% of the NTFP collections take place in the six states of the central belt; Maharashtra, Madhya Pradesh, Chattisgarh, Bihar, Orissa and Andhra Pradesh and many tribal women face several constrains operating in the NTFP economy. This is because they spend a considerable amount of time in fetching water and therefore do not have the time to add value to minor forest produce (which would help to increase their income), the women who bring produce to the market are also exploited because they lack knowledge on proper weights and prices for the timber and there is a language barrier (traders are often from the plains with whom tribal women find difficult to communicate and bargain for prices). Programmes for tribal women therefore need a different approach to help overcome some of these constraints.

There should not be any centrally generated blueprints for tackling women in agriculture issues. It is important to recognize the various categories of women farmers that exist and their needs in the agriculture sphere and from there to develop appropriate strategies to assist them e.g. whilst in some parts of India require trained women to reach women farmers, others may require trained women as motivators only, and other areas may require the male agricultural officers to be trained on women's issues to disseminate technology to women.

Science & Technology for Women

Advancement of science and technology in different fields has created new vistas for progress and well-being of humankind. Agriculture is one such field that continues to benefit from new knowledge and technological breakthroughs. An important aspect of all these changes that was missing earlier, but has gradually been realized is the scope and opportunities of agricultural knowledge & technologies for women. There are many technologies developed and standardized for agriculture by the National Agricultural Research System, but their potential for women and agriculture has not been adequately demonstrated. There is dire need to harness the potential of science and technology by empowering women and demonstrating the benefits. Subsequently, the technology based models would be up-scaled for wider impact. Some of the areas that would be focused for empowerment of women are:

- **Crop production and diversification:** Adoption of varieties with improved and acceptable traits for both home and market, eco-friendly management practices such as integrated pest management practices, cropping/farming systems, conservation technologies etc.
- **Horticulture and floriculture:** Improved, dwarf, high yielding varieties/hybrids, nursery technologies, protected cultivation, meadow orcharding, inter-cropping and management practices, INM & IPM, use of biotechnology, micro-irrigation etc.

- **Livestock production and management:** Feed management using locally available materials, health management, farming systems, small ruminants and poultry, use of improved socially acceptable breeds/varieties etc.
- **Aquaculture:** Low cost technologies including poly culture, integrated fish farming, nursery rearing, management of backyards and community ponds through women groups, etc.
- **Tools and equipment:** Evaluate, refine and develop women friendly tools and equipment for drudgery reduction in agricultural operations.
- **Post-harvest management and value addition:** Low cost, eco-friendly storage practices, packaging and processing etc.
- **Home management:** Human development, energy saving practices, time and resource management, recycling of household wastes, inner environment etc.
- **Food and nutrition:** Assessment of nutrition gap, development of module for nutritional education, develop and standardize the models of nutrition gardens etc.

The processes of liberalization, globalization & climatic changes might have pushed the farming community into a situation of increased the risk and uncertainty emanating from structural changes, dwindling crop prospect, technological changes, market volatility, institutional constraints etc. But at the same time, new and expanding opportunities also galore that need to be tapped through more and more use of scientific knowledge and technology.

Strategies for Gender Mainstreaming

Gender mainstreaming is the current international approach for advancing gender equity and equality in the society. It involves incorporating gender perspective into policies, plan, programmes and projects to ensure that these impact women and men in an equitable way. However, below-mentioned strategy could be useful for mainstreaming the gender:

- Organizing women Groups: Male extension workers can be trained to work more closely with women in settings that are culturally acceptable, such as women groups. Such groups can also improve access to infrastructure.
- Technologies to reduce energy and time spent, particularly the household and farm production activities. Extending the technological innovations such as weeders, paddy threshers, winnowers, sprayers, harvesting tools, parboiling units, maize shellers, dal making machines etc., will reduce the burden of women.
- Increasing the biomass production to meet fuel needs, plantation of fast growing fodder in common lands and developing mechanisms for sharing the fodder helps women in saving lot of time and devote this time for income generating activities.
- Innovative credit programmes using non-traditional forms of collateral and local institutions (women groups) can ensure that women are able to obtain access to credit.
- Identifying the right training and extension needs of women is one of the most important steps in initiating any developmental programme. Gender analysis of activities, resources, constraints, implications and benefits should be understood using Participatory Approach. This information should be taken into consideration for the need assessment. The staff members/extension functionaries' ability to do this has to be built up.
- Giving women farmers more access to meetings, trainings, exposure visits and demonstrations, organizing training programmes based on the needs of the women. Institutional and village based trainings to be organized as per the convenience of the women farmers.
- Where severe fragmentation exists, collective farming should be encouraged by women.
- Farmer-to-farmer training or participatory training need to be encouraged.

- Active women can be selected, trained and they should be provided with inputs and credit to practice the improved technology. Their fields can be used as demonstration plots for training other women.
- Recruiting more women extension workers from the rural areas and train them.
- Female para-extension agriculturists-relatively uneducated women with short crash courses on agriculture can be posted in their own villages.
- Appointing female supervisors and subject matter specialists.
- Making better use of male extension agents; change the stereo-typed attitude of male agents with regular gender sensitization courses; increasing awareness of gender roles; developing skills in use of language and communication to suit women
- Using women as contact workers.
- Proper health care support for girls and women.
- Most of the micro enterprises undertaken by the women are based on the skills and raw material available rather than considering the market needs and market dynamics. In depth marketing study would help identify effective marketing strategy for products. Cooperative marketing of products and assigning brand names for the products would also be helpful in finding sustainable markets.
- While developing farm women programmes, the cost of the hiring consultants to conduct market analysis and market development should be kept in mind.

Conclusion

There are many constraints and challenges to address the gender issues, and create opportunities for women in agriculture in the face of rapidly changing agricultural scenario. It is well evident that educated, informed and empowered women can contribute to sustainable and inclusive development. Therefore, a two-way approach; focusing on women's need & capability, and focusing on exigencies and opportunities in agriculture will be paramount. ICAR, SAUs and other institutions are committed to create an environment of greater gender sensitivity and a culture of gender parity within National Agricultural Research System and outside. It will work towards strengthening gender perspective in agricultural research so as make output of research more relevant and appropriate, and there is enhanced scope for appreciation and application of findings. Concerted efforts are needed to create the gender sensitized and capable professionals who would be instrumental in guiding gender based action. Science and Technology based innovations and institutions would be developed to reduce the vulnerability of women against shocks. A viable strategy could be harnessing the untapped potential of women and promoting gender mainstreaming in agriculture. Some positives favouring strategy are: emerging technological and market opportunities, increasing literacy among women, more favourable policy environment, increasing attention to women with incentives, good number of schemes in agriculture with gender focus and increasing investment in agriculture etc. These schemes could certainly help to women folk and their role in agriculture.

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Gender Issues in Agriculture

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Introduction

Agriculture occupies a key position in the Indian economy providing a source of livelihood for a majority of the population. Successes in agricultural front with high production levels, especially in food grains have indeed been achieved. But more energy in the form of mineral fertilizers, chemical pesticides and farm machinery are required every year to produce the same quantity of farm products. The yield plateau of crops in Punjab, Haryana, Western Uttar Pradesh and other states strongly indicate that there is a disturbance in our natural resources management and the present practices are not conducive to sustainable agriculture. The major cause of concern, particularly in the core Green Revolution belt, has been the decrease in genetic diversity of major HYV crops, which has increased the potential danger for sudden widespread loss of crops from unknown/uncontrollable diseases. Depletion of natural resource base due to deforestation, over grazing, desertification, excessive agricultural intensification, over fishing and agriculture on marginal lands leads to decline in agricultural production potential leading to decrease in the sustaining/ carrying capacity of agriculture. Natural resources (soil, water, nutrients) have boundaries and improved management is needed to reverse the degradation of this resource base and develop agricultural production systems that sustain our ecosystem.

Effect of Over Exploitation of Natural Resources on Women

The interrelationship between human factors and natural resources management is complex and has remained at the centre of the development debate. It is acknowledged now that economic growth goes side by side with deteriorating conditions of work and living for sizable section of the poor, especially women. This is so because the growth process itself imposes new forms of deprivations, dislocations, exclusion and alienation from the productive resource base. In effect poverty, malnutrition, population, ecology and sustenance of our agricultural systems can no longer be dealt with or even thought of as separate issues. They are interlinked in practice and must be linked in policy formulation, for development to be meaningful, especially if it has to have a positive impact on women. Historically, women have been the managers of natural resources as they are dependent on them for their livelihood and their family's needs. The consequences of over exploitation of these resources have rendered them scarce.

The effect of environmental degradation and its consequences can be examined from the disturbance of linkages of women with respect to land, water and work. Over grazing of pastoral lands, degradation of land by water, wind erosion, salinity, alkalinity have all resulted in increasing working hours of women as she has to traverse long hours to locate productive areas. Women are linked with forests for their supplies of fuel, fodder and minor forest produce. Non-commercial sources of energy-firewood, crop wastes and cow dung-provides nearly 90% of rural household energy requirements.

The rural women collect over 28% of all energy consumed in India in the form of firewood. Most of the 140 million tonnes of firewood burnt annually come from forests. Deforestation and depletion of forest resources and loss of access to and control of forest resources have increased poverty, unemployment and drudgery of rural and tribal women. Soil erosion, water logging, siltation, shifting

cultivation, construction of dams and reservoirs, mining and industrial activities and large scale tree felling for commercial purposes have taken a toll on agricultural and forest areas. Thus rural women are forced to work more, walk greater distances for long hours to collect fuel wood, fodder and other household biomass.

Discharge of effluents from industries and households have resulted in pollution of surface water and over exploitation of ground water, have led to fall in the water table. Natural reservoirs of rainfall have been diminished due to deforestation. Water is thus becoming a scarce commodity. The effect of depleting water resources is more severe on rural women. Women in Rajasthan and *Kutch* region of Gujarat travel several hours to fetch water to meet their family's needs. Even in high rainfall, hilly regions of Uttar Pradesh and North East deforestation had led to water shortages in summer forcing women to walk several miles in search of water.

Poverty and unemployment in rural areas have resulted in large-scale migration to urban areas. Women are being forced to take up more drudgerous jobs as a source of livelihood as most of the migrants are absorbed into the construction sector. Women form the largest work force in agricultural sector. Male out migration from rural areas in some instances is strong enough to suggest a process of "feminization of agriculture" or perhaps more accurately, of self-provisioning food farming.

Households headed by women now form on an average between 20 to 25 per cent of all rural households in developing countries. The rural woman's drudgery has thus been doubled with women performing the man's role as well. Thus women, the sustainers of family's health and prosperity, have slowly become the primary victim of deepening environmental crisis as they are the main users and providers of household biomass.

Woman's Contribution to Sustainability of Natural Resources

Sustainable agriculture is sustainable exploitation of renewable natural resources including annual and perennial cropping, agro-forestry and livestock as well as the conservation measures needed for long-term maintenance of resources. Thus, sustainable agriculture involves sustenance of our agricultural systems. This should be the major emphasis for all technological innovations involving land and water use so that there is no adverse effect on the biological productivity of the resource base in the long run.

Even in the larger scenario of rapid exploitation of natural resources woman has inadvertently been contributing to the sustenance by her traditionally assigned role. Domestication of crops is widely believed to have begun by women. Seeds are the source of food and are valued for their quality to maintain genetic continuity. From time immemorial, it has been a woman's domain to sort seed at home by observation and through experience. In doing so, the methods of seed storage were always practised by women. The search for medicinal seeds and plant material for her family, fruit seeds for kitchen gardens and ornamentals to quench her aesthetic needs have all contributed, indirectly, for preservation of seeds and the biodiversity that we are endowed with.

These activities make women trustees and users of crops, land races, forest genetic diversity, medicinal plants and also a source of information on use of local cultivars and various modes of conservation. Maintaining land fertility and sustaining it by adding domestic refuse and cattle dung to land when needed, use of trap crops as barriers, bench terracing and recycling water from water storage ponds to her kitchen gardens are all recognised activities by women practiced out of necessity. Realizing the importance of stabilizing the coastline planting shelter belts with coconut, areca nut, or grasses for stabilising coastline agriculture has been practiced. The farms are also dependent on the multiple uses of these trees. These are perennial and yield late and women have been involved in growing short duration intercrops to meet their family's nutritional needs.

Caring for livestock comes naturally to women. The most drudgerous jobs in livestock production like cleaning of the cattle sheds, feeding the cattle, collection of fodder etc. always fall on the woman. Care for young animals and backyard livestock is also largely done by women. In caring for sick young animals women have evolved several ethno veterinary practices. Many such practices, based on indigenous technical know-how vested with crop husbandry (especially in complex, diverse, risk-prone areas), animal husbandry, fisheries and home management have been traditionally practiced by women. These practices are usually eco-friendly, sustainable, economically viable and are examples of best utilisation of local resources and waste/bi-product recycling and management. The long association of women with environment can be utilised in the process of solving major environmental problems, by using their traditionally acquired skills and integrating it with scientifically studied and developed techniques.

Technology Development & Women

The devaluation and marginalisation of indigenous knowledge and skills have disproportionately affected women as they have generally been excluded from the institutions through which modern scientific knowledge is created and transmitted (Agarwal, 1992). There is increasing evidence from agricultural project and program evaluations that insufficient attention to gender issues tends to increase or reinforce gender inequities in ways which hold productivity and welfare below the potential. Women have thus far been neglected by and large as human resource in most of the development programmes and strategies.

Despite recent agricultural innovations there is no respite for rural women. While agricultural innovations leads to the reallocation of family labour and the assignment to men of complete control over output and income, without associated changes in the allocation of obligations, welfare and nutritional status of the family may actually decline (IFPRI, 1983). One of the barriers is agricultural extension through which so many innovations and services are channelled. In addition to the pressures which encourage field-level extension staff to work with larger farmers rather than small holders the fact that most extension staff are male has meant that, for any farm size or income category, extension agents have tended to work with male farmers rather than female farmers (Swanson *et al*, 1985).

A technology development process which is so structured that technical innovations in food cropping simply do not reach a major portion of the farming community makes very little sense. When new varieties were being developed, little thought was paid to the bi-products and their utilisation in rural existence. These products not only have a role within the domestic economy, they are the input to often complex divisions of labour and enterprise providing income and employment to very many of the rural poor. Collection of household biomass is largely the job of women.

Women also use the bi-products in a variety of ways, both for domestic use as well as income generation. Straw from traditional varieties of rice was used as fodder and for thatching. But, straw from short height, high yielding varieties, developed to prevent lodging, cannot be used for thatching and yield less fodder. Possibly the importance of the contribution of multiple use of biomass to rural economies has been obscured by the concentration on the more favoured, irrigated areas where the high profits from HYVs complement existing, or induce the development of new infrastructures, commercial and industrial networks and livelihood opportunities. Technologies developed in areas like post-harvest operations have never really studied the inter-relationship that exists between production and post-harvest activities at the domestic level. Post-harvest technology was so far being designed from a distance.

Studying domestic processing, storage and cooking technologies can lead to development of appropriate technologies that are genderized as well. Mechanization of agriculture has not been gender sensitive. It has led to large scale dislocation and unemployment among rural women. Harvesters, transplanters and combines usage in field crops is one example. Failure to perceive women-over half the world's population and important to technology development as producers, workers and consumers-as clients of, or as forming an important constituency for agricultural research is one of the major blocks towards overall development (Jiggins, 1986).

Technologies for Empowering Rural Women

Recognizing the fact that women can and must play an important role in the sustenance of our agricultural systems they have to be involved in the process of evolution of new technologies which are eco-sustainable. Their needs and physical limitations have to be taken into account during technology innovations and development. Training, to disseminate these technologies, must be made a regular feature. The training should be vocational (skill oriented), organised for short duration within her social boundary during the lean months of her involvement in agricultural activities. Suitable Audio-Visual aids can be used to take the message across. Teaching aids like samples, models and visuals that are appealing and interesting must be used to improve the comprehension of the illiterate women and their capacity to retain the message disseminated.

Location specific traditional media like folk songs, folk theatre and folklore can be utilised to communicate technical information in an effective way. Ergonomically designed machinery, especially tools and implements, which are genderized can assure rural women employment and add value to her time. Implements like dibblers, hoes, weeders, seed and fertiliser drills, seed treating drums, pedal operated pumps and threshers and serrated sickles have been developed, but are yet to be popularised. Improvements in implements like clod breakers, tillers and transplanters have to be made for easy handling by women. Location specific, remunerative cropping systems that have capacity to enrich the soil, can tap nutrients from different soil layers and which includes legumes and tubers can be developed and suggested for practice. This has the added advantage of breaking pest cycles if properly planned, e.g. paddy-black gram and paddy-groundnut-green gram cropping system. Inter cropping like sorghum-red grams which have been traditionally practiced have been scientifically proven too, to be suitable to dryland areas. Finger millet and horse gram intercropping is also found to hold lot of promise especially in the marginal lands and risk-prone environments.

Women also need to be provided knowledge and skills in multi-storied cropping which can create favourable micro climate for crops and can tap solar energy efficiently. Eg: betel leaf+moringa, coconut+pepper+banana+pine apple. Integrated farming systems with inclusion of diversified farming components: Crop (food grains/plantation/ horticultural crops/cash crops/fodder), Livestock (Dairy/sheep/goat/piggery/poultry), Allied (sericulture/apiculture/mushroom cultivation) can be suitably packaged and taught to rural women. The scarce resources can be optimally utilised without over exploitation of any one resource and it also helps in risk aversion. Pest scout concept for use of IPM technology, for differentiating and diagnosing pest/disease/nutrient deficiency symptoms, and taking up preventive and curative measures including predators, parasites, microbes or botanicals (Neem and Karanj), biofertilizers like microbial manures (Azatobactor, Azospirillum, Rhizobium, Azolla), green manures (Sesbania, Crotalaria, green gram, Pongamia), organic manure (FYM, vermicompost) are eco-friendly and sustainable technologies which offer immense scope for employment of women.

Cultural practices such as contour cultivation to prevent soil erosion, summer ploughing, stale seed bed preparation, clean cultivation for weed control, micro watershed development for rain water harvesting, cyclic flooding and drying in rice for water conservation, seed selection and treatments by using germination tests, salt water and hot water, nutrients application on seed, use of pesticides/botanicals for prevention of seed borne diseases and enhancement of early vigour have to be taught to women. Hybrid technology, a seed producing activity, involves skilful, finite operations which women have been found to have a natural knack for. The industry recognises this and 70% employees in hybrid seed production are women. However, the wage pattern should be based on skill rather sex which is at present very disproportionate and to the disadvantage of women.

Tissue culture technology offers new scope for conservation and rapid multiplication of cells. This is a highly skillful activity that can be taught to women and thus form an avenue of employment. Women's role as preservers of forest wealth can be further accentuated by technical knowledge on nursery maintenance - nursery grafts of horticulture and perennial crops-,agro-forestry, silvi-pastures etc. which can also generate additional income. These practices can be integrated in the farming system itself so that it can also meet the household biomass needs too. Ethno-botanical techniques are part of habits of tribal groups. Information search on ethics and ethos of these women and on modes adopted to choose plants for conservation is needed, to develop a national database.

Protecting bio-diversity and genetic conservation and women's role in this process has to be strengthened and policies made to modulate these operations. Livestock participatory extension services with an objective to empower women with scientific livestock production technologies like "clean" milking concept, new fodder grasses (amenable for multi-cuts and identified for marginal lands) are ways for sustaining production systems. Recycling of wastes and their use as animal or poultry feeds will help the animal husbandry component. Composite fish-culture can also be taken up as part of the integrated farming systems wherever feasible. But all these sustainable avenues cannot be harnessed till policy makers, decision managers and women involve themselves in decision making process. Technological empowerment must be reinforced by social empowerment. This calls for gender sensitising field extension personnel at all levels and equipping them with new technological advances, knowledge of ecologically sound farming practices and management skills. Para-agricos, on the lines of para-vets, from rural areas, especially women school dropouts, can be trained in scientifically developed, sustainable technologies, provided with tool kits and inducted at grassroots level as barefoot extension specialists.

Professional-Rural Women Linkages

The number of women professionals in the field of agriculture, veterinary science and allied areas are increasing. This human resource can be effectively utilised to cater to the needs of the rural women. To be effective professionals they have to be involved in the process of decision making and thus aim for key positions of planning and policy making in with the formal organisations. They can help genderize research and development in their disciplines. The Professional-Rural Women linkages can be strengthened through formulation of gender sensitive, location specific, inter-disciplinary research with compulsory involvement of rural women in planning, technology re-assessment and evaluation process through PRA and PTD methods. More number of women have to be inducted into the formal extension system and provided with facilities like secure accommodation and transport, incentives for off campus activities and due recognition.

The professionals and para-agricos have to be given periodic refresher training courses in sustainable technologies to be able to effectively train their rural counterparts. The development and training programmes in IVLP, LLP and KVK should involve more number of women beneficiaries and professional women can play a decisive role in this. Professional women should also handle extension

projects targeting rural women. Professional women should document successful and revalidated indigenous technologies developed by rural men and women and help them gain due recognition.

Farm Women's Day should be organised by research institutes with active involvement of all development departments, NGOs and women entrepreneurs for better awareness, exposure and creation of interest in farm women about new technologies. Vocational counselling and guidance service should be provided to rural women by professional women in research and development sectors. Data banks may be set up to disseminate information on technologies available for production, processing, bi-product utilisation etc. along with information on training facilities. Networking of women professionals among themselves and with NGO's and other grass root level social organisations working with rural women should be set into motion and strengthened. Sustenance of our resources and systems of agriculture are intrinsically linked with women and their roles. If we have to preserve our mother earth, the mother of the family also has to be able to carry on her jest for sustenance in a more scientific way.

Some Intervention Points for Gender Sensitivity in Agricultural Sector

1. Development of improved farm and home technologies integrating the livelihood opportunities of women in research: Varieties, cropping sequences, farm management, post-harvest operations, low cost improved implements and tools suited to the needs of farm women standardised interms of energy, cost and time efficiency and comfort in use based on ergonomics of women, incorporating the indigenous knowledge available, (seed treatment drums, seeders, transplanters, inter-cultivators/weeders, pedal operated threshers, miniatured grain mills, dal mills, cleaners, graders, maize shellers, ground decorticators), non-pesticidal pest management, smokeless chullah, Solar driers and other non-conventional energy devices etc.

2. Providing counselling and vocational training for knowledge and skill development in areas where women participation is high such as Dairy, sericulture, bee keeping, mushroom cultivation, poultry, rabbit rearing, livestock management, bio-diversity maintenance, waste land development, pond management (common properties management), nursery management, integrating farming systems, rural crafts, entrepreneurial development and frontier areas such as bio-technology, hybrid seed production, Computer aided water management, renewable energy technologies etc. Women groups can be organized for production purposes involving various enterprises and providing specialised short-term and long term training for entrepreneurial development in areas like raw material procurement, processing, storage, quality control and marketing of finished products etc. Farm women can also be trained in safe handling and safety precautions for equipment and pesticides as well as educating on occupational health hazards and first aid training, including research and support components in training, providing package of technology, services and public policy which function in a mutually reinforcing manner. Therefore, appropriate technology kits to be designed and distributed.

3. Screening the existing technologies and developing inventory by documenting women specific technologies which are relatively simplified, economical in terms of time and resources, efficient and capable of drudgery reduction and increasing women employment which will also serve the purpose of setting research priorities suitable for women.

4. On-the-spot guidance and service for the women co-operatives (dairying etc.). Recognising and supporting successful NGOs through technical services. Information shops to be set up in areas where women programmes are implemented for continuous upgrading of knowledge and information.

5. Advocating in the policy making bodies for:

   a. Tree pattas for farm women with a right to use tree products

   b. Legislation that offers social security, health insurance and accident cover maternity benefits, crèche & primary health facilities, subsidies extension to farm women at normal times and at times of natural calamities.

   c. Comprehensive legislation covering wastelands, degraded forests in and around villages to be distributed to landless labour families in the name of women only.

   d. Constituting separate cells in R&D institutes, SAUs for promoting work on women in agriculture and for gender equity evaluation, monitoring and evaluation.

   e. NCW and its multi-disciplinary task force of professional women to advise Government on documentation preparation for a sub-chapter on 'Women in Agriculture' spelling the Govt.'s proposals related to public policies regarding production and post- harvest technologies, training and re-training, techno-infrastructure including support services, trade, land ownership, wages and credit.

   f. Subjecting all research proposals to gender audit before approval.

   g. Policy interventions to build in access for resources and enterprises, such as milch animals, sheep and poultry; short-term operational ownership for women due to leasing land; and joint ownership for existing land resources.

6. Launching of mass literacy Campaign with the help of State and District level legal aid boards for farm women regarding their rights and awareness creation in the aspects of environmental degradation and consequences. Getting trained or have awareness on existing constitutional provisions for women in providing equality, opportunity and protection to women in agriculture in order to develop realistic plans for farm women development.

7. Energising extension system through sensitising extension personnel in gender related issues, and through development of technical women cadre in extension on priority basis to serve technological needs of women farmers. Multi-disciplinary team approach for all extension activities with one women member in the team to study impact of technologies on women and on sustainability of natural resources is essential. Further, working along with agricultural labour inspectors for enforcing labour wages for farm women and counselling the farm women labour to get due wages and for awareness creation, working through *mahila mandals* and panchayats for organised extension work. Using progressive farm women as potential resource persons to facilitate extension work, and to interact with research and extension functionaries and following peripatetic training following the family approach at the time, duration and location is preferred by the farm women.

8. Documentation of the indigenous knowledge of farm women both at home and farm and validating, refining and blending with modern technologies for impact. Documenting the occupational health hazards, occurrence of accidents for women in various agro-climatic zones and the reasons for the same. Maintaining feedback from farmwomen on working of various tools /implements /equipment is thus essential.

9. Developing databases for the above publications, professional women available in agriculture field with their specialized areas of work for networking and awareness creation among the organisations dealing with agriculture and women. Creation of databases or Agricultural Census with separate section for women to include qualification in terms of different categories of

women in agriculture, different categories of agricultural operations to facilitate desired policy shift by the Government.

Database on activities and multiple roles of farm women in farming systems and farm women needs and software at R&D institutes to include latest technologies, indigenous technologies and success stories /experiences etc.

10. Promoting environmentally friendly concepts on sustainable agriculture such as natural/ organic farming which are traditionally practiced by farm women.

11. Promoting publications on gender issues for sensitising at national and international levels and for interactions, and publications for communicating the women specific technologies in local languages.

12. Organising *Mahila gosthis*, farm women days, melas, exhibitions for sharing information and getting direct feedback and communicating modern technologies and concepts through various traditional media specific to a region which are appealing to farm women by working with the traditional artists for the treatment of the knowledge base.

13. Following participatory approach in appraisal, technology development and transfer. Emphasising on action research and demonstration oriented technology transfer programmes.

14. In Agricultural Education, by formulating a gender-sensitive curriculum with special emphasis on sustainable agriculture through compulsory 'Rural Work Experience Programme' for the agricultural graduates to identify gender-specific technologies, present level of adoption, their impact to provide feedback to the R&D system.

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Optimizing Water Productivity through IFS Model in Water Logged Areas

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Introduction

Water is crucial for agriculture-aquaculture and thereby for economic development of the country. Multiple uses of water provide challenging opportunities for increasing water productivity at various scales ranging from farm to basin scales, both under irrigation and rain fed conditions. Seasonal water logging due to improper management of canal water and accumulation of runoff is another issue, which is hampering the productivity of land in canal commands. Utilization of such stagnated water for suitable products that enhances its productivity is another issue that needs special attention. Effective utilization and management of drainage congestion of small water bodies in post rainy season, better production techniques at outer periphery of the system (crop + fish + agro - forestry + livelihood support activities) suiting to hydro morphic condition with multiple use of water may be alternative options. All these require location specific recommendation developed with participation of various stakeholders / institutions for large-scale uptake. Aquaculture would form a substantial part of adoptable technologies on farmer's field in multiple water use management scenarios. This will lead to multiple use of abundant water by integrating crops, livestock, fisheries & horticulture for enhancing water productivity to improve food security, health and environment and ultimately the improved livelihood of the resource poor farmer whose well being depend upon this fragile but potentially productive eco-system.

Canals and ground water are the two major sources of water for irrigation, besides small area being irrigated with tank-stored water. Huge investment is required for creating infrastructure for surface water sources, while operating cost is relatively less. For ground water irrigation, both the initial and operating costs are higher and has to be borne by individual farmers, though with little subsidy in purchasing and operation of electrical pumps. Further, over-exploitation and widespread pollution of these water resources in making them vulnerable to uncertainties that may affect production in a bigger way. Therefore it is imperative to develop strategies, which are sustainable and more productive. In general, two pathways for increasing the productivity of water are being in practice and are as under.

- Deplete more available water supply for beneficial purposes by reducing non-beneficial depletion and converting it to beneficial depletion (i.e. by reducing the waste or through real water savings).
- Produce more output per unit of water depleted.

Multiple water use for Enhancing Water Productivity

In order to derive maximum benefit from the depleted or diverted water and maximize output to increase water productivity, the productive or beneficial interventions of multiple nature both non-consumptive and less water consumptive such as fisheries, aquatic crops, livestock etc. may be integrated into the existing irrigation and water use systems/ water infrastructures. Such multiple use of water is aimed at:

- Enhancing water productivity
- Increasing farm productivity without any additional diversion of water
- Enabling diversification to high value outputs
- Reducing risk, better use of resources and increased resource use efficiency

- Ensuring increased income and better flow of income throughout the year
- Enabling better utilization of otherwise wasted/ depleted water resources, water congested/ waterlogged areas.

It is increasingly recognized that promoting multiple water use entails significant, but largely untapped opportunities to enhance water productivity. However, conventional irrigation systems, water harvesting schemes and water supply systems tend to ignore or lack multiple uses of water and have rarely considered this aspect in planning and design. Multiple water use systems distribute water from several sources such as canals, streams, rivulets and springs in hills, pumped ground water, water harvested from watersheds or roofs, and may also include unused or underutilized water bodies and water congested areas and use of poor quality waters in peri-urban areas. Even though their qualities may be different, there is sufficient similarity to treat them in the first instance, as contributing to the same 'pool'.

In India and elsewhere in developing or under developed countries, a lot of interest has been generated and work on multiple water use has been undertaken at experimental farms, watersheds and farmers field. Evidences of multiple uses could be found in irrigated, rain fed, water logged, coastal and hilly areas/ watersheds. Some opportunities of multiple uses of water under canal and tube well based irrigation systems, harvested rainwater, water logged areas and coastal areas have been discussed in the following section:

Multiple Uses of water Under Irrigation System/Canal Seepage

Mostly farmers own 5.0 hp pumps to irrigate their field with a discharge of less than 5 1/s. Applying this discharge with any of the gravity irrigation method (border, check or furrow) results in more loss of water in conveyance and reduced irrigation application efficiency. For better performance, a discharge of 15-25 1/s is necessary depending upon the irrigation method and soil condition. Integration of secondary reservoir or small tank in the tube well based irrigation system has been demonstrated at ICAR- RCER, Patna as an effective mechanism to better regulate water and also enhance water productivity by raising fish in the reservoir and vegetables on the bunds to generate additional income and improve livelihood. If a secondary reservoir is incorporated in the system such that the irrigation water is routed through it and stored up to a desired capacity and then released in desired stream size, it improves the overall efficiency of the irrigation system. Such reservoir also provides an opportunity for multiple uses of the available irrigation water before it is finally delivered into the field. Fish production in such a reservoir is quite a remunerative proposition without incurring any extra cost on water (except seepage and evaporation losses). Figure-1 illustrates conceptual model of secondary reservoir to enhance the productivity of each use (irrigation & fish production) by optimal management.

The fishpond-cum-secondary reservoir provides the condition for semi-flowing type of environment for fish production in which water exchange takes place each time when irrigation water is routed. This improves the quality of reservoir water (pH, turbidity, oxygen etc.), reduces the thermo-chemo stratification and their harmful effects and replenishes dissolved oxygen (DO). However, it removes the nutrients and reduces plankton density from the water body, which needs to be compensated with little additional expenditure on fertilisers. However, the removed material benefits the crops being irrigated using routed water and reduces the fertiliser needs. Such a condition makes the secondary reservoir congenial for intensive fish production.

water contains small amount of dissolved oxygen, while canal water needs to used with precautions and screening mechanism to avoid incidences of entering wild fishes in the system which may harm fish culture. In a four-year study, a fish yield of 11.0 t/ha/yr was obtained when weekly water exchange was followed for full season while less fishes were harvested (7.9 t/ha/yr) when water exchanges were disrupted during summer of 2001-02 (Bhatnagar et al., 2004). This yield was high as compared to normal fish yield of 2.0 t/ha obtained in ordinary fish pond. Net income from fish in dugout pond with horticulture on dykes was Rs.132590 per hectare per year. Fruit crops contributed 56 percent to the net income followed by fish (27%) and vegetables (17 %). Nevertheless, net income gained from fish alone in dugout secondary reservoir was Rs.93550 per hectare per year. Use of canal networks for cage fish culture was investigated by WTC, TNAU, Coimbatore (Srivastava and Satpathy 2004) which indicated a net return of Rs 10000/- from rearing of fish fry to fingerlings in a canal of 1 KM length (100 cages).

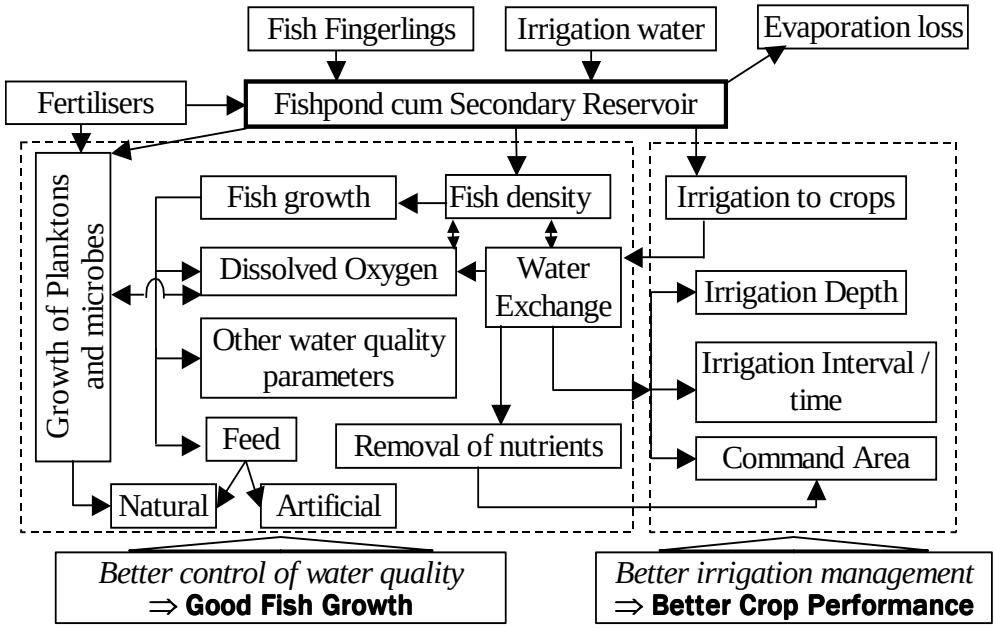

Fig. 1. Conceptual model of fish pond-cum-secondary reservoir

At farmer's field in Naubatpur block in Patna, a secondary reservoir with provision for water exchange and aeration system was evaluated in a participatory mode and found that water exchanges improved the fish growth and farmer harvested more than 3.0 t/ha of fish. The berseem irrigated with routed water produced 20-30% higher yield with better quality as compared to irrigation with directly fed water from pump.

Multiple Uses of Harvested Rainwater

Rainwater harvesting systems, be it surface runoff harvesting structures or sub- surface water harvesting systems, form important and major component of watershed management programs. These are also commonly used in rain fed/dry land areas to harvest and store rainwater to tide over moisture stress and /or provide supplemental irrigation. Water harvesting structures hold promise for multiple uses of water with bare minimum extra resources as evident from limited case studies of watershed projects by integrating fish into ponds. Water User's Society (WUS) of Relmajara watershed in the district Nawan Sahar of Punjab has been earning revenue by leasing out the Relmajara dam's reservoir (13.7 ha- m of designed storage) for fish culture. Normally, multiple stocking and harvesting are

practiced in water harvesting structures to enhance overall fish production. Enhanced land and water productivity through multiple use of water has also been demonstrated in the mid Himalayas, Tehri Garhwal, Uttaranchal at Sainji watershed by integrating crops with fish, poultry and piggery in conjunction with water mills by harvesting of natural springs/ streams in a pond by CSWCRTI, Dehradun.

Utilization of Waterlogged areas through Multiple Water Use

Eastern region has a substantial area where water remains stagnated for a long period. In Bihar, about 2, 00, 00 ha is under Chaurs and nearly 7300 ha under Mauns (Singh and Ahmad, 2003). In addition, large portion of the canal commands or lowlands get seasonally waterlogged during monsoon period. Such areas remain poorly utilized with some paddy production with very low yields (1-2 t/ha) and harvesting of some wild fishes (100-200 kg/ha). In order to utilize such water and land resources, efforts have been made at ICAR-RCER, Patna by exploring possibilities and viabilities of different interventions as described here under as IFS Models:

1. Rice-Fish Farming

Rice-fish farming is globally important Ingenious Agricultural Heritage System, which has a sustainable form of agriculture, providing invaluable protein especially for subsistence of the farmers managing rain fed or waterlogged systems. In India, growing fish in the rice fields as a source of additional income is traditionally being practiced in Northeastern region, Orissa and other coastal areas.

Rice-fish farming trials conducted at ICAR-RCER has found to be useful in productive utilization of seasonally waterlogged lands in canal commands. After rearing fish for 120 days in rice fields having 10% refuge area, the partial harvesting resulted in an average yield of 1.16 tones/ha in 2005-06, which was slightly less as compared to the yield of 1.42 tones/ha during 2004-05. One of the reasons for low yield was attributed to fish mortality. H.molitrix and C.catla in general performed better growth rate. It was observed that low depth (around 0.25 -0.40 m) of water in the refuge could have triggered the fish disease in the month of November/December. Paddy yield found to increase due to stocking of fish by 7 to 13%. Stocking of yearlings gave better fish yield as compared to fish fry stocking. Maximum fish yield was obtained from the trial having 30000 yearlings/ha. Stocking of fish in the rice fish enhanced the overall income by 23-32% as compared to sole rice crop grown in the waterlogged conditions. Thus, under low intensive fish culture (no fertilization and no feed) in rice fields, a fish yield of 1.5-2.0 t/ha was obtained as an additional income which accounted for around 20% enhanced rice equivalent production after considering area occupied in refuge and annualized cost of refuge construction.

In a participatory attempt in Sone canal system, a refuge of about 20% of total area was excavated in the seasonal waterlogged area having water depth of 50-60 cm, and the excavated soil spread on rice field to raise its height by 35-40 cm. It created congenial conditions for intensive rice-fish farming with ponding depth varying between 15-25 cm for most part of the monsoon season. Nylon net fixed on bamboo stakes was provided around the field to isolate it from other areas in the widespread waterlogged area and to prevent escape of fishes. Rice yield of around 5.6-t/ha and fish yield of about 3.5 t/ha in the refuge was obtained. The same area in earlier years had wild fish yield of 100-150 kg/ha. The net income from the system was more than 20,000/ha.

2. Fish Trench-cum-Raised bed

Lands having water stagnation of more than 0.5 m are not much beneficial for rice-fish culture. Fish trenches in such areas can be excavated such that excavated soil is filled in alternate strips and trenches. In Mekong Delta in southern Vietnam, farmers employ trenches within their fruit orchards, usually surrounded by a lateral trench and a connection to the adjacent rice field. Fish and freshwater prawns are cultured between the sub-systems and benefit from decomposing rice straw, the fallen fruit and insects droppings into the water. Excavation of the trenches results to raise bed for plantation of fruit trees.

Two types of fish trench – cum – raised beds are under investigation at Patna. First simulates the river flow conditions, in which trenches are made in meandering style, and water may be allowed to enter from one side with enough provision for protecting culture fishes. The second simulates pond type conditions in which continuous trenches are excavated with island type of raised bed, which may provide enough security to any high value production on the beds, and fishes have access to continuous movement around the island. Banana with vegetables has been grown on the raised beds and composite fish culture in fish trenches. A water source is necessary with this intervention to cater the needs of irrigation to plants on beds and maintain water level during dry periods or off-canal period if fed by canal seepage. A cost of Rs 2000-2500 is estimated for diesel to lift ground water during off periods for an area of 1000 m^2 with fish trenches on 45% area. The fish harvested in May 2005, gave fish yields of 72.7 kg (1.66 t/ha) and 80.9 kg (1.74 t/ha), respectively for meandering type and pond type trenches. Similarly, in 2005-06, the fish yield in from meandering type and pond type trenches were 1.97 t/ha and 1.92 t/ha respectively. Plantation on the raised bed and bund yielded about 980 kg of vegetables from the 444 m^2 areas in seven months. Results indicate a net profit of Rs 80,000 per ha can be obtained which depends largely on type of crops and management practices adopted.

Conclusions

Multiple uses of water are found to be beneficial to enhance overall productivity of water resources. It provides variety of food materials e.g. fish, fruits, vegetables, eggs, etc. apart from cereals and other crops. It also helps in ensuring the nutritional security to the rural population as they are deprived of such things under prevailing rice-wheat cropping system. As the products are complementary in nature, one product benefits other and this synergy is used in the concept of multiple uses which has the potential of improving the livelihood of poor farmers who own small patch of lands. Experiments indicated a net benefit of Rs 28,000-1, 32,000 from the waterlogged lands, which was otherwise poorly utilized with some wild fish harvesting. Increase in net income was highest (374.13 percent) in Fish in dugout pond with horticulture on dykes. It was 6.18 percent in Rice-wheat system with fish refuse in the center, 189.47 percent in fish in sunken trenches with horticulture on raised beds, and 234.53 percent in fish in dugout secondary reservoir. However, still there are some constraints that need to be removed through intensive research efforts and social mobilization, e.g. social impediments (religious feelings), poaching and theft, local conflicts and water rights, pereniality of water, capital investment and resources in developing the system, provision of aeration & mixing specially for resource poor and socially disadvantageous users.

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Women Empowerment through crop based farming system

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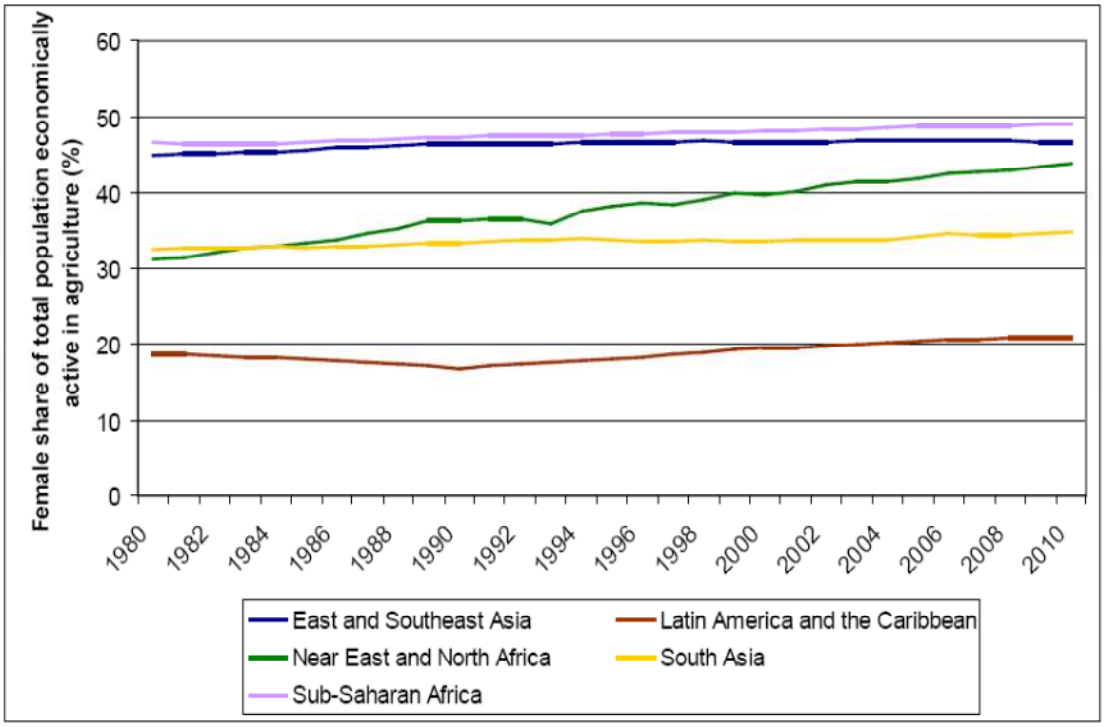
Women play a crucial role in achieving food and nutritional security through agricultural production. Worldwide, women play a major role in agriculture (including fisheries, forestry and livestock) and rural development. However the nature and extent of their involvement is different in various agro-production systems. The mode of female participation in agricultural production varies with the landowning status of farm households. Their roles range from managers to landless labourers. In over all farm production, women's average contribution is estimated at 55 per cent to 66 per cent of the total labour with percentages, much higher in certain regions. In the Indian Himalayas a pair of bullocks works 1064 hours, a man 1212 hours and a woman 3485 hours in a year on a once hectare farm, a figure that illustrates women's significant contribution to agricultural production. (FAO, 1991). Although an old data this points to the nature of work women carried out in the past.

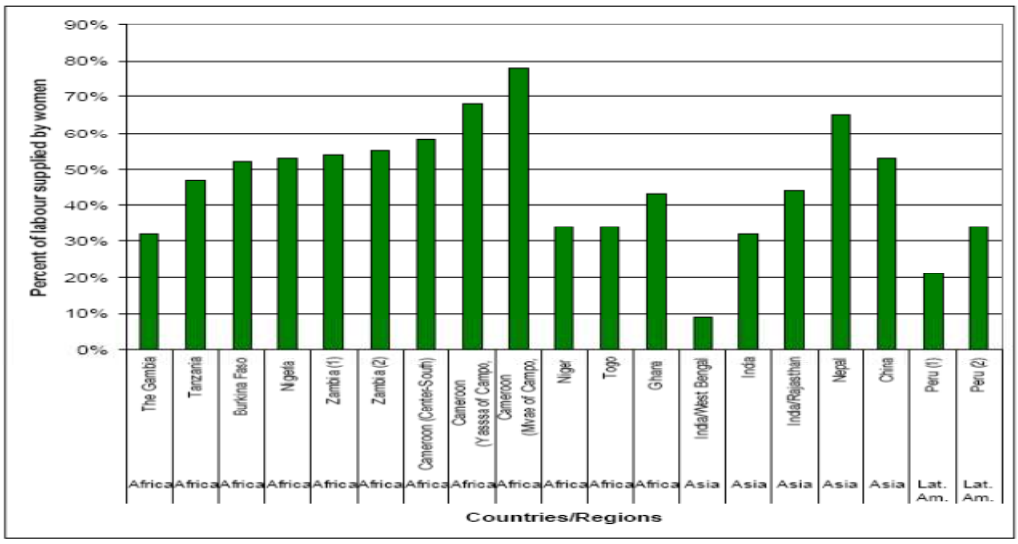
Share of Female in agricultural labour force



Source. FAOSTAT.

Note: The female share of the agricultural labour force is calculated as the total number of women economically active in agriculture divided by the total population economically active in agriculture. Regional averages are weighted by population.

Proportion of labor in all agricultural activities that is supplied by women



Source: FAOSTAT

Sources and notes: Only the survey for India is nationally representative

The globally average is dominated by Asia and within Asia sub-regional averages ranged from above 35 per cent in South Asia to 50 per cent in East and South East Asia. The Asian average is dominated by China. In China the female share of agriculture labour has increased over the past three decades whereas in Malasiya. The globally average is dominated by Asia and within Asia sub-regional averages ranged from above 35 per cent in South Asia to 50 per cent in East and South East Asia. The Asian average is dominated by China. In China the female share of agriculture labour has increased over the past three decades whereas in Malaysia there has been a declining trend. The proportion of women labour for selected crop indicated 70 per cent in upland rice in Indonesia to 45 per cent in Vietnam, 20 per cent in Philippines and 10 per cent in Bangladesh. In Rubber plantation cinnamon and tomatoes women's contribution of labour was high. Most of the food produced with labour contributions of both men and women in a collaborative process.

Participation of women in farm related activities in different states

The role of women in each activity under farming indicated that independent participation of male member was higher than the female members in all the states except Uttarakhand. Among all the states, participation of women in farm related activities was found highest in Uttarakhand (29.41%) and negligible in Punjab, Haryana, Karnataka and Maharashtra. Joint participation with female members was higher in Andhra Pradesh, Himachal Pradesh Maharashtra and Rajasthan in seed selection, nursery raising, transplanting, weeding and harvesting, highest was recorded in Assam whereas joint participation of male members with other male member was higher in land preparation, plant protection, irrigation, engagement of labour and procuring and repayment of loan in Assam, Andhra Pradesh, Maharashtra and Karnataka.

State wise comparison reflected a different picture in Himachal Pradesh; nearly 17.70 per cent rural women were completely responsible for different activities, which is much higher than the national average of 6.67 per cent. The reason behind this is mainly because the male members remain outside their home for a long period of the year serving outside their hometown. Inter zonal variation was visible with regard to role and responsibility profile in all the states.

Table 1 - Gender analysis of crop farming systems

S. no.	Activity	Participation in %	
		Male	Female
1.	Land preparation	100	Nil
2.	Seed preparation for sowing	8	82
3.	Raising nursery and transplanting	25	75
4.	Direct sowing	92	8
5.	Irrigation	83	17
6.	Applying FYM	75	25
7.	Fertilizer application	83	17
8.	Weeding	17	83
9.	Plant protection	83	17
10.	Harvesting	42	58
11.	Threshing	58	42
12.	Bagging/ storing of grain	17	83
13.	Marketing of produce	92	8
14.	Storing dry fodder	66	34
	Over all	60	40

Source: Dhaka *et al*., 1995.

Empowerment of women in crop based farming system

Agriculture is a dynamic sector and rapid changes occur such as those in environment and climate, technologies, development priorities, impact of changes in other sectors and social changes such as family structure, migration and international policies such as globalization and liberation.

Agriculture, the single largest production endeavour in India is increasingly becoming a female activity. About 90 per cent farmwomen are uneducated and method used by them indiscriminately resulting in health hazards and drudgery. Women perspective is a theoretical and methodological approach. Gender mainstreaming is incorporating gender perspective into policies, plan, programmes and projects to ensure that these impact on women and men in an equitable way. For empowering women in crop production/crop based farming system following points are very important;

- Technology
- Access to resources
- Control over resources
- Knowledge of Post-harvest process
- Institutional support
- Policy support including research, extension and development

- Recognizing the gender based differences in roles and responsibilities and contribution of different socio-economic groups
- Appropriate technologies and policies for sustainable use of resources

Crop based farming system consist two components: Crop production and Horticulture. Empowerment of women will be discussed under following two headings.

A. Crop production

In crop production role of women is very high and women carry out different operations including field preparation, transplanting, and weeding, harvesting and post-harvest handling etc. In this section women empowerment is needed in the area of new technologies such as; drudgery reducing tools and equipments and increased productivity for household food and nutrition security and income generation.

1. Women friendly tools and equipments

Drudgery of farm women in various field operations could be reduced by providing improved farm tools and equipment. The improved tools and equipment are primarily developed keeping men workers in consideration while farm women in the country are also involved in most of the operations. Hence, already developed equipment may not be suitable to farm women as such because ergonomical characteristics are different than men workers (Singh et al, 2006 b). The result is that women workers have to carryout the operation with their hands, and there is a lot of drudgery involved in it in addition to occupational health problems. The posture adopted during the operation are also not proper and lead to occupational health problems, if not given due attention. This may also result unemployment of women workers, more over it also appears that improved technology is being kept away from them. The importance of developing farming technologies relevant to farm women has only recently been recognized as an extensive participation of farm women in the field of agriculture, food security, horticulture, processing, nutrition, sericulture, fisheries, and other allied sectors has been gradually realized in coming years. The suitability of equipment to farm women can be judged in better way using ergonomical studies as ergonomics cover all aspects that deal with anthropometry, assessment of workload, working environment and safety features/mechanism to optimise human-machine environment system. This helps in increasing their working efficiency with reduced drudgery by fitting to the capabilities and limit of human operators/workers.



2. Training

Technology development should invariably follow by commercialization, awareness and infrastructural support. In the present scenario of fast growth and development in all spheres of science and technology, it is utmost essential to transfer the technologies to the end users in a most effective way. This is more relevant when the technology involves tools and equipment where training in operation, repair and maintenance is a must particularly to strengthen service support. Due to socio-cultural bindings, rural women workers seldom come forward to operate mechanical equipment in the field. Even in handling simple hand tools, they have reservations. If urban women can operate machines, there is no reason why rural women should not be encouraged to operate agricultural equipment. It only requires infrastructure and facilities for training them at places which are within their reach. This may be accomplished either by training them in their own environment or by bringing them to the training centres located in their close proximity. It will help in skill up gradation of women workers for operating various agricultural tools/ equipment.

3. Extension Services

It is important to ensure greater access for farm women to various inputs (including farm tools and equipment) needed by them to carry out their work more efficiently and with minimal drudgery. Farm women have little access to non-formal education and trainings. It is a fact that the agricultural extension services are mainly composed of male agents and as such they tend to channelize knowledge and training on improved technology to male farmers/workers only. There is also lack of infrastructural facilities for women in relation to technical training, accommodation and transport provisions. It is imperative that Central/State government departments, R&D institutions and NGOs promote improved technology to enhance labour productivity of women workers and to reduce their drudgery. They should also recruit the women extension staff in their extension wing for effective transfer of women specific technologies to farm women. The CIAE is providing necessary training on various tools and equipment to women facilitators from different states. These facilitators can act as resource persons for their own state to propagate the technologies.

4. Future Strategy for Technology Development and Promotion

In the changing scenario, the participation of women workforce in agriculture is going to increase to 50% by 2020 i.e. out of the total estimated agricultural workforce of 240 million, about 120 million will be the women workers. This is expected to happen mainly because male workers will either get involved in other non-farm activities or migrate to towns and cities for other jobs. To meet this situation, it is necessary to take the following steps.

1. Design the tools/equipment keeping in view the anthropometric data of women workers,
2. Organize demonstrations and trainings to rural women on various modern tools/equipment in proper and safe operation. This will help in reducing their drudgery and increasing productivity.
3. Encourage manufacturers/entrepreneurs to fabricate improved tools and equipment
4. Make these tools and equipment available in rural areas for purchase by users
5. Assist farm women, after being duly trained to get loans from banks/ other
6. organizations to procure various tools/equipment

7. Building up of linkages with central/ state depts., NGOs, banks, and other stakeholders to promote these improved tools and equipment.

B. Horticulture

Horticulture play a unique role in country's economy by improving the income of the rural people, ensuring livelihood security, Cultivation of horticultural crops is labour intensive and generates employment opportunities for the rural community.

1. Source of Farm income and employment

Horticultural crops are normally sold at a higher rate compared to cereals. Some times fruits and vegetables are sold even at cheaper rate in peak season, but due to their higher yield and productivity, total monetary return is more**.** Off season horticultural crops provide better return per unit area to the growers as compared to cereal crops. Multiplication of planting materials and seed production of horticultural crops fetch much better return to the growers.

2. Export and industrial values

Horticulture has enormous potential for foreign exchange earning The APEDA has identified many horticultural crops which have good export potential. Government of India has provided many incentive including transport subsidies on export. As horticultural crops are gaining importance owing to their commercial, nutritional and export potential, the role of women is likely to be more substantial. Women mainstreaming through quality planting material production will be a small step towards prosperity of farming community.

3. Protected cultivation of vegetables

In the present scenario of perpetual demand of vegetables and shrinking land holding drastically, protected cultivation is the best alternative and drudgery- less approach for using land and other resources more efficiently. In protective environment (green house glasshouse or poly house), the natural environment is modified to suitable conditions for optimum plant growth which ultimately provides quality vegetables. Nursery for ornamentals, flowers, vegetables, fruits and plantation crops can be successfully developed inside greenhouse. Women can grow the high- priced vegetables such as asparagus, leek, tomato, cucumber and capsicum round the year especially during winter season for sound profit.

4. Production of quality planting materials

Quality planting material is the foundation of enhanced production, profitability and income of horticultural crops. However, sector is experiencing inadequacy of quality planting materials, and the degree of unavailability varies with regions and crops. Women play an active role in the production of

quality planting materials of horticultural and ornamental plants for entrepreneurship and employment generation.

5. Processing and Value addition of various crops, fruits and vegetables

Post harvest management, processing, storage and utilization of vegetables and vegetable products are generally the domain of women at home scale. Cultivation of horticultural crops plays a vital role in prosperity and it's directly linked with health of people. These crops are not only used for domestic consumption but also processed into various products like pickles, preserves, beverages, jam , jelly squash, etc., which offers employment opportunities to the rural women. The focus on the value addition in the horticulture sector is vital for comprehensive development of the rural economy.

6. Interior plant decoration

Interior plant decoration is also getting momentum due to change in the life styles and particularly women can earn a income by doing interior designing through ornamental and flowering plants not only in various functions but also in various offices, hotels, hospitals etc

7. Mushroom cultivation

Now days mushroom is getting much popular in our country, have a good scope for export. About a decade ago, the government promoted the mushroom cultivation for protein mal nutrition, generating employment and supplementing the income of the women and earning foreign exchange. As production of mushrooms requires a small area and waste materials and it can be used from different crop residues, so it is very cheap to produce highly nutritive alternatives of the meat. It does not require a highly skilled supervisory staff and can be managed by rural women easily. So, rural women can be supported by educating and training them in mushroom production technology. The Madhya Pradesh Agro-industries Corporation popularized mushroom cultivation in the tribal areas of Chhattisgarh by supplying spawned compost to the prospective growers. Cultivation of paddy straw mushroom is popular in Bhubaneswar. Entrepreneurs and growers from Tamil Nadu, Karnataka, Kerala, Andhra Pradesh and Maharashtra have recently taken up large scale mushroom cultivation. Various women shelf help groups in north east region are growing paddy straw mushroom in backyard.

8. Nutritional, health and livelihood security

Several horticultural crops, especially tuber crops are used as staple food in the world. Fruits and vegetables are also rich source of vitamins, minerals, proteins and carbohydrates, etc., which are essential in human nutrition as protective foods, and have importance for nutritional security of the people. Fruits and vegetables provide substantial amount of nutrients important for human health they are particularly the important source of micronutrients, pro vitamin–A vitamin-B6, vitamin C and vitamin E as well as folic acid, iron and magnesium. With the development of new improved varieties of horticultural crops, the demand for seed and genuine planting material has increased manifold across the country. This offers unique scope for development of high- tech nursery which further generates employment opportunities for rural women.

The horticultural activities such food processing, preservation, packaging, marketing and retail sales of fruits, vegetables, flowers, spices medicinal plant produce, etc offers enough opportunities in development of agri- business for strengthening and financial empowerment of rural mass. Besides fresh consumption, horticultural crops provide raw material for many ancillary industries. Processed horticultural products have also good export potential in our country. Vegetables and fruit processing and preservation play a great role to provide employment and industrial base for export of dehydrated and preserved products. Mostly dehydrated vegetable are being exported. The other products that are being exported or consumed with in our country are juice, ketchup, pickles and canned vegetables and

fruits. Tapioca is used for manufacture of industrial products like sago, stars noodles and quick food products.

C. Women friendly farm enterprises

1.	Processed products of rice/wheat/millets	8.	Off-season vegetable cultivation
2.	Vermin composting	9.	Backyard Poultry rearing
3.	Marigold cultivation	10.	Papaya cultivation
4.	Mushroom cultivation	11.	Raising vegetable seedlings and fruit plants
5.	Preservation of local fruits and vegetables	12.	Value added agro-products
6.	Coir/jute work	13.	Leaf plate making
7.	Spices powder making	14.	Rice processing

Conclusions

Many farm tools and equipments are of low cost and women friendly. These improved implements will reduce the drudgery of farm women in different farm operations. Small and medium farmers can make use of these technologies for production and preservation of various crops and horticultural produce. It will enhance the productivity of farm women and also helpful in increasing cereals/millet/fruits and vegetables availability as a measure of food security and additional income/employment generation for the farm women. The success of the rural development schemes depends upon proper formulation of the communication policy. Side by side, there should be sensitizing programmes to change the attitude of farm women as a favourable attitude towards improved agricultural technologies suited to various farming systems by reduced drudgery. There should also be capacity building programmes to empower farm women through group approach for improving their skill, efficiency and family economy.

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Integrated Farming System models for food and nutritional security

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Many new agricultural technologies, even when considered as technically sound, are of limited value if they are not adopted by the farming community. New agricultural technologies developed and transferred by the conventional research and extension efforts have not been adopted uniformly by the farmers operating under widely varying agro- climatic and socioeconomic environments. When adequate attention is not paid to the basic understanding of the agro-climatic and socioeconomic milieu in which the farmers operate, the technologies evolved at research stations and subsequently transferred are found to be found inappropriate to the needs and circumstances of the practicing farmers. The potential beneficiaries, particularly those small farmers with limited resources and operating in less favorable natural environment, often do not adopt new technologies due to various reasons (Raman and Balaguru, 1992). Some of the major reasons for poor adoption of new technologies are:

i) Lack of awareness about the new technology
ii) Ineffective extension services (publishing, media, illiteracy, ignorance)
iii) Unsuitability of the technology due to local conditions
iv) Lack of resources to invest on the required inputs
v) Non- availability of inputs in time
vi) Negligible farmers participation while designing the technologies
vii) High cost and skill oriented technologies.

Farmers generally seek those technologies which increase their income while keeping risks within reasonable bounds under their own circumstances and management practices. In order to develop and transfer more appropriate technologies to meet the specific client demand, emphasis on farmer participatory, systemic research and extension efforts are now gaining momentum in India and neighboring countries. Many programmes have been initiated in recent years, with an orientation and focus on farming systems. Attempts have been initiated in recent years, with an orientation and focus on farming systems. Attempts have been made in these programmes to integrate the desirable features of farming system research (FSR) strategy into the mainstream agricultural research so that the technologies developed are relevant, client- oriented and location–specific. However, the actual experience of implementing the FSR strategy in the Indian context has been very limited.

The term Farming system, in its broadest sense, is any research that views the farm in holistic manner and considers interactions (between the components and of components with the environment) in the system (CGIAR, 1978). This type of research is most appropriately carried out by interdisciplinary teams of scientists who in association with extensionists, continually interact with the farmers in the identification of problems and in devising ways to solve them. It aims at generating and transferring technologies to increase the resource productivity for an identified group of farmers. Farming System research is an approach to agricultural research and development that view the whole farm as a system and focus on 1) the interdependencies between the components under the control of members of the household and 2) how these components interact with each other in respect of physical, biological and socioeconomic factors not under the household's control (Shaner *et al*, 1982).

Indian economy is predominantly rural and agriculture oriented where the marginal and small farmers constitute 76.2 % of farming community. Due to failure of monsoon, the farmers are forced to judicious mix up of agricultural enterprises like dairy, poultry, pigeon, fishery, sericulture, apiculture etc., suited to their agro-climatic and socio- economic condition. The farming system, as an concept, takes into account the components of soil, water, crops, livestock, labour, capital, energy and other resources, with the farm family at the center managing agricultural and related activities. The farm family functions within the limitations of its capacity and resources, the socio-cultural setting, and interaction of these components with physical, biological and economic factors.

Core characteristics of Integrated Farming System

The core activities of FSR can be conceptualized in different ways, the approach is open to multiple interpretations. Many authors define characteristics of Farming system in a different way but despite of the variations in their knowledge and perception about the FSR, the approach has certain core characteristics which are:

1. **It is problem solving*:*** As an applied problem solving approach, it emphasizes on developing and transferring appropriate technologies to overcome the production constraints through the diagnosis of biophysical, socioeconomic and institutional constraints that influence the technological solutions.

2. **It is holistic*:*** The whole farm is viewed as a system encompassing interacting subsystems; and no potential enterprise is considered in isolation.

3. **It acknowledges the location specificity** of **technological solutions*:*** Recognizing the location-specific nature of agricultural production problems, it emphasizes on testing and adaptation of technological solutions based on agro-ecological and socioeconomic specificities.

4. **It defines specific client groups***:* Emphasis is made on the identification of specific and relatively homogeneous groups of farmers, with similar problems and circumstances for whom the technology is to be developed, as the specific client group. On tile basis of common environmental parameters, production patterns and management practices, relatively homogeneous recommendation domains need to be identified.

5. **It is farmer participatory*:*** It revolves round the principle that successful agricultural research and development efforts should start and end with the farmers (Rhoades and Booth, 1982). Farmer participation is ensured at different stages of technology generation and transfer processes such as problem diagnosis, design and implementation of on- farm trials, and providing feedback through monitoring and evaluation.

6. **It gives weightage to ITK system*:*** The Indigenous Technical Knowledge (ITK). which is time-tested at the farmer's 'level for sustainability through a dynamic process of integrating new innovations into the system as they arise, has to be properly understood by the scientists and utilized in their research activities.

7. **It is concerned with 'bottom-up' research strategy*:*** It begins with an understanding of the existing farming systems and the identification of key production constraints.

8. **It is interdisciplinary*:*** It lays greater emphasis on interdisciplinary co-operation among the scientists from different areas of specialization to solve the agricultural problems that are of concern to farmer.

9. **It emphasizes extensive on farm activities*:*** It involves problem analysis through diagnostic surveys, on-farm, testing of the developed technologies, and providing feedback through evaluation to influence the research agenda of the research stations. It provides a structural framework for the farmers to express their preferences and apply their evaluation criteria for selecting technologies suiting to their circumstances.

10. **It is gender sensitive***:* while explicitly acknowledging the gender-differentiated roles of farms family in agriculture, emphasizes the critical review of farming systems in terms of activities, analysis, access and control over the resources and benefits, and their implications in developin[g] relevant research agenda.

11. **It is iterative***:* Instead of trying to know everything' about a system at a time, it requires step-by-step analysis of only key functional relationships.

12. **It is dynamic***:* It involves recurrent analysis of the farming systems, permitting continuous learning and adaptations.

13. **It recognizes interdependencies among multiple clients*:*** The generation, dissemination and adoption of relevant technologies to improve the productivity and sustainability of agriculture require productive and interactive linkages among the policy planners, scientists, developmental agencies and farmers. The approach attaches more importance for this critical factor.

14. **It focuses on actual adoption*:*** It is to be judged by the extent to which it influences the production of socially desirable technologies that diffuse quickly amongst specified groups of farmer clients.

15. **It focuses on sustainability**:

It seeks to harness the strengths of the existing farming practices, and to ensure that the productivity gains are environmentally acceptable. Towards preserving the natural resource based and strengthening the agricultural production base, it attempts to develop technologies that are environment friendly and economically viable.

16. **It complements experiment station research**:

It only complements, but does not substitute, the on-station research. It has to draw upon the scientific knowledge and technologies generated at research station. It has to be kept in mind that approach is not being promoted as panacea for all e maladies of local agricultural production systems.

Agricultural performance of eastern states is far below its potential, as is evident from the decline in per capita output over the past decade. The growth of agriculture has also been highly volatile, with annual output swings between minus 20% and plus 30%, which has had significant implications for poverty alleviation and income security of the poor. In spite of rich natural resources, as high as 42.60 percent population lives below poverty line (BPL). Bihar's crop productivity is constrained by the general lack of infrastructure, land holding patterns, and other

environmental factors. State's gross sown irrigated area of around 50% is relatively low as compared to 95% in Punjab, 67% in Uttar Pradesh, and 60% for India as a whole. The average ground water exploitation is 39%, indicating a large unexploited potential. Annual flooding has exacerbated land degradation and created a host of related economic and social problems. About 9.41 lac/*ha* of land is suffering from water logging / water stagnation / drainage congestion including areas under *tal, chaur* and *mauns* (oxbow lake) and canal induced water logged areas in canal commands. These areas offer great potential and challenge for their productive utilization through multiple use and farming system including cereal crops, fisheries, and horticulture like banana, vegetables, makhana and other aquatic crops.

Land holdings in Bihar consist predominately of small & marginal farm holdings with a high degree of fragmentation. About 85 per cent of the farmers are small and marginal but sharing only 50 per cent of the land. The average size of the holding is 0.83 ha, with that of small and marginal farmers range from 0.32 to 0.5 ha. These tiny holdings are fragmented & scattered and land tenure system does not enable private investments for permanent improvement of land and infrastructure. With the average size of land holdings shrinking as a result of increasing fragmentation, many marginal farms are becoming economically non-viable and oriented towards subsistence. This has slowed the diversification into commercial crops from low value-added cereals that continue to dominate cropping.

Keeping above points in view, ICAR Research Complex for Eastern Region, Patna has developed two integrated farming systems modules for small and marginal farmers of Eastern region for lowland and midland irrigated ecosystems. The details of the module are given as:

A) Two acre IFS module (Lowland Situation) :

Components:
Crop + Livestock + Fishery
Allied: Duckery / Vermicomposting / Bee keeping/ FYM

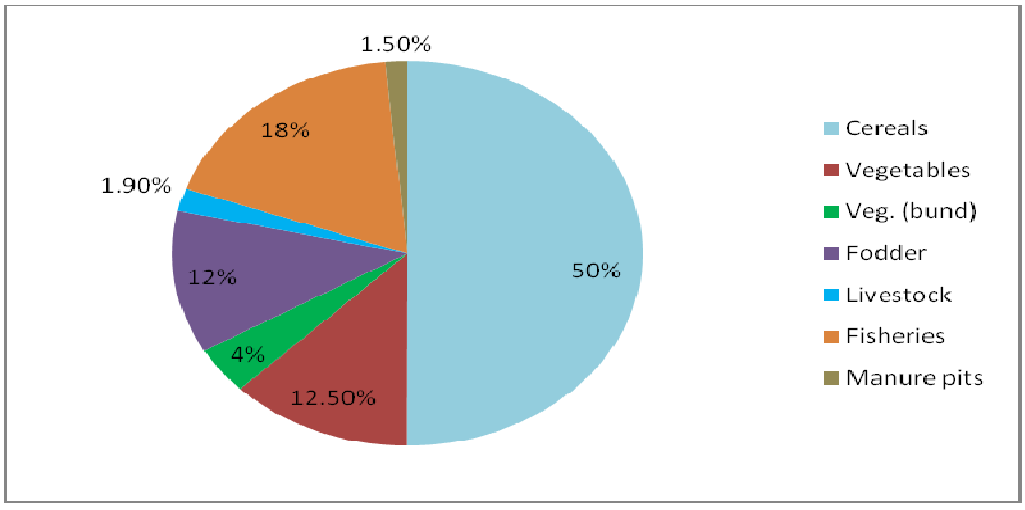


Fig-1. Land allocation to different enterprises 2 Acre IFS module

1) **Cereal crops** (50 % area)
Kharif: Rice
Rabi: Wheat/Maize/ Lentil/Mustard

2) **Horticultural crops** (Fruits + vegetables): 12.5 % area
Vegetables:
Kharif: Cucurbits/Brinjal/Okra
Summer: Brinjal/Boro/ Okra/ Bitter gourd/Cucumber etc.
Fruits
Papaya (On pond's dike and field bunds)
Banana (On pond's dike)
Lemon (On pond's dike and Horticultural block)
Guava (On pond's dike and Horticultural block)

3) All around the field bunds cucurbits or seasonal vegetables having lesser water requirement may be raised by making wire fences.

4) **Fish + Duck** integration (17.8 % area)
i) Mix carp culture: Rohu (20 % as column feeder), Catla (30 % as surface feeder), Mrigal/common carp (50 % as bottom feeder)
ii) Duck: For 1000m2 water area 40 number of ducks are sufficient
Khakhi Campbell breed of duck is right choice for this area (Dual purpose)
A thatched hut of 10 X 15' size is optimum for 40 ducks above the water or on the pond's dike.

5) **Livestock** (1.80 % area)
A size of 3 adult cows + 3 calves is optimum for two acre land in respect of FYM requirement for the fields and fodder requirement for the livestock. A thatched hut of 20' X 30' with sufficient paddock space is sufficient for above no. of animals. The Cow shed should be connected with the pond with a drainage channel so that urine and water can move into the pond. A storage hut for storing of animal feed should be also made near the animal shed.

6. **Fodder production**: (12.5 % area)
For feeding of 3 cows and 3 calves 1000 m2 land is sufficient if year round fodder production is carried out. In addition to green fodder, straw, leaves, stems of different cereals and vegetables can be also used as animal feed.
Kharif: M.P. Chari/Sudan grass/ Napier/Maize
Summer: Boro/Lobia/Maize/Sudan grass
Rabi: Berseem/Oat/Maize etc.

7. **Spices**: In the sheds or where light intensity is less like orchards, spaces between the huts etc. turmeric, ginger or guinea grass can be taken.

8. **FYM / vermi composting pits**: (1.4 % area)
Optimal sizes pits for preparation of FYM and Vermi compost should be made depending upon land available near the cowshed so that required raw materials for making manures should be made available nearby for convenience and to avoid transportation charges (Sanjeev *et al*, 2011). Some of the economic parameters for one acre, two acre, vegetable based IFS model (one acre) and half acre IFS models are presented below:

Table1: Establishment, income and expenditure statement of two acre IFS module

SI. No.	Components	Establishment cost	Gross Income (Rs.)	Net Income (Rs.)
1	Crop (0.4 ha)	-	29618	28748
2	veg. (0.15 ha)	--	27841	24659
3	Orchards/fruits	2,500	15119	14701
4	Fodder (0.01ha)	-	9216	11584
5	Fishery (0.1 ha)	70,000	17119	11961
6	Duckery (on the pond)	18,000		
7	Dairy (3 +3) 0.016 ha	1,00,000	135241	70295
8	Crop waste	-----	1578	31267
9.	V.C.	15,000	5341	8659
	Total	2,05,000	2,40,093	2,02,874

Table2: Economic analysis of different components and system under two acre IFS module

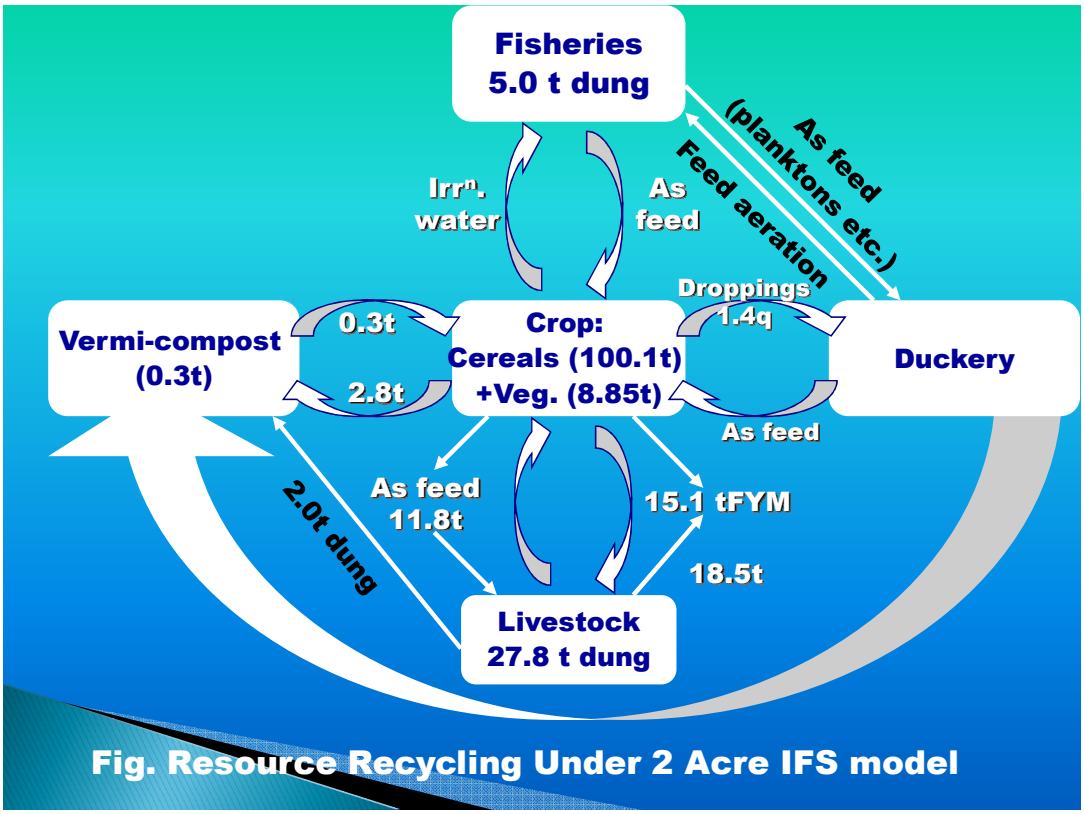
Farming system	Rice-Wheat	Vegetable	Fishery	Duckery	Cattle	Net income (Rs.)
Rice- Wheat system	46122	-	-	-	42290	46122
Rice- Wheat + Dairy	43815	-	-	-	42290	86105
Rice- Wheat +Dairy + Fishery	38050	-	22500	-	42290	102840
Rice-Wheat + Dairy + Fishery + Duckery	38050	-	22500	18000		144165
Rice-Wheat + Dairy + Fishery +Duckery	38050	-	22500	18000	42290	134130
Rice-Wheat + Vegetable + Dairy	32285	53790	-	-	42290	128365
Rice-Wheat + Vegetable + Dairy + Fishery	32285	53790	22500	-	42290	150865

Table3: Employment generation under two acre IFS module

Cropping system	Wheat-Rice	Vegetable	Fishery	Duckery	Animal husbandry	Total (Rs.)
Rice -Wheat system	402	-	-	-	-	402
Rice -Wheat +Dairy	390	-	-	-	160	550
Rice-Wheat+Dairy+ Fishery	378	-	42	-	160	580
Rice-Wheat+Dairy+ Fishery +Duckery	378	-	42	80	160	660
Rice-Wheat+Vegetable+ Dairy	378	148	-	-	160	638
Rice -Wheat	330	148	42	-	160	680

+Vegetable + Dairy+Fishery						
Rice-Wheat+Vegetable +Dairy+Fishery+ Duckery	330	148	42	80	160	760

Fig.2 Nutrient recycling within the system (Two acre IFS model):



Out of above mentioned income, we get about 27.8 t Cow dung and Vermi compost 1.2 t which is equivalent to 482 kg Urea, 400 kg of SSP and 396 kg of MOP. In other words we can curtail the cost of cultivation up to Rs. 8,000- 9,000/year by recycling these organic wastes into the system (Sanjeev *et al*, 2012)

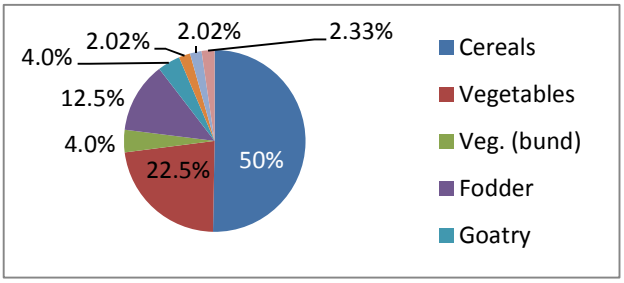
B) One acre IFS module (midland situation) :

Components:

Crop + Goat + Poultry

Allied: Mushroom/Goat manure/ Vermi composting

Fig3. Land allocation to different enterprises under one acre IFS module



1. **Cereal crops** (50 % area)

   Kharif: Rice

   Rabi: Wheat/Maize/ Lentil/Mustard

2. **Horticultural crops** (Fruits + vegetables): 22.5 % area

   Vegetables:

   Kharif: Cucurbits/Brinjal/Okra

   Summer: Brinjal/Boro/ Okra/ Bitter gourd/Cucumber etc.

   Fruits

   Papaya (On field bunds)

   Banana (On field bund)

   Lemon (In Horticultural block)

   Guava (In Horticultural block)

3. All around the field bunds cucurbits or seasonal vegetables having lesser water requirement may be raised by making wire fences (About 4 % of total area)

4. Livestock (Goat): 2.5 % area A size of 20 female got + 1 buck is optimum for one acre land in respect of manure requirement for the fields and fodder requirement for the livestock. A thatched hut of 20' X 30' with sufficient fenced paddock space (to move the goats freely as goats have to kept on stall feeding) yis sufficient for above no. of animals. The goat shed should be airy and sunny A storage hut for storing of animal feed should be also made near the animal shed. Black Bengal breed of goat is suitable for this region.

5) Poultry (100 birds)

100-200 birds (broiler) can be reared in an area of 225 sq. ft. by making a thatched hut. All around wire meshing should be done at the inner walls to protect the birds from predators and hunting animals. The hut should be airy and proper arrangement of bulb or other lightings should be done before rearing the chicks.

6) **Mushroom**
Year round mushroom production can be done in an area of 25 X 20' by making a thatched hut for optimum return. In this shed about 200 mushroom bags can be kept at a time by making bamboo shelves. Selection of the mushroom strains should be done on the basis of climate and humidity in the atmosphere as
March – September: straw/paddy/milky mushroom
October- February: Oyster/ Button mushroom

7) **Fodder production**: (12.5 % area)
For feeding of 20 + 1units of goat an area of 600m^2 is sufficient if year round fodder production is carried out. In addition to green fodder, dry husks, leaves, stems of different cereals and vegetables can be also used as feed.
Kharif: M.P. Chari/Sudan grass
Summer: Boro/Lobia/Maize/Gunea grass
Rabi: Berseem/Oat/Maize etc.

8) **Spices**: In the sheds or where light intensity is less like orchards, spaces between the huts etc. turmeric, ginger or guinea grass can be taken.

9) **Fym/ vermin composting pits**: (1.4 % area)k
Optimal sizes pits for preparation of goat manure and Vermi compost should be made depending upon land available near goat shed so that required raw materials for making manures should be made available nearby field and livestock.

Table-4: Employment generation under one acre IFS module

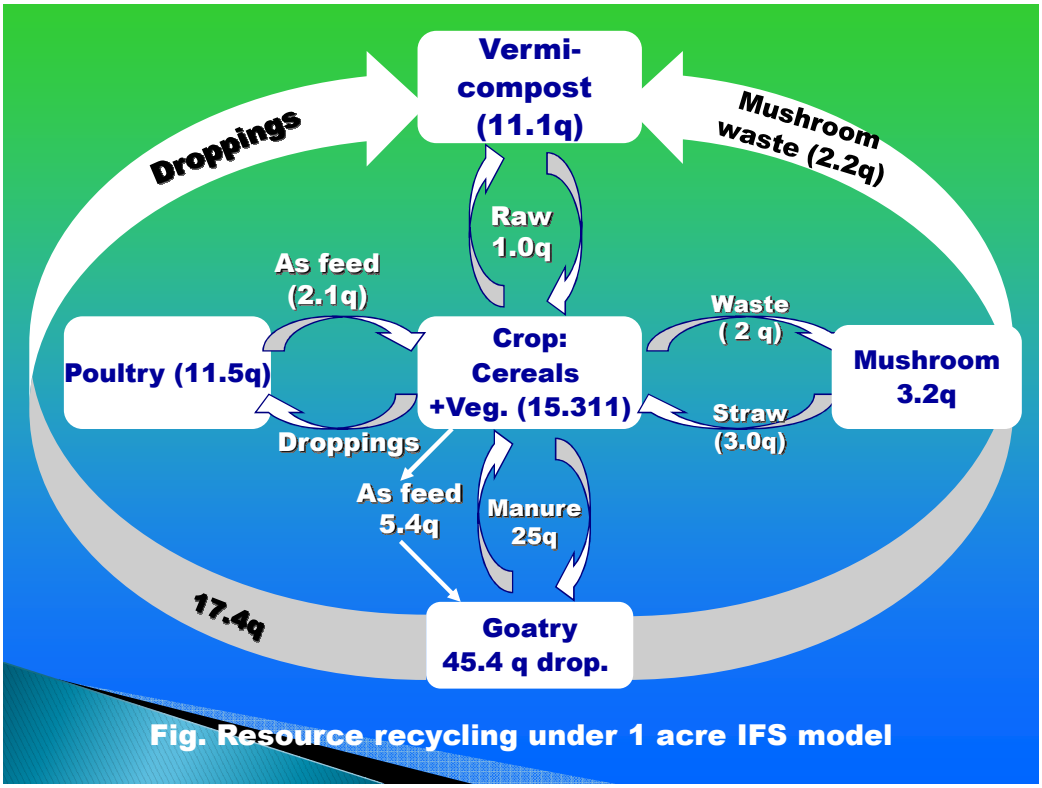
Farming System	Cereals Only	Vegetables	Poultry	Duckery	Fishery	Goatry	Dairy	Total mandays
Cereals Only	416	-	-	-	-	-	-	416
Crop + Veg	220	310	-	-	-	-	-	530
Crop + Fish + Poultry	376	94	60	-	40	-	-	570
Crop + Fish + Duck	376	94	-	50	40	-	-	560
Crop + Fish + Goat	376	94	-	-	40	110	-	620
Crop + Fish + Cattle	376	94	-	-	40	-	170	680
Crop + Fish + Poultry + Duckery	376	94	60	30	40	-	-	600
Crop + Mushroom + Goat	376	94	-	-	40	110	70	650

Note: 1 day = 8 hrs.

Table-5: Establishment and expenditure statement of one acre IFS

Sl. No.	Components	Establishment cost	Gross Income (Rs.)	Net Income (Rs.)
1	Crop (0.2 ha)	-	16007	11035
2	Horticulture (0.09 ha)	1080	20900	19750
3	Fodder	--	6380	10820
4	Goat (20 + 1) (0.018 ha)	65,000	52826	24444
5	Mushroom (0.003 ha)	10,000	9500	16100
6	Poultry (700 chicks) (0.0015 ha)	12,000	53810	39205
7	Crop waste	--	1050	9090
8	V.C. & Manure pits	8,000	2650	5150
9.	Fruits		7424	7114
	Total	96,080	1,70, 547	1,42,708

Fig.4 Resource recycling under 1 acre IFS model



In addition to above mentioned income about 5.6 t of goat manure and 0.6 t of Vermi compost is also prepared within the system which were recycled within the system. The above mentioned organic manures are equivalent to 100 kg Urea, 170 kg SSP and 40 kg MOP in addition which costs about Rs. 4000/-. The straw available from the crops was recycled into the system in form of mushroom, feed to animals and vermin composting. A total increase in man power employment was also reported from the system (Sanjeev *et al*, 2012).

C) Vegetable based farming system model (one acre):

For Urban and peri- urban areas, where the land is available and facility for truck gardening is available, vegetable based farming system will be the best option for better economic returns from the system. Keeping in view ICAR- RCER, Patna has also developed one one acre vegetable based farming system model in which cereals were also integrated with seasonal vegetables, fodder crop, goatry and vermin composting. Crop enterprises have been established on 80 per cent, having cereal and pulses in 26 per cent and seasonal vegetables in 54 per cent area where as 20 per cent area was allocated for other enterprises such as fodder crop (12.5 per cent), goatry (5 per cent) and vermin composting pits (2.5 per cent)

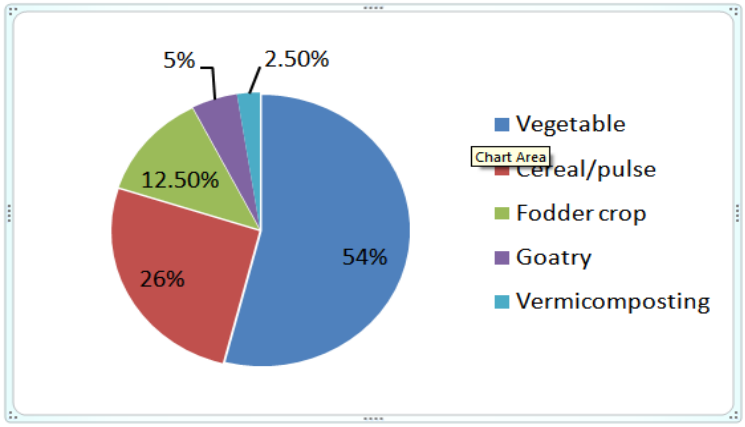


Fig. 1 Area allocation of different components

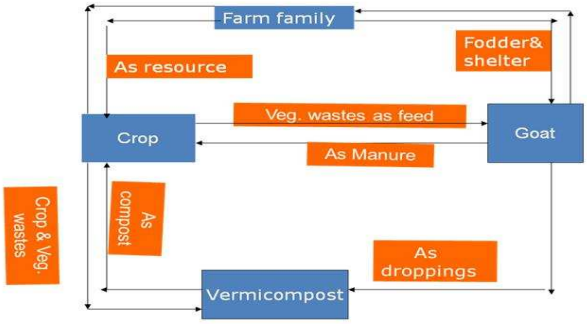
Rice as kharif crop and green gram as pulse crop has been taken as cereal and pulse crop. After harvesting of rice crop farmers generally grow wheat during rabi season (Rice-wheat-green gram cropping system) but in this study it has been found that growing potato as rabi crop is more beneficial than that of wheat. Wheat matures in the month of April and after that if green gram is sown, it gives poor yield whereas potato is harvested earlier than wheat and it gives full scope for growth and development of green gram. Consequently the yield of green gram in rice-potato-green gram system is higher than rice-wheat-green gram cropping system. Based on ladies finger yield equivalence the yield of rice-potato-green gram (13.21t/acre) was found nearly doubled than rice-wheat-green gram (7.61t/acre).

Bitter gourd-tomato- bottle gourd and ladies finger-potato-onion are the two vegetable based cropping systems which were grown in the area allocated for vegetables (2160 m^2). Bitter gourd & ladies finger as kharif crop, tomato & potato as rabi crop and bottle gourd & onion were grown as summer crop in the vegetable block.

Livestock component consisted of eleven goats (10 does + 1 buck). Black Bengal breed was reared in 5% area of the field for meat purpose. A fodder block of 12.5% was kept for growing green fodder throughout the year. Maize and cowpea were grown during kharif and summer season where as berseem and oat was grown during rabi season. Napier grass was grown as perennial grass for goat unit.

Vermi composting pits were prepared in 2.5% area for making vermin compost from farm wastes. Approximately one- third quantity of the goat droppings were added with vegetable wastes to prepare vermin compost. Two-third quantity of goat droppings was converted into goat manure. In this system approximately 1.5 tons of goat manure and 1.9 tons of vermin compost was produced which were used within the system. Recycling of goat droppings as goat manure and vegetable wastes as vermin compost minimizes the dependency upon chemical fertilizer to some extent, making the system more sustainable in terms of soil health and increasing resource use efficiency of the system. The net income from this one acre model was estimated to be Rs. 87,060/-. In this model all components are interdependent on one another and by product of one component act as input for other component (Fig.) thus reduces the cost of cultivation and fetches more income than growing crops only.

Fig- 6. Interdependence of components in IFS model



D) IFS model for Resource poor farmers (0.5 acre)

There are a number of farmers in Bihar and in eastern India who possesses a very less amount of land i.e. less than one acre. The economic condition of such farmers is very pity and they have no other resources except to earn their livelihood through wages. In order to improve the livelihood of such resource poor farmers, a 0.5 acre IFS model has been developed at Vaishali, vill. Chakramdas, Farmers' name: Mr. Lali Sahni under NAIP Component-3 project.

For development of IFS model of 0.5 acre for resource poor farmers, under crops like rice/wheat/ vegetable were allocated in an area of 1400 m^2 while a pond of 400 m^2 was dugged out in the land left as waterlogged for rearing of fishes (mix carp culture). 10 ducks were also reared on the pond's dike which was fed on the family left out. Two buffaloes were also taken (100 m^2) for better recycling of nutrients within the system and the buffaloes were kept on grazing as sufficient grazing lands are available in the village. Mineral mixtures and other feed supplements were also provided. Vermi-composts & FYM were prepared with the waste materials available within the system. On the pond dike of 1 m width, seasonal vegetable and fruit crops were also raised either supplement the nutrition to the farm families or to sell in the market. On an analysis of this developed module it was found that there is an increase in income by four folds over traditional cropping in the same area of

2000 m^2. Now the farmer is planning for mushroom cultivation so that income of the system may be enhanced further. Before the intervention, the farmer having 0.5 acre of land was doing farming with rice-wheat cropping system and was hardly getting sufficient money to sustain his family. Livelihood statuses of the farmer were below standard and his family members from child to adults all were engaged as laborers to sustain. With introduction of IFS module in this cluster with the help of NAIP, now the farmer is able to sustain his family with his own resources/income and getting a sum of Rs.55, 578 with the developed module.

Before intervention	**After intervention**
	

*G.I- Gross Income, C.C- Cost of Cultivation, N.I- Net Income, LR – Labour requirement, md – man days Additional man days employment: 120 man days over cropping alone. Price: Paddy= Rs.10/kg., lady-finger =10/Kg., Milk= Rs. 24/lit, Egg=Rs. 4/egg. Fish=Rs. 70/kg., labour charge = Rs. 100/day

Note: In addition, to the above income 9.3 t of FYM and 1.0 q of vermi-compost were also produced, which were recycled in the crops, while buffaloes were kept on grazing as in the village, sufficient grazing land are available & supplemented with balanced ratio/ mineral mixtures & vitamins as per need.

On complete analysis of these developed models it can be interpreted that these models have enhanced the income of farm families by 3-4 times in general and had also increased the resource use efficiency by means of nutrient recycling within the system. The system had also increased the opportunity of labour employment (man-days) in appreciable quantity and therefore, it can be emphasized that Integrated farming system is very much suitable for Bihar and eastern states. Economy of Bihar is predominantly rural and agriculture oriented where the marginal and small farmers constitute 76.2 % of farming community. Due to failure of monsoon, the farmers are forced to judicious mix up of agricultural enterprises like dairy, poultry, pigeon, fishery, sericulture, apiculture etc., suited to their agro-climatic and socio- economic condition and largely dependent on the farm size. For such prevailing situations, There is need to integrate agriculture, horticulture, fisheries and other allied enterprises like apiculture, sericulture, mushroom cultivation etc. with livestock which holds promise for this region in a scientific way for improvement in the livelihood of marginal, small and medium household farm families. The resource use efficiency at present level is poor due to lack of adoption of appropriate farming system models. Good quality of fertile land, rich water endowments, biodiversity and manpower can be used in an integrated manner in a farming system mode by recycling of wastes to secure high resource use efficiency and improved livelihood.

Table-6 Economics of the developed model (0.5 acre)

Previous Income	Income from different Components (Crops+Fish+Duck+Livestock)	Yield (REY)	G.I	C.C	N.I
Rice-Wheat (0.2 ha) *G.I=11400 C.C=3872 N.I=7528 Labour employed = Family labor (58 man days)	**Crops** Rice-Wheat-Moong (0.07ha) Rice-Potato+Maize (0.07 ha) **Total (LR – 58 md)**	 9.8 q 12.0 q 21.8 q	 9800 12000 21800	 4200 5100 9300	 5600 6900 12500
	Veg. & Fruits (Pond's bund) **(LR – 8 md)**	Lady finger equivalent yield (L.F. E.Y.) 2.2 quintal	2200	1144	1056
	Fish pond (0.04 ha) Rohu+Common Carp + Silver Carp+Mrigal (300 fingerlings) **(LR – 15 md)**	140 kg	9800	2064	7736
	Duckery (9+1) on ponds dike 9 female duck & 1 male duck. **(LR – 23 md)**	2250 egg.	9000	4300	4700
	Livestock (2+2) Area=0.01 ha 2 Buffalos & 1 calf **(LR – 74 md)**	Milk Yield 2160 lit.	52,840	22,254	29,586
	Total	--	95,640	39,062	55,578

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Women Empowerment through Integrated Fish Farming System

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In the present days, women is becoming the backbone of the agricultural workforce and play a vital role in agricultural management and production activities in addition to their responsibilities at the homestead level (Sidhu, 2011). They are now directly involved in the production and management processes in agro- horticulture, livestock and fisheries, forestry and post harvest activities. The growing awareness of the importance of women as economic providers and their pivotal role in sustaining the family has urged to include women in development programmes or to facilitate their participation in ongoing programmes. It has been observed that income earned by women is more likely to be spent on food and other basic needs than income earned by men (Panda et al., 2012). Consequently, it is recognized that an increase in women's income is more likely to improve family status than increased household income per se (Dehadrai and Yadava 2004).

As per the estimate that in 2008, almost 45 million people worldwide directly engaged (full time or part time) in primary sector and an additional estimated 135 million people employed in the secondary sector, including post-harvest activities (FAO 2012a). Out of which 5.4 million women worked in the primary sector *(*12%). In China and India, women represented 21% and 24%, respectively, of all fishers and fish farmers. In Asia and West Africa, in general women make up at least 50% of the workforce in inland fisheries sector, while women market around 60% of seafood. Moreover, case studies suggest that women may comprise up to 30% of all those employed in fisheries, including primary and secondary activities (FAO, 2012b). FAO's National Aquaculture Sector Overview1 provides insights into the roles and contributions of women in the aquaculture sector in countries around the globe. In Cuba, female workers constitute 27 % of the aquaculture workforce. In Estonia, the gender ratio of the aquaculture workforce is 1:1. In Jamaica, about 8–11 % of fish farmers are women who own and operate fish farms; and in processing plants, women dominate the workforce. In Malaysia, women account for about 10 % of the total aquaculture workforce, and they are mostly involved in freshwater aquaculture and hatchery operations for marine fish, shrimp and freshwater fish. In Panama, 80 % of the workforce in processing plants is women, but in the production sector, only 7 % of workers are women. In Sri Lanka, women constitute 5 % of the workforce in shrimp aquaculture and 30% of those engaged in the production and breeding of ornamental fish. (FAO 2012b).

Fisheries sector has witnessed a steady growth from a meagre annual fish production of 0.53 million tons in 1950-1951 to 8294 million tons during 2010-2011. This transformation from a purely traditional activity (in both aquaculture and fisheries) to a full-scale commercial enterprises opened considerable scope and potential for employment generation and contribution to the food and nutrition security and foreign exchange earnings of the country. Like in agriculture and animal sectors, fisheries sector also contributes significantly to the livelihoods for millions of people around the world.

As a general global trend it is estimated that, overall, women accounted for at least 15 % of all people directly engaged in the fisheries primary sector in 2010. The proportion of women is considered to be higher (at-least 19%) in inland water fishing, and far more important, as high as 90 %, in secondary activities, such as processing (FAO 2012a).

Aquaculture plays a multi-disciplinary role and aims at providing food security, generating employment, economic gains and optimum utilization of resources and finally upliftment of the socio-economic status for those who are directly or indirectly connected with exploitation, production and processing of fish (Ninawe and Diwan 2005). Aquaculture production was 55.7 million tons in 2009 out of the total global production of 144.6 million tons (38.5%). Major aquaculture production comes from the Asian subcontinents. In these countries, women play a crucial role in production process. Nandeesha (1994) found that in Cambodia the ponds where women carried out at least half of the tasks associated with aquaculture had higher yields than did other ponds. In some parts of Thailand and China, because of male migration to cities, women bear the sole responsibility for farm production, including aquaculture (Kusakabe 2003). It was found that, women who are involved in intensive aquaculture have more resources in terms of land, cash, and knowledge than women who are involved in subsistence aquaculture—but they have less decision-making power. Even when they have more resources, their choices to use them are restricted by 'ideology'—the socially defined roles and responsibilities placed upon women. Conforming to these ideologies is necessary to avoid conflict in the household, which most women cannot afford to create (Kusakabe 2003). Some of the factors that weaken women's capabilities in decision-making are: lower literacy rate; increase pressure of house hold activities like cooking, time burdens, restricted mobility, limited autonomy and decision making process, lower participation in formal organizations; less leadership roles in formal organizations.

Integrated fish farming is a diversified and coordinated method of faming system, where one or more separate farming systems (agriculture and/ or animal husbandry) are integrated along with fish farming for efficient utilisation of farm space for multiple productions as well as for recycling of waste or by-product generated. In this system organic by products generated from one system becomes the input of other system. This type of farming system is becoming very popular among rural people in many parts of India. The integration of aquaculture with livestock and crop farming offers great efficiency in resource utilization, reduces risk by diversifying crop, and provides additional food and income. As it is mostly followed by the marginal and small land holding people and less labour intensive, women are actively getting acquainted and taking part in this production system. Jahara (1998) mentions that integrated aquaculture activities are 'often perceived as an extension of the women's household chores', which makes it easier for women to combine the two activities.

Advantages of integrated fish farming system

1. Recycling of the waste generated during animal farming
2. Efficient utilization of time and space
3. Higher rate of production
4. Increased economic benefit
5. More employment scope
6. Minimized per unit cost the production

Integrated farming system involving livestock-fish, poultry-fish, duck- fish and rice-fish farming have been well developed and practiced in many South East Asian countries like China, Vietnam, Thailand, Malaysia etc. It is practiced in many states of India.

Fish culture in integrated fish farming:

In fish based integrated farming the main component is the fish culture. All the other components are added to the fish culture system mostly as a source of organic input for fish farming like cow dung, poultry dung, duck dropping, green leaves out of horticultural components etc. Though general management practice of fish culture is almost similar in all systems but based on the associated components, nutrient requirements, waste generated in subsidiary components suitable modification will be required in the fish culture practice. Fish culture practice can be broadly divided in to three sub sections;

a. Pre stocking management
b. Stocking management
c. Post stocking management

A general fish culture practice followed in integrated fish farming is mentioned below: Pond selection: Pond size generally should be 0.4 – 1 ha of 2-3 m depth of rectangular shape. Clearing the fish pond: Fish pond should be cleared from all aquatic vegetation. More of quatic plants reduces light penetration and create problem in oxygen deficiency.

Clearance of unwanted weed fishes: All unwanted fishes like weed fishes and carnivorous fishes should be removed from the pond as they compete for food, shelter as well as for dissolved oxygen which is the limiting factor in a fish pond. This can be done by repeated netting or by drying the pond bottom. Fishes can also be killed by application of bleaching powder 300- 500 kg/ha or any organic pesticide like mahua cake (2500kg/ha) or derris rootpowder.

Liming: Liming should be applied as per the pH of the water. For example moderately acidic soil pH (5.0 6.5) requires around 1000 kg/ ha of lime. As such 400kg/ha can be applied in the pond (¼ initial dose then split the rest to 11 instalments and apply every months).

Fertilization: Additional fertilizer is not required in integrated farming system. Fertilization using organic waste is done after 7 days of liming, In case of pig - fish farming; dung has to be added in the pond continuously. The pig dung, urine and spill out feeds from pig sites are collected every day in a pit and distributed into the ponds. In case of duck- fish farming duck dropping and left over food are directly given to fish pond. In poultry –fish, the deep litter are packed in gunny bags and apply in the pond as and when required. Fertilization should be continues after fish stocking also.

Stocking fingerling fishes: In a well managed pond stocking density should be maintained 6000 - 8000 number/ha (40% surface feeder, 30% bottom feeder, 20% column feeder, 10% grass carp). Always avoid excess stocking. Excess stocking will not only decrease the growth rate of fish but also creating stress to the fishes and become susceptible to diseases. The stocking size of fishes should be 10-15 cm in length. Yearling is always better in comparison with fresh one as they are hardy.

Feeding grass carp: For feeding grass carp aquatic weed or soft terrestrial plants like banana etc. are applied on the pond surface in a bamboo rack. In general no feeding is required in this integration; however, in some cases like low primary productivity, low organic input etc farmer can start supplementary feeding. Periodical netting is done in order to assess health status of the fishes. Netting should be done at least once in a month and length and weight increase and disease symptom has to be

recorded. Final harvesting is done at the end of 10-12 months. Except harvesting and netting, all other activities can be done very effectively done by the women.

Rice cum fish farming:

Fish culture in rice is an age old practice in many rice growing countries of the world. Rice fish integration encourages synergism between rice and fish leading to increase in grain yield by 5-15% and straw yield by 5-9% (Kumar and Ayyapan, 1998). In North eastern part of India, farmers cultivate rice as their staple food. Traditional rice-fish production systems have an important socioeconomic part in the life of the farmers and fishers in the region (Das 2002). This is mostly practice in the low line rain fed area where water level gradually increased during rainy days. Women's participation in rice-fish is considered to be high, since women are already involved in rice production (Dehadrai, 1992). Thus, in rice- fish integrated farming system women workforce can make significant contribution starting from the rice plantation to fish culture. In the unmanageable vast waterlogged rice environments, perennial waterlogged wet rice lands, oxbow type rice fields or flooded river basin rice fields, naturally occurring fishes and prawns enter the field during the monsoon and grow together with the rice crop (Das 2002). In these water bodies, tribal women harvest fish through group fishing of the flooded rice areas using local devices. In general, small fishes, snails and crabs are the common harvests from most of the rice environments (Das 2002).

Integration with duck

Fish cum duck integration is based on the mutually beneficial biological relationship between fish and duck. Duck raising in fish ponds is an ancient practice in Asian countries. Ducks consume tadpoles, snails, insects dragonfly and their larvae, thus assist in eradicating many predators of fish fry creating an excellent, essentially disease free environment. Fish utilizes the feed spilled by ducks and their droppings. Movement of ducks also provides oxygen into the water. Furthermore, the protein content of these natural food organisms of duck is high. Therefore, duck raising in fish ponds reduces the demand for protein in duck feeds. In many parts of India, ducks is mainly maintains by the women folk only. Feeding, egg collection, cleaning of the duck house etc. are mostly done by the housewife apart from distributing feed and duck house waste to the pond.

Integration with other activities

Importance of women participation has been seen in many other integrated farming systems. Many of the farmers who are engaged in of aquaculture have other sources of income like wage labour, agricultural firm, plantation crop etc. In this case, women play the major role in maintaining the farming system. In North Eastern India, pig fish farming is one of the popular farming practices, and here too women play the pivotal role in the integration, starting from the pig maintenance to the monitoring fish pond. Mushroom-fish integration is another potential integrated farming model where women can play an active role. Mushroom cultivation requires optimum humidity for their growth and can be cultivated in the vicinity of fish pond. The paddy straw used in mushroom propagation is enriched in proteins, inorganic nutrients and organic matter and can be fed to cattle after used in mushroom production. In turn, cow dung can be used in culture pond for fish production. Apart from that horticulture – fish integration also an important integration model where women can make major contribution.

Conclusion:

The growing awareness of the importance of women as economic providers and their pivotal role in sustaining the family has urged to include women in development programmes or to facilitate their participation in ongoing programmes (Panda et al., 2012).The international community is now paying more and more attention to women and their role in maintaining the health in fisheries.

Aquaculture can be seen as a micro enterprise activity principally in the hands of women (Kusakabe, 2003). Women's work is generally perceived to be 'light and simple', and thus aquaculture activities, except harvesting, are supposed to be suited to women (Minh et al. 1997). It was also well documented that women managed aquaculture ponds has higher yields which indicates that in future, women will play a crucial role in aquaculture production system. Simultaneously their involvement in fish farming activities which is still very low, will also going to increase significantly. However, there are several issues hindering the contribution and participation of the women folk in integrated farming system and fisheries as a whole are low literacy rate among the women, poor mobility, less participation in the decision making process etc. It is high time that more and more women participation should be encouraged in the integrated farming system for their social and economic empowerment. Formation of women self help group for development of self-esteem, need based training programme on different aspects of aquaculture and associated farming system etc. should be encouraged which will help and encourage more and more participation of women.

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Role of women in animal husbandry practices

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Introduction

A number of challenges face the livestock sector on which about 70% poor smallholder households in eastern India is dependent. These challenges demand innovative and sustainable approaches involving women as a player for ensuring food, resource, and livelihood security for the family. In fact, women oriented societies in ancient India gave more importance on animal husbandry as sources of milk, meat, egg, wool, hides & skin and of course the "living money". At present, though livestock sector contributes about 27% of agricultural GDP of the country, its role and importance has been ignored as the importance of women in the society. A number of gender issues are central to discussions of agricultural livelihoods and to fight against hunger and poverty (FAO, 2002). These include access to and control of assets and gendered divisions of labor (IFAD 2004). The roles, right, responsibilities and decision making power of women in the societies varies across region and socioeconomic conditions of the family. The aim of this article is to identify area where capacity building of women in animal husbandry is required in Bihar.

Role of women

Women perform a variety of roles, of which many are of greater economic significance (Bhopale and Palki, 1998). The role and contribution of women in dairying other than usual household responsibilities had been interpreted in social than economical pretext. Contribution of farm women in agriculture is likely to be around 50 to 60 per cent while rural woman contributes a share of more than 75 per cent in animal husbandry operations (Upadhyay and Desai, 2011). On an average a women contributes about 4-6 hours for animal husbandry operations in rural Bihar.

Role in animal husbandry

Women play an important role in animal husbandry activities as manager, decision makers and skilled workers. Caring of animals is considered as an extension of domestic activities in Indian social system and most of the animal husbandry activities like bringing fodder from field, chaffing the fodder, preparing feed for animals, offering water to animals, protection of animals from ticks and lice, cleaning of animals and sheds, preparing of dung cakes, milking, ghee-making and marketing of produce are performed by farm women. Thus, involvement of farm women in farming activities is a common feature in Indian rural setting. They help in farm operations, take their animals for grazing, look after the sale of milk, and in addition, perform the functions related to house management. Most of the work and decision-making by women takes place at the household level, while old men or children take the livestock for grazing and male members participate in public meetings that relate to animal husbandry or else. Almost all important decisions are taken jointly by both the man and the woman heading the household. These decisions include which animals to sell and at what price, disease diagnosis and treatment of sick animals.

Role in nutritional security

Food security is essentially built on three pillars: food availability, food access, and food utilization. An individual must have access to sufficient food of the right dietary mix (quality) *at all times* to be food secure. Those who never have sufficient quality food are chronically food insecure. Those whose access to an adequate diet is conditioned by seasonality are food insecure and are generally

called *seasonally* food insecure. Individuals who normally have enough to eat but become food insecure in the face of disasters triggered by economic, climatic, and civil shocks (war and conflict) are *transitorily* food insecure. The "at all times" element of the food security definition makes risk and associated vulnerability an important element of the food security concept. It has been observed that ssixty percent of the calories and proteins consumed by humans today come from just three plant species: maize, rice, and wheat. Seventy-five percent of our food supply comes from just 12 plants and five animal species (Lambrou and Laub 2004), but yet dietary diversity is extremely important. Diets dominated by cereals lack an adequate array of micronutrients such as iron, vitamin A, B vitamins (niacin, thiamine), vitamin C, zinc, iodine, and folate. Deficiencies in micronutrients are costly in economic terms and in terms of people's well-being. Deficiencies in vitamin A, iron, and zinc all rank within the top 10 leading causes of death through disease in developing countries (WHO 2002). Vitamin A and Iodine deficiency are very common among children and iron and folic acid deficiency among women. Women are typically responsible for food preparation and thus are crucial to the dietary diversity of their households. Women are generally responsible for selecting food purchased to complement staple foods and to balance the household's diet. The prime sources for micronutrients are fruits, vegetables, and animal source foods, including fish. Animal source foods are particularly good; they are high density in terms of micronutrients, and those micronutrients are also more bio available to the human body. Agriculture is thus a key to dietary diversity, particularly in areas that have less access to markets given the perishable nature of fruits, vegetables, and animal source foods.

Women's typical role within a livestock production system is different from region to region, and the distribution of ownership of livestock between men and women is strongly related to social, cultural and economic factors. Generally, it depends on the type of animals they raise. In many societies, for example, cattle and larger animals are owned by men, while smaller animals – such as goats, sheep, pigs and backyard poultry kept near the house – are more a woman's domain. When the rearing of small animals becomes a more important source of family income, ownership, management and control are often turned over to the man. Women are crucial in the translation of the products of a vibrant agriculture sector into food and nutritional security for their households. They are often the farmers who cultivate food crops and produce commercial crops alongside the men in their households as a source of income. When women have an income, substantial evidence indicates that the income is more likely to be spent on food and children's needs. Women are generally responsible for food selection and preparation and for the care and feeding of children.

Women empowerment on animal husbandry sector

1. Dairy sector
    a. Feeding of milch animal
    b. Processing of crop residues
    c. System of grazing in forest areas and procedure of lopping of trees for fodder
    d. Care of pregnant animal
    e. Care of calf
    f. Primary health care
    g. Vaccination schedule
    h. Deworming schedule
    i. Care of animal during heat stress
    j. Clean milk production
    k. Processing and value addition of milk
    l. Breeding of dairy animals

m. Record keeping
n. Zoonotic diseases and their precautions
o. Livestock management in emergency like flood, drought, cyclones etc
p. Culling and restocking programmes
q. Conservation of fodder

2. Goat husbandry
3. Backyard poultry keeping
4. Pig husbandry in tribal areas
5. Others: Vermicomposting, compositing, waste utilization for fuel

Issues

Despite their considerable involvement and contribution, women's role in livestock production has often been underestimated, if not ignored. Gender-blindness is the result partly of a paternalistic bias, and partly due to the attitudes of the women themselves, who may be conditioned by their culture and society to underestimate the value of their own work. As a result, it is difficult to obtain information on the role of women in livestock production. In addition, women's work is rarely reflected in national statistics. However, following issues may be considered for empowerment in animal husbandry sector:

1. **Decision-making and empowerment***:* Livestock ownership is increasing women's decision-making and economic power within both the household and the community. It is also a source of cash and can open up access to credit (the sale of small ruminants can provide an emergency source of cash for medical treatment or school fees, while daily milk provides a regular flow of cash income often used to purchase food and household items). Low participation of farm women was observed in decision making about economic aspects where execution is carried out by them. So there is need to make them aware about financial regulation, loans and insurance of animals and marketing structure.

2. **Household welfare***.* The management, processing and marketing of livestock products generate more income than most of the activities women tend to be involved in, and bring benefits for the whole family (for instance by increasing food security at the household level: small ruminants provide food products such as milk, butter, cheese and meat, all of which are a source of protein, minerals and vitamins)

3. **Income generation***.* Animals provide raw material such as wool, skins, and bones used by women to make clothes, or as fuel for home consumption and for sale. Processing of these materials can be an important source of additional employment and income for poor rural women

4. **Access to credit and resources***.* Livestock ownership increases the likelihood of gaining access to credit and assets. Milking, processing and marketing of milk products, does not necessarily mean that women can control decisions regarding livestock or own it.

5. **Access to information and organization**, specifically to (i) livestock extension and veterinary information and services; artificial insemination services; participation in developing livestock programmes and policies (e.g. vaccination, culling and restocking programmes); (ii) emerging livestock-related technologies (e.g. fodder, breeding, disease prevention, livelihood decision-making tools); and (iii) training and involvement as community animal health workers and para-veterinarians.

6. **Access to markets** and distribution of risks and gains along different steps of livestock value chains varies according to the gender of (i) producers (e.g. rights to income generated from livestock); (ii) processors (access to processing technologies and information); (iii) market agents (access to transportation, safe market spaces and overnight accommodation, risk of sexual harassment and abuse); and (iv) economies of scale (bringing women together to improve their market position).

7. **Risk and vulnerability**. Women and men have different experiences and capacities to face: (i) livestock sector trends (e.g. policy biases and changes, "supermarketization", the lengthening of livestock value chains, vertical integration); (ii) regional shocks affecting livestock climate/ecosystem change, drought, flooding, animal disease, demographic changes, political upheaval, conflict); (iii) household shocks (illness or death of family member; "distress sales" of livestock to pay for medical treatment, property or asset grabbing).

8. **Self-esteem**. Owning, controlling and benefiting from livestock production increases women's self-esteem and strengthens their role as producers and income generators within the household and in the community.

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Role of Women in Integrated Farming Systems: Some experiences from Eastern region

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The Indian Green Revolution of the 1960s and 1970s, with its package of improved seeds, farm technology, better irrigation, and chemical fertilizers, was highly successful in meeting its primary objective of increasing crop yields and augmenting food supply. However, the Green Revolution as a development approach has not necessarily translated into benefits for the lower socioeconomic strata, particularly the rural poor and farm women, in terms of greater food security or greater economic opportunity and well-being (Bharadwaj *et al.*, 1999). It has increased the need for cash incomes in rural households to cover the costs of technological inputs which has forced women to work as agricultural laborers and increased the need for unpaid female labor for farming tasks.

In the era of burgeoning population and shrinking natural resources integrated farming system may be the panacea. Integrated Farming system approach envisages the integration of agroforestry, horticulture, dairy, sheep and goat rearing, fishery, poultry, pigeon, biogas, mushroom, sericulture and by-product utilization of crops with the main goal of increasing the income and standard of living of small and marginal farmers. Integrated systems are about bringing crops and livestock into an interactive relationship with the expectation that together, as opposed to alone, they will generate positive effects on outcomes of interest, such as profitability overall productivity, and conservation of non-renewable resources. It is, however, much more than this. The “system” includes the environment, soil characteristics, landscape positions, genetics, and ecology of plant and animals. It involves management practices, goals and lifestyles of humans, social constraints, economic opportunities, marketing strategies and externalities including energy supplies and costs and impacts of farm policies. Systems also reflect available natural resources and the impact on their use, wildlife issues, target and non-target plant and animal species, micro-organisms, and indeed all of the definable and indefinable factors that ultimately interact to result in an outcome that is never constant. The aims of integrated farming system is to increase productivity, profitability, sustainability, balanced food, clean environment, recycling of available resources and income round the year. Besides we can also think for adoption of new technology, solving energy crises: fuel and fodder crises, avoiding deforestation, increasing employment generation by taking more than one component, input-output efficiency and enhancing opportunity for agriculture oriented industries as well as uplifting living standard of the farmers (Gill *et al*, 2010).

Characteristics and potentials of agriculturestrongly vary across the regions of India.Likewise components of integrated farming system also vary depending upon the available natural resources and socio-economic factors in these regions. In our country women constitute 48.47% (591.4 million) of total population and about 74 percent of the entire female workforce is engaged in agricultural operations. Depending on the region and crops, women's contributions vary but they provide pivotal labor from planting to harvesting and post-harvest operations. Women are a vital part of Indian economy. They have played and continue to play significant role in every sphere of agricultural activity. Over the years, there is a gradual realization of the key role of women in agricultural development and their vital contribution in the field of agriculture, food security, horticulture, processing, nutrition, sericulture, fisheries, and other allied sectors. Women form the backbone of agriculture, in India, comprising the

majority of agricultural laborers; women have been putting in labor not only in terms of physical output but also in terms of quality and efficiency. Women work harder and for longer hours than men. The mode of female participation in agricultural production varies with the land-owning status of farm households. Their roles range from managers to landless laborers. In overall farm production, women's average contribution is estimated at 55% to 66% of the total labor with percentages much higher in certain regions (Venkateswaran, 1992). In the Indian Himalayas a pair of bullocks works 1064 hours, a man 1212 hours and a woman 3485 hours in a year on a one-hectare farm, a figure which illustrates women's significant contribution to agricultural production (www. FAO.org/sd/WPdirect/ WPre0108.htm). Farmwomen of all ages work in agriculture and from 75% to 80% of farm work is carried out in family farm while their contribution in hired agricultural laborer is 50% to 66%. Male farm workers are relatively free during off-season; however, farm women work during these periods too.

The loss of biodiversity in agriculture is the key threat to food security and sustainability. The diversity in food, feed, fish, and animal stocks has narrowed down alarmingly. In rural India, it is women who conserve biodiversity on farm as well as ex situ through various rituals. The role of women as custodians of agriculture and livestock still cannot be ruled out. For farm women, biodiversity manifests in both farm plants and their wild relatives. Their extensive knowledge of wild plants, leaves, berries, nuts, seeds, spices, and condiments required for food preparation and preservation is exhaustive (Ramprasad, 1999). Rituals and ceremonies in various parts of the country show this close relationship. Be it the *lohri* (harvest festival) of Punjab, Makar Sankranti of Bihar or *navadhanya puja* (worship of nine cereals) in southern India, both emphasize the role of women in biodiversity preservation.

Women are critical to the well-being of farm households. Aside from raising children, women are expected to prepare all meals, maintain the homestead, and assist in crop and animal production, all the while tending to the general health of their families. Perhaps, ironically, it is because women who have so many responsibilities that they have been over-looked by agriculturalists and policy makers–it has been more convenient to label men as farmers and women as child raisers and cooks. Rural women form the most important productive work force in the economy of majority of the developing nations including India. Agriculture, the single largest production endeavor in India, contributing about 18% of GDP, is increasingly becoming a Female Activity. Agriculture sector employs 4/5th of all economically active women in the country. 48% of India's self-employed farmers are women. Operations that involve less physical labor and more drudgery, such as weeding, are left to women, and women undertake these tasks in addition to their primary function as housekeepers and home makers. In the plantation sector women are the crucial laborers. There are 75 million women engaged in dairying as against 15 million men and 20 million in animal husbandry as compared to 1.5 million men. Beyond the conventional market-oriented narrower definition of 'productive workers', almost all women in rural India today can be considered as 'farmers' in some sense, working as agricultural labor, unpaid workers in the family farm enterprise, or combination of the two. In general, women in tribal households enjoy more decision-making power than women in many other Indian households because of their greater contribution to household income. Moreover, several farm activities traditionally carried out by men are also being undertaken by women as men are pulled away into higher paying employment. Thus, Rural India is witnessing a process which could be described as Feminization of Agriculture.

Role of women in Crop production

India has a variety of crops grown in irrigated and rain fed areas. Rice, wheat, jowar, maize and bajra are the major food grains. Oilseed, sugarcane, cotton and jute are the important cash crops. Likewise, tea and coffee are important plantation crops. India's agricultural production systems also

include a wide range of horticultural crops. Rice is widely grown in Southern, Eastern and Northeastern states. Wheat is mainly grown in Punjab and Haryana. Jowar and Bajra are important food grains in dry land areas. Assam and West Bengal are famous for tea, whereas Karnataka, Tamil Nadu and Kerala are coffee and coconut producing states. In the highly diversified Indian context, no simple gender division of labor exists with regard to crop production. In certain areas in India women play a key role as seed selectors and in seedling production. Their knowledge on seeds and seed storage contribute to the viability of the agricultural diversity and production. As weeders, women contribute to crop management. Male shoulder the responsibility of agricultural activities such as ploughing, sowing, transport and sale of agricultural products. The female on the other hand, the activities carried out by women are transplanting, preparing and applying green manure and farm yard manure, manual weeding, transplantation, harvesting, threshing, winnowing dehusking and storage. There are some of the activities which are carried out by man and women jointly. Gender differences exist in both work carried out by rural women as well as in wages they are paid. Rural women are engaged mostly in household activities in Uttar Pradesh but considerable amount of time is also spent in dairying and agricultural activities. Dairying activities included fodder chaffing, washing cattle and dung cake preparation while the agricultural activities undertaken were fodder transportation from fields to homes, harvesting and irrigation (Kumar & Fulzele, 1998).

In Meghalaya women mainly carried out transplanting, weeding and harvesting while men did the ploughing and threshing. Similarly in West Bengal rural women more actively indulged in household activities than in poultry keeping and other activities related to agriculture. The conservative family structures and low education levels of women were the reasons attributed to this disparity. In Kerala majority of farm women “solely” participated in sowing/planting and harvesting of vegetables, half of them supervised plant protection operations, half of them jointly decided the type of weed control to be adopted, manure/fertilizer to be applied and irrigation management. In Chhatisgarh majority of female farm laborers participated in weeding, harvesting, winnowing and transplantation in rain fed areas. In the irrigated area, grass cutting is the major job for women laborers. In contrast, the tribal women (*santhals, mundas and oraons*) of West Bengal participated more in subsistence activities such as trading firewood and other forest produce and less in other activities such as agriculture, animal husbandry, agricultural labor, liquor trading, hunting, fishing, capture/collection of various animals and plants which was carried out by men. However, women were completely responsible for rearing of animals.

So far as rice cultivation is concerned studies show that women participate in all major operations for example; sowing/transplanting (86%), Weeding (84%), storage of grains (78%), land preparation (72%), cleaning seeds for sowing (70%), gap filling (68%), manure and fertilizer application (68%), harvesting (64%), threshing and winnowing (62%), watching birds (41.6%), and rate and rodent control practices (58%). Nataraju and Lovely (1993) concluded that the majority of women participate in pre-harvestings like, reaping the crop (98%), bunding and transporting (94%), operation trampling (80%), transporting and spreading of seeds (60%) whereas, in post harvest activities 84% women are involved in threshing and 92% in winnowing. In cultivation, except ploughing, leveling and irrigating the field, all the other works such as sowing, weeding, transplanting, harvesting, stocking of straw, husking, drying and storing are female dominated tasks. The tasks such as preparation of field, irrigating crops and construction/repair of field channels are mainly male dominated tasks. In inter cultivation activities farmwomen play a major role in weeding, application of fertilizers, thinning and gap filling, irrigation and dusting.

Women and Livestock

In integrated farming system, livestock plays a multi-faceted role in providing draught power for the farm, manure for crops, energy for cooking and food for household consumption as well as the market. In animal husbandry women have a multiple role. With regional difference, women take care of animal production. In eastern states their activities vary widely ranging from care of animals, grazing, fodder collection, cleaning of animal sheds to processing milk and livestock products. In livestock management, indoor jobs like milking, feeding, cleaning, etc. are done by women in 90% of families while management of male animals and fodder production are effected by men. Women accounted for 93% of total employment in dairy production. Depending upon the economic status, women perform the tasks of collecting fodder, collecting and processing dung. Dung composting and carrying to the fields is undertaken by women. Women also prepare cooking fuel by mixing dung with twigs and crop residues. In livestock management, majority of farm women solely took responsibility of maintaining cattle sheds, feeding poultry birds and hatching of eggs/chicks. But when it came to the care of sick animals, type of milk product to be prepared, hatching of eggs, marketing of eggs and milk, the decisions were taken jointly by farm women and men. Though women play a significant role in livestock management and production, women's control over livestock and its products is negligible. The vast majority of the dairy cooperative membership is assumed by men, leaving only 14% to women.

Table 1: Participation of Men and Women in Different Operations of Paddy Cultivation

Sl.No.	**Farm Operation in Rice Cultivation**	**Carried out by**
1.	Land preparation	Jointly
2.	Cleaning seeds for sowing	Women
3.	Nursery sowing	Women
4.	Nursery aftercare	Women
5.	Seeding uprooting	Women
6.	Rice-transplanting	Women
7.	Irrigation	Jointly
8.	Top –dressing	Men
9.	Gap filling	Jointly
10.	Weed Control (Manual)	Women
11.	Weed Control (Chemical)	Men
12.	Plant Protection	Men
13.	Harvesting	Jointly
14.	Threshing	Jointly
15.	Winnowing	Jointly
16.	Marketing	Jointly
17.	Storage	Women
18.	Dehusking	Women

Women and Forestry

In rural areas fuel wood contributes 84% of the total household energy consumption. Unfortunately, forests are deteriorating massively due to encroachment of agricultural production, mining, construction of dams, industrial and railway demand. The country has been losing 1.5 million hectares of forest cover annually. In India about 16% of the total geographical area is covered by woodland and forests. Gender roles in using forest resources vary widely depending upon the region as well as socioeconomic class and tribal affiliation. Rural Indian women's interface with the forests is varying - gathering, wage employment, production in farm forestry and management of afforested areas in the community plantation. In India, women are the major gatherers and users of a much more diverse range of forest products than men. Depending upon the sociocultural variations among different communities, primarily Non-timber Forest Products (NTFP) is collected by women and timber by men. In several parts of India, large proportions of the population depend on NTFP as their main source of livelihood. Apart from fodder and fuel, women collect food, medicinal plants, building materials, material for household items and farm implements. Sal and Tendu leaves are primarily collected by women. As women are the ones who have traditionally been collecting forest products, they possess the knowledge of properties and potential uses of these products.

Women and Fisheries

About 5 million people in the coastal areas carry out fishing and allied activities for their livelihood. Fish drying/curing, marketing and hand braiding and net-mending are the main areas of women's involvement in Tamil Nadu, Andhra Pradesh and Orissa. Women are also involved in shrimp processing in these states. Among the mangroves of Bhitarkanika on the Orissa coast, both women and men fish in the fresh water estuarine areas. Men cast nets while women and children catch fish with hands. But fishing by boat in the flood tides is exclusively performed by men. In contrast, women's participation in small-scale fisheries is very limited in West Bengal. Even ancillary industry, which in the other Indian east coast states is a women's domain, is dominated by men, as a relatively low number of days in a year is spent on actual fishing. In the fishing villages, fish drying/curing is performed by both women and men who do not belong to the fishing community. In coastal aquaculture, women are involved in prawn and seed collection to a very limited extent.

Women and Rural production

Women in rural India generate income in various ways. Women are highly involved in processing of the NTFP, particularly in small-scale enterprises. This includes basket, broom, rope making, tasar silk cocoon rearing, lac cultivation, oil extraction, and bamboo works, etc. Women constitute 51% of the total employed in forest-based small-scale enterprises. However, this does not mean that men do not have any role in these activities. Among the scheduled-caste weavers in Orissa, men collect grass for basket making while women cure it and make the basket. In the Jeypore Tract (Orissa), men and women are equally involved in collection, processing and marketing of forest products such as grass, bamboo and resin. The challenge to the sustainability of a production system lies in integrating technology, work, and resources (financial and social) effectively with gender so that both women and men can play an active role in improving the productivity, profitability, stability, and sustainability of major farming systems.

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Rural Backyard Poultry: A viable option for income generation

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India has billion mouths to feed. One-fourth of the population does not have access to the basic essential commodities- food, clothes and shelter. About 60 % of rural population is unemployed/ seasonally employed. Most of the rural poor are small and marginal farmers and landless labour. Backyard poultry produce eggs and meat at an insignificant cost barely 20-30 % compared to modern intensive system. About 70% of the cost involved in intensive system is on feed. Since backyard poultry scavenge on vegetable garden and kitchen wastes hence cost incurred on feeding is less. Elaborate housing structure is also not required for them. Backyard poultry is recognized as stepping stone for the poorest households enabling them to take the first step towards breaking out of the vicious circle of poverty and deprivation. The eggs/ meat produced can be consumed by the household, thereby providing a cheap and available source of quality animal protein. While eighty percent of the birds in China comprise rural poultry producing 100-120 eggs annually only thirty percent of the eggs in India are produced by rural poultry. Hence, there is ample scope for increase in rural backyard poultry.

The *desi* birds are broody in nature and produce 70-80 eggs a year. They can defend themselves from predators due to alertness, light body weight, longer shank length and aggressiveness. Natural selection has made them better disease resistance; thrive well under adverse circumstances of poor housing, management and feeding. The meat has higher content of arginine and lysine and certain minerals such as iron. The eggs are rich in threonine and valine. The desi eggs and meat have superior organoleptic attributes. More physical activity results in reduced abdominal fat and improved breast muscle. Chicken has its origin in India; there are a large number of Indian breeds reared in the villages as *desi.* Some of them are recognized breeds such as Aseel, Kadaknath, frizzle, naked neck, Haringhata black, Nicobari, and Kashmir fevorellla. The American class famous for dual purpose have the blood of Aseel. The Aseel, famous for fighting ability is available in various plumages, peela (golden red), Yarkin (black and red), Nurie (white), Kagar (black), Chitta (black and white silver), Teekar (brown) and Reza (light red)

They have been used for development of varieties suitable for rural backyard poultry/ varied agro-climatic condition. The production parameters of these native breeds are described below:

Table 1: Prominent native breeds of India and their production

Breed	Body weight (20 wks)	Age at sexual maturity (days)	Annual egg production(nos.)	Egg wt. at 40wks age, g.	Fertility	Hatch ability (%), FES*	Speciality
Aseel	1220	196	92	50	66	63	Fighting quality
Frizzle	1005	185	110	53	61	71	Heat dissipation
Kadaknath	920	180	105	53	55	52	Melanin pigment, Fe content
Naked Neck	1005	201	99	54	60	71	Tropical climate

*FES= Fertile eggs set.

The native breeds found in various regions of the country are:

Breed	Region	Breed	Region
Aseel	Andhra Pradesh and Madhya Pradesh	Kadaknath	Madhya Pradesh
Ankleshwar	Gujarat	Kalahasti	Andhra Pradesh
Busra	Gujarat	Kashmir Fevorella	Jammu and Kashmir
Chittagong	Meghalaya and Tripura	Miri	Assam
Danki	Andhra Pradesh	Nicobari	Andaman and Nicobar
Daothigir	Assam	Punjab Brown	Punjab
Ghaghus	Andhra Pradesh and Karnataka	Tellichery	Kerala
Haringhata Black	West Bengal		

Hence the researchers felt the need to develop birds that have all the benefits of *desi* birds like scavenging habit, multi-coloured plumage, and long shanks but have higher egg and meat production than the *desi*. However with increased egg production the broodiness character present in *desi* birds has been lost. For realizing optimum egg and meat production there are certain practices the farmers' need to follow:

1. Vaccination for protection from New castle disease and Infectious Bursal disease.
2. Moisture level in feed should not exceed 12% so as to avoid mould growth. Feed should be protected from infestation by rodents, vermin and insects which are a source of salmonella.
3. Proper cleaning of feeders and waterers.
4. Simple wire meshed housing to protect from predators.

Crores of Indian rural households are engaged in backyard poultry production. It is common with communities like muslims, tribals, and other economically depressed or marginalised communities it is a traditional woman centric activity of rural families undertaken as a household chore. It is not a highly producing and very remunerative activity but a significant contributor to livelihoods of especially the poor. While commercial poultry made rapid progress in urban or semi-urban areas the rural sector has lagged behind. It is pertinent to note that while most of the poultry eggs and meat are produced in the rural areas they are quickly dispatched to the urban/semi-urban areas for consumption. The pockets of poultry areas exist in the country and the production and consumption is not uniform throughout. The eggs/ broilers are re-routed from the urban to rural areas and they are available at higher rates in the rural areas. The production, productivity and area under pulses have not increased. Hence the price of pulses has gone up depriving the rural people of cheaper plant protein source. Milk prices have also gone up. In this context, rural backyard poultry can provide cheap quality animal protein to the rural people.

2. PRIVATE EFFORTS:

Private sector organizations engaged in rural backyard poultry are:

S.N.	Name of organization	Released stock
1.	Kegg farms, New Delhi	Kuroiler
2.	AVM Hatcheries, Coimbatore	Coloured layer
3.	Deejay Hatcheries, Bangalore	a. FR 295- Coloured layer b. Coloured mini broiler
4.	Kalyani Poultry Farms, Mumbai	DKF

The private sector engaged in rural backyard poultry is Kegg farms. They introduced kuroiler in the year 1993and sold more than a million chicks in the first year itself. By 2005-2006, the number reached 14 million. Kegg farm was awarded the 'Business India Innovation Award' under social entrepreneurship category.

Kegg farm has developed a model to reach the nook and corner of the country.
Breeding farm/ hatchery→chicks→Dealers (Feed, chicks, medicines) →Mother (Brooding units rear chicks up to3-4 weeks growers) →*Pheriwalas* (cycle vendors)→ rural farmers.

The author has seen unemployed rural youth of Bihar procuring kuroilers chicks from the nearby districts/state and rearing them to marketing age. They then wholesale it to the retailers who dress it and sell it in the market. There are some other poultry producers who rear chicks up to 2 weeks of age. They make a profit of Rs.5/- per bird and sell it to *pheriwalas*. The *pheriwalas* are cycle vendors who keep live chicks in bamboo baskets covered with mosquito net. These *pheriwalas* sell the produce among rural folk at a small marginal profit.

The services provided by the kegg farms include farmers' training, technical assistance, organizing seminars and workshops, circulating literature in local language.

Performance parameters of kuroilers

S.N	Parameters	Productivity	
1.	Body weight (in kgs) at 20 weeks	Males	2.3-2.4
		Females	1.8-1.9
2.	Yearly egg production (nos.)	Scavenging condition	150
		Village condition	200

3. GOVERNMENT EFFORTS:

In 2009, the Government of India launched a centrally sponsored scheme for "Poultry development". Birds with higher productivity are to be distributed among BPL families and mother units for rearing chickens up to 4 weeks are set up.

S.N.	Name of Organisation	Released stock
1.	Project Directorate on Poultry, Hyderabad	Vanaraja, Krushibro
2.	Central Avian Research Institute, Izatnagar	CARI Gold, Nirbheek, Hitcari
3.	Central Poultry Development Organization (ER), Bhubaneswar	Kalinga Layer
4.	Central Poultry development Organization (NR), Chandigarh	Chabro
5.	University Of Agricultural Sciences, Hebbal, Bangalore	Giriraja, Girirani
6.	Jawaharlal Nehru Krishi Vishwavidyaalaya, Jabalpur	Krishna J
7.	Poultry Research Station, Nandanam	Coloured layer

Among the government sector Vanaraja has been widely popular among the rural hinterlands. Vanaraja has been developed by the Project Directorate on Poultry (PDP) using Cornish population as male line and random bred meat control as female line. The bird has multi-coloured plumage and adaptability to adverse climatic condition. It is widely popular as rural backyard poultry among the various states. The author has seen these birds being immensely popular among the people of Kashmir valley for its body weight, bright colour plumage, egg laying capacity, disease resistance, and chick survival. It was their prized possession they showed to their guests and offered in dinner during Id or Bakrid. Vanaraja survived the harsh winter of Kashmir. However, its voracious appetite, eating whatever is there in the kitchen garden, bullying the native Kashmir fevorella, long and hard bone (poor organoleptic attribute) and non-broodiness has not gone well with the Kashmiris. Since the birds are non-broody the eggs have to be hatched under native fevorella hen or in the government hatchery. In Bihar, Vanaraja chicks have been distributed among the rural population by the animal husbandry department. Hatcheries have been set up and eggs of Vanaraja are being hatched for supply to the farmers. However, more effort is still needed.

Performance parameters

S.N	Parameters		Productivity
1.	Body weight (kgs)	at 6 weeks	0.8
		at 26 weeks	2.0-2.2
2.	Average egg weight (g)		55-63
3.	Yearly egg production		140-150

Birds for rural backyard poultry released by the Central Avian Research Institute

CARI Devendra: Dual purpose medium sized bird developed from coloured synthetic broiler as male line and Rhode Island Red as female line. It has attractive bright plumage colour.

Performance parameters

S.N	Parameters		Productivity
1.	Body weight (kgs)	at 8 weeks	1.1-1.2
		at 10 weeks	1.4-1.5
		at 12 weeks	1.7-1.8
2.	Feed conversion ratio (0-8 weeks)		2.5-2.6
3.	Age at sexual maturity (days)		155-160
4.	Yearly egg production		190-200

CARI BRO Dhanraja: Commercial cross of coloured synthetic male and female lines. It has bright plumage with single comb.

Performance parameters

S.N	Parameters		Productivity
1.	Body weight (kgs)	at 6 weeks	1.5-1.7
		at 7 weeks	2.0-2.1
		at 12 weeks	1.7-1.8
2.	Feed conversion ratio (0-7 weeks)		1.92

Birds developed for tropical climate: Various genes responsible for characters such as naked neck (absence of feathers in the neck region) and frizzle plumage have been introduced for tropical climates.

CARI BRO Mrityunjay: Developed through introgression of naked neck gene into coloured and white synthetic broiler lines. The stock has adaptability to high ambient temperature and ideal for tropical environment.

Performance parameters

S.N	Parameters		Productivity
1.	Body weight (kgs)	at 6 weeks	1.4-1.5
		at 7 weeks	1.8-2.0
2.	Feed conversion ratio (0-6 weeks)		1.95

CARI BRO Tropicana: Naked neck and frizzle genes were introgressed to broiler stocks from desi. These stocks were crossed to develop this bird.

Performance parameters

S.N	Parameters		Productivity
1.	Body weight (kgs.)	at 6 weeks	1.3
		at 7 weeks	1.8
2.	Feed conversion ratio (0-6 weeks)		2.11

Some Indian breeds have been used to develop birds adapted to Indian condition Aseel a native breed is endowed with fighting ability and Kadaknath with organoleptic attributes.

CARI Nirbheek: A cross of Aseel with CARI Red. They escape from predators due to activeness and fighting character.

Performance parameters

S.N	Parameters		Productivity
1.	Body weight (kgs) at 20weeks	Males	1.85
		Females	1.35
2.	Annual egg production (nos.)		198

CARI Shyama: A cross of Kadaknath with CARI Red. Black plumage and the viscera is also black coloured due to deposition of melanin pigment. Melanin causes increased protein deposition and decreased fat and muscle fiber length.

S.N	Parameters		Productivity
1.	Body weight (kgs) at 20weeks	Males	1.46
		Females	1.12
2.	Annual egg production (nos.)		210

Hitcari: A cross of native naked neck with CARI Red. The neck region is devoid of feathers. Birds can tolerate high temperatures in extreme summer.

S.N	Parameters		Productivity
1.	Body weight (kgs)	at 8 weeks	0.5
		at 12 weeks	1.0
2.	Annual egg production (nos.)		100-120

Upcari: Indian native chicken with frizzle plumage has been utilized for development of Upcari birds. These multi-coloured birds are better adapted to tropical climate because of frizzle plumage.

Performance parameters

S.N	Parameters	Productivity
1.	Body weight (kgs) at 20 weeks	1.3
2.	Age at sexual maturity (d)	165
3.	Annual egg production (nos.)	220
4.	Egg weight at 40 weeks (g)	60
5.	Hatchability, Fertile eggs set (%)	84

Recently efforts have been made for improvement of native ducks and other alternative species of poultry for diversification and adoption among farmers. The author has observed that for proper

adoption among farmers in the initial stage they should not be provided day-old chicks. Farmers do not provide proper brooding, medication, vaccination in the initial phase and the result is heavy mortality. Infrastructure creation at farmers' level will also entail heavy expenses. Hence such extension programmes providing day-old chicks to farmers are deemed to fail. Even before distributing 4 weeks old chicks reared under proper vaccination and brooding they have to be observed for other disease as well such as coccidiosis and it is prudent to provide medication before distribution among farmers. Before distribution, farmers have to be made aware that whenever they notice any observable symptoms of disease among their flock they should immediately report it to the veterinarian. They should also provide some supplementary feeding of broken rice, crushed maize etc to realize their full growth potential. The veterinarian should at proper intervals visit to see the symptoms of the disease and if needed perform post-mortem examination for proper diagnosis. Newcastle disease and Infectious Bursal Disease have been commonly observed among the flock in rural poultry almost anywhere in the country and Infectious coryza have been observed in the Kashmir valley.

Another problem with the rural poultry is predators. Fear of wild animals such as foxes and domestic animals such as cats consuming backyard poultry dither farmers. Hence some cheap housing with wire mesh and bamboo or wood work has to be provided to the birds for safety from predators. The farmers who have previous experience and cheap housing can be given backyard poultry for successful adoption. Many of the people from the scientific community hold the view that introduction of developed stock and their successful adoption among farmers will lure them from rearing *desis* and the native population such as Kashmir Fevorella may be endangered. Besides the non-broodiness of these birds, dominance for feed and their mating with the indigenous stock will produce yet another cross. Hatcheries in sufficient numbers are lacking and 24hrs assured electricity for hatcheries is a must. However, author is of the view that *desis* enjoy advantage on organoleptic attributes over any of these stock; Kadaknath in particular has no parallel. Their heavy consumption may rather endanger them. Which of the view is right that is for the future to decide.

Apiculture for Livelihood Support to Women Folk

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Introduction

Beekeeping is an important activity for many rural people - both men and women. Increasingly both governments and NGOs are working to encourage women's participation in rural development and beekeeping has been identified in many places as a means of additional income generation that is suitable for women. Few cultures have any taboos threatening the involvement of women in beekeeping. Apiculture is a very profitable occupation and suitable for small and marginal farmers and even for landless. India has achieved some progress in this industry using its own technologies and developmental Planning. A more than 5000 tone of honey is produced annually in our country. Apiculture is an absorbing hobby to some, and to others it is an industry for producing honey and wax. In ancient times, honeybees have been kept in a crude manner in India. Apiculture today is based upon improved methods using the principles of movable frame hive, honey extractor and the smoker. Apiculture is an ideal hobby because it involves outdoor works and does not require much time. It is both interesting and instructive. Moreover, the return in the form of money and mental satisfaction are highly gratifying. Apiculture is an asset as honeybees help in increasing crop yield through pollination and gather nectar to produce honey and wax. It is a well considered view that the income derived by increased crop yield due to beekeeping is quite substantial. Beekeeping is a rewarding livelihood activity for many farming communities globally (Adjare 1990; Hussein 2000). Unlike other agricultural practices, beekeeping can be undertaken with marginal infrastructure, little capital and easy-to-learn skills (Singh 2000). Worldwide, significant livelihood improvements have resulted from small-scale beekeeping initiatives (Singh 2000).

Apiculture for women folk

Beekeeping can be started cheaply and built up as resources allow, there is little need for land ownership and, with some technical know-how, and hives can be located close to home. The demands of time are not great and these can be fitted in with family responsibilities. These are all positive attributes that should encourage women. Nonetheless, beekeeping is frequently perceived to be a male activity and women's participation in beekeeping projects is often lower than might be expected. Therefore, the promotion of beekeeping as an income-generating activity for women folk should be the promoted in especially in rural areas where mostly women’s are involved in agricultural activities.

The country like India, it very low participation of women in beekeeping. The reasons uncovered were: women were afraid of bees; they could not climb trees; beekeeping was considered a 'man's occupation'. Moreover, traditional ways of living restricted women to carrying out domestic activities close to the homestead which hindered participation in beekeeping. Author of this chapter suggests these reasons mirror those given for limited access of women into beekeeping in other parts of the world.

However, women commonly use the fruits of beekeeping to make value added products such as candles or beer. The production of secondary or value added products made from honey, beeswax or other hive products offers a unique space for women's traditional skills. Where work and childcare commitments constrain women to remain within the vicinity of their homes, enabling women to produce value added beekeeping products can be an ideal opportunity for income generation. Male beekeepers are often not interested in this area so it is not challenging to the cultural status quo. Women's role in enterprise and household decision making, their access to assets and their control over the self earnings have improved significantly among client than non-client group. The livelihood diversification activities are of increasing importance for women empowerment (Bryceson, 1996 and 2000; Bryceson and Jamal, 1997) through additional income earning and improvements in family welfare (Ellis, 1999) supplemented by self help micro credit (Hulme and Mosley, 1996; Johnson and Rogaly, 1997).

Women in Apiculture

The question which usually presents itself, however, is whether Apiculture is suitable for women as a means of earning a livelihood and repeatedly has the writer been asked for advice on this subject. Professional beekeeping on a scale sufficiently large to supply an adequate income requires long hours of work in the hot sun, heavy lifting and unremitting physical endurance. On a small scale these obstacles may be overcome, but in a commercial apiary, the work must be done promptly, for delay means loss. While some women have found pleasure and profit in the commercial beekeeping, it emphatically cannot be recommended for the majority of women, and this should be made clear to avoid disappointment for those who may be attracted to it. Of course, this applies only to those women who have no man in the company to do the heavy work. Many a professional beekeeper has received assistance of incalculable value from the women of the family. It should be made clear that the obstacles to the commercial success of women beekeepers are physical ones only. Many women can and do handle bees with marked success. In those parts of the business which require delicacy of touch and minute attention, such as queen-rearing, women often surpass men in proficiency as amateur beekeepers they are at home. For the management of honey bees in the rural area it is so important to cater the need of farm women in agriculture. Even though the number of farm women is less in apiculture.

Apiculture

Even though apiculture is concerned with only the industrial aspect of the honeybee, it is essential to know its biological aspect too to be able to understand the former. So this topic can be described under three subheads: The Honeybees, Beekeeping and Bee Products.

A) The Honeybees

Usefulness of honeybees has been known to man from the prehistoric times. The bees have been mentioned in the Vedas, the Ramayana, the Mahabharata, the Quran and other holy books. Honeybees belong to that group of insects which are called by their generic name, *Apis*. There are only four species of *Apis* in the world, all of which build wax combs gather and store a surplus of pollen and nectar. Two species *Apis florea*, the smallest of the four, and *Apis dorsata* the largest, build a single comb in an exposed area, usually under a large branch of a tree. They do not nest in cavities and found in tropics only and have the least economic value. The other two species namely *Apis indica* and *Apis mellifera*

nest in protective place and found in both temperate and tropical areas kept in modern movable frame hives.

Kind of Honey bees

We shall briefly describe these species in the following paragraphs.

***Apis dorsata*:** Also called rock bees and giant bees, these are the largest of all the bees and found all over India and make the largest hives- 6 feet long and 3 feet deep that hang from high rocks and tall trees. The colonies shift from place to place to avoid extremes of climate or search of honey. They are very industrious, produce about 36 kg honey per colony per year but unfortunately are also the most ferocious not spring their victim even inside the water. Their poison can kill the man.

Apis cerana indica: It is the common Indian bee found both in the forests as well as in plains throughout our country. It is smaller than the rock bee but larger than little bee. Unlike the *Apis dorsata* and *Apis florea*, the Indian bee builds many parallel combs in the cavities and hollows of tree, caves and such other hidden sites; the combs being parallel to the direction of entrance in the plains and right angles to the entrance in cold regions. It is mild and capable of domesticated and is commonly reared in south India. The annual yield of honey is 2 to 5 kg per colony. A queen can lay 350-1000 eggs per day. Races of this species found in hill region are darker and larger and plain races smaller and yellow are recognized.

Apis florea: It is known as the little bee since it is the smallest of the four species of *Apis*. It is seen only in the plains. It also builds single but small combs on bushy plants and corners of roofs. It yields very little honey, about 0.5 to 1 kg per year from a colony, and so, it is not domesticated and reared.

***Apis mellifera**:* or the European bee has originated in Italy and been introduced into all the countries of the world where they have formed the well recognized races viz. *Apis m. ligustica*, (Italy), *Apis m Indica* (India), *Apis m sinensis* (China) etc. The behavior and look of *Apis mellifera* are so similar to those of *Apis cerana indica* that one can be easily mistaken for the other but has a prolific queen, swarm less and has good honey gathering qualities, yielding about 45-180 kg per year and can guard its nests against enemies except wasps. As such beekeeping has proved to be a productive commercial proposition in the USA. It has adopted itself well to modern methods of movable frame hives and, therefore, is the darling of beekeeping industry the world over.

Organization of bee colony:

Like other social insects a honeybee colony comprises three casts: the drone (male), the queen (Functional female) and the worker (sterile female). The drones are more heavily built than the workers and the queen. They do nothing except fertilize willing virgins either of their own colony or of any other colony. They are of lazy habits, eat a lot; 3-6 worker bees are needed to feed a single drone. They beg workers for their food. At the end of the breeding season (spring) and before monsoon and winter, they are driven out of the nest either to die of starvation or go to neighbouring nests having virgin queens. The queen is larger than the other two castes with her abdomen swollen with eggs. There is only one egg laying queen in a colony. Five to 10 days after emergence, she takes one or more flights (nuptial or marriage flights) followed by several drones. Only one drone succeeds in mating which may occur 1-6 times during the flight. The drone dies in copula and both fall to the ground. The female frees herself from her dead mate and returns to its nest often with the reproductive organs of the male sticking to her posterior. During mating, the female is able to store about 2 crores of spermatozoa in her spermatheca where they can survive for over 3 years. The queen has the ability to fertilize her eggs at will. Fertilized eggs produce females, the unfertilized ones males. A queen can lay up to 15,000 eggs per

day, a perfect egg-laying machine. The workers are smaller than the sexual and have underdeveloped reproductive organs due to the influence of the pheromones produced by the queen. A worker bee has a life of 6 weeks of which 3 are spent on indoor chores performing all the household duties like feeding and attending the queen, feeding the drones (if they are still needed) and the brood, secreting royal jelly and beeswax, constructing combs, cleaning, ventilating, cooling and guarding the hive, evaporating nectar and storing honey. During the next 3 weeks, it takes to an outdoor life foraging to collect nectar, pollen, propolis (bee gum) and water and ripening honey in its honey stomach (proventriculus). A worker bee dose not has an individual existence; it lives for the good of the entire colony. It dies in harness during flight to flowers. The proverbial busy- bee is able to gather just a dessert spoon full of honey in its lifetime. To collect 1/2 kg honey, the workers have to make 40-80 thousand trips from their hive to the flowers and considering each one –way trip to be of $1^{1}/2^{-3}$ miles, they cover a distance equivalent to going round the equator 5 times to collect this much of honey. A bee colony is called week or strong according to the number of workers it has. An average colony of *A. indica* has 15,000 workers and a strong one 80 thousands. The feature distinguishing the 3 castes are summarized in the Table below.

Morphological features distinguishing the three castes of a honeybee

	Drone	**Worker**	**Queen**
1.	Eyes meet over head	Eyes far apart	Eyes far apart
2.	Abdomen black, rectangular, blunt and without a sting	Striped, triangular with barbed sting	Golden (A. florae) or black (A. indica), triangular but more elongated (beyond the wings) with a sword-shaped sting
3.	Has a life-span of 3 weeks	6 weeks	2-3 years

(a) Life- history of a honeybee

The nest or comb of a honeybee has 3 types of hexagonal cells: worker cells (smallest, 1/5" in *A. indica*), drone cells (larger than those of the worker, ¼") and queen cells (the largest). The queen walks over the combs deciphering the cell-sizes with its antennae and depositing one egg in the bottom of each cell. The eggs may be fertilized to produce females or unfertilized to produce males and they are accordingly deposited in the cells of the required size. The eggs are perpendicular to the bottom when laid, get inclined on the second day and turn horizontal on the third day when they are about to hatch while hatching time for all eggs in the same (3days), period of development of larva and pupa differ amongst the castes. They are given in the Table below.

Periods of development of different castes of *A.indica*

	Egg	**Duration (in days) Larva**	**Pupa**	**Total**
Queen	3	5	7-8	15-16
Worker	3	4-5	11-12	18-20
Drone	3	5-7	13-14	21-24

(b) Feeding of larvae

The transformation of 3 castes depends on the amount of 'royal jelly' or 'brood-food' produced by the pharyngeal salivary glands of the workers. The chemical composition of royal jelly is lipoproteins, neutral glycerides free fatty acids, sugar, amino acids and all the B vitamins. For the first $2^1/_2$ days all larvae are given plenty of this food (obligatory feeding) after which those destined (chosen) to become workers and drones (identified by the size of their cells) are given rationed (controlled) food for 6-7 days and those destined to become queens continue to receive abundance of brood-food for $4^1/_2$ -5 days (facultative feeding). On the 8th, 9th and 10th day of emergence, the cells of the queen, worker and drones are respectively sealed i.e. capped with wax. The cap of the drone cell in convex with a central hole, those of the workers, queen, honey and pollen cells are flat.

5. The comb

The comb provides accommodation for rising of the young bees and the storage of food. The combs are built with beeswax which is secreted by 4 pairs of wax glands located on 3-6 abdominal sterna. The wax, secreted in a liquid from, collects in the intersegmental regions, hardens in to thin flakes that are picked up by the legs and passed on to the spatulate mandibles for being kneaded and stuck to the top of nesting cavity and extended downwards bit by bit. Several bees hang like a string to do this job. First to be constructed is the midrib on both surface surfaces of which are also made hexagonal, cells for the broods and food. After the first or central comb is completed, adjacent combs are made $13/_8$ inch apart in the case of *A. mellifera* and much larger in the hill varieties of *A. indica* but a little less in the plain varieties. As the combs increase in number, they are attached to the sides of the cavity as well as to the top but seldom to the extreme bottom. As already mentioned, the nests of *A. dorsata* and *A. florea* are made of single vertical comb; those of *A. mellifera* and *A. indica* comprise a series of parallel (horizontal) combs. There is a definite sequence in the locations of the cells for different function. Usually the cells meant for honey storage are located uppermost near the point of attachment of the comb below which are pollen cells spread in 2" wide band, further down are worker brood cells which is followed by the drone and queen cells. New queen cells are built only when the old queen being in ineffective to rule is to be replaced by a supersedure queen or if the queen accidentally dies and an emergency queen has to be produced or when the colony has the urge to reproduce by swarming. As mentioned earlier, the worker cells are the smallest, drone cells larger than the worker cells and queen cells, the largest. Worker and drone cells are directed sideway, queen cells vertically with open ends downwards. The cells of the size of worker and drone cells used for storing honey and pollen. Cells are caped or sealed after the purpose for which they are meant is over. Cells containing unripe honey or developing brood are uncapped; those with fully ripe honey and fully fed grubs and capped and pollen cells are generally not capped. Only drone cells, as noted above, have a dome shaped or convex caps with a central hole, other have flat caps.

Swarming: Swarming is a method of reproduction in which a part of the colony migrates to a new site to make a new colony. Its preparations start when a colony has built up a considerable strength and there is a need to make another colony.

Supersedure: A failing queen who is unable to lay as many eggs as the colony require, or who begins to run out of spermatozoa and so lays a high proportion of male eggs will need to be superseded (replaced) by supersedure queen.

Emergency queen: In the event of death of the queen and therefore, a complete absence of the queen substance, the workers are stimulated to get set for producing an emergency queen.

Absconding and swarming: Complete desertion of a hive is known as absconding. This may occur due to lack of water, exhaustion of food store (either due to short supply of nectar or robbery of honey), overheating due to poor insulation and ventilation of the place where nest is made, constant pest attack and even by excessive interference by the beekeeper in which case the keeper is regarded as an enemy.

B) **Modern method of beekeeping:** Currently there are four types of frame hives in use the world over: Smith, British commercial, Langstroth and Modified Dadant types. A movable frame hive, Langstroth or M.D. is composed of the following Parts: Stand, Floor Board, Brood box, hive frame, Queen Excluder, Supers and covers which are briefly described as follows:

1. **Stand:** It is a four legged structure, 6-9 inches high with dimension to support the floor board.

2. **Floor Board:** It is a tray with its entire four side raised by side runners and a piece 5"x7/8" is removed from the middle of the front side runner to allow entry to the bees.

3. **Brood box:** It is a rectangular box without top and bottom. The number of brood boxes could be increased to 2 when the colony becomes strong.

4. **Hive frames:** These are wooden frames and it's under surface is grooved to receive the edge of the comb foundation. To be precise and perfect, comb foundations are made by machines.

5. **Queen excluder:** To obtain pure honey free from extraneous matter, it is necessary to separate the brood chamber from the supers where honey stored with the help of zinc or wire frame with 2.3- 3.5 mm perforations to enable the workers to pass through but not the queen.

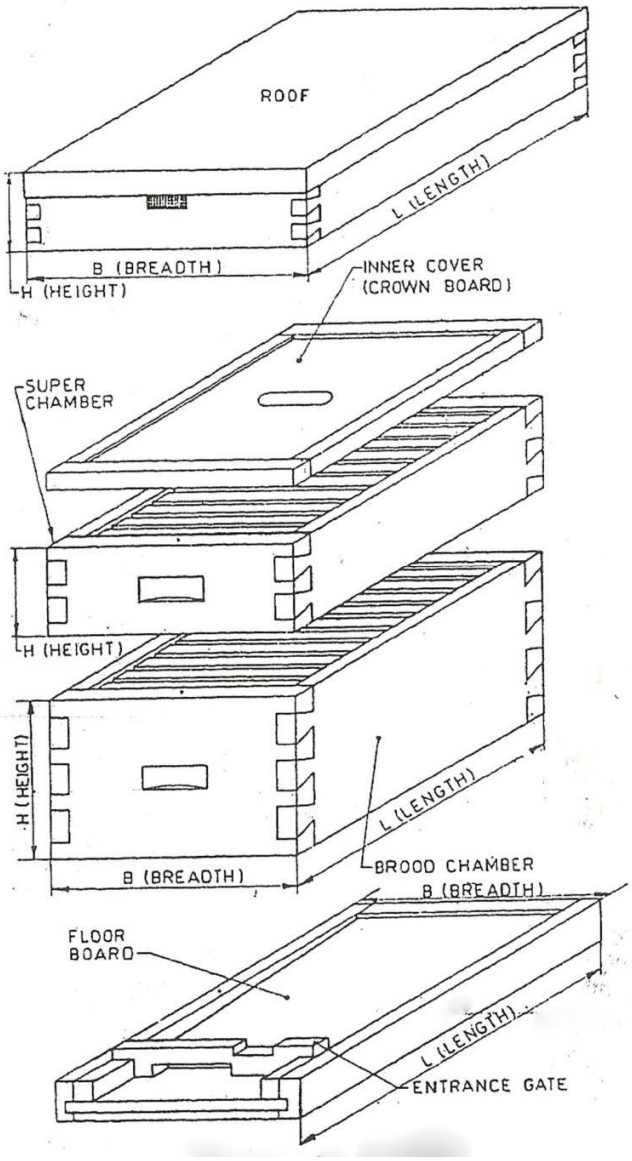
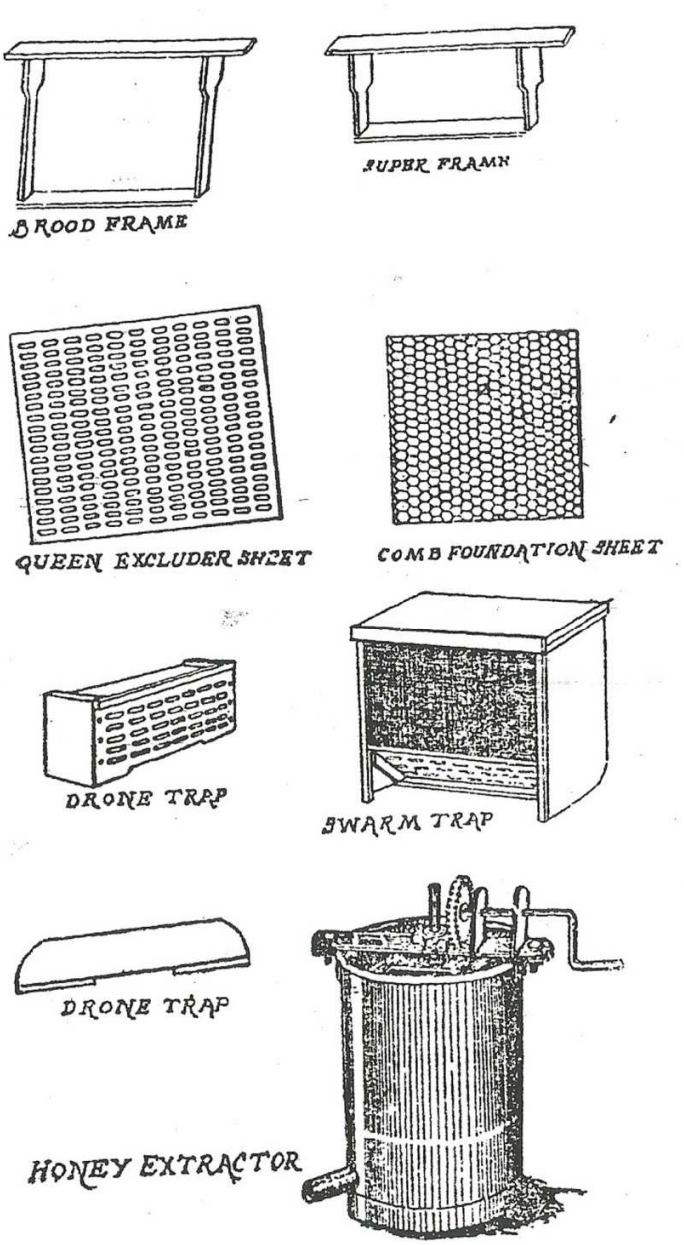


Fig. 1. Exploded Assembly Bee hive and its Components (From IS 1515: 1998)



6. **Super:** It is like brood boxes and is placed over the queen excluder.
7. **Cover:** There are two covers: an Inner is flat broad with oval holes allow the bees to go out but not re-enter. The outer cover acts as a roof for the hive.
   Inside dimensions (in inches) of the components of a Langstroth frame hive-

	Length	**Width**	**Height**	**Thickness**	
Floor Board	22	$16^{1}/_{4}$	-	$^{7}/_{8}$	
Brood box	18	$16^{1}/_{4}$	$9^{1}/_{2}$	$^{7}/_{8}$	
Super	18	$16^{1}/_{4}$	$9^{1}/_{2}$	$^{7}/_{8}$	
Queen excluder	20	$16^{1}/_{4}$	-	$^{7}/_{8}$	
Cover					
Inner cover	20	$16^{1}/_{4}$	-	$^{3}/_{8}$	
Top flat cover	21	17	-	$^{3}/_{8}$	
Top sloping cover	20	$16^{1}/_{4}$	-	$^{3}/_{8}$	With 26" slanting ruffs all either side
Frames					
Hoffman self spacing type :top bar	19	1	-	$^{7}/_{8}$	Its under surface is grooves to receive come foundation
Side bar	$9^{1}/_{8}$	$1^{3}/_{8}$	Upper half	$^{3}/_{8}$	(with four holes for warring)
		1	Lower half		
Bottom bar	$17^{5}/_{8}$	¾	-	$^{3}/_{8}$	
Staple spacing type:					
Top bar	19	1	-	$^{7}/_{8}$	Its under surface is grooves to receive come foundation
Side bar	$8^{3}/_{4}$	1	-	$^{3}/_{8}$	(with four holes for warring)
Bottom bar	$16^{7}/_{8}$	1	-	$^{3}/_{8}$	

The bee hive should be made from suitable timbers that do not emit strong smell. Suitable timber like teak and toon painted white only on the outside.

Other Equipments needed for beekeeping:

1.	Bee Veil	**10.**	Swarm bag
2.	Overall	**11.**	Smoker
3.	Bee glove	**12.**	Wireless embedder
4.	High boots	**13.**	Comb cutter
5.	Hive tools	**14.**	Bee Brush
6.	Scraper	**15.**	Cold uncapping knife
7.	D.B (Division Board)	**16.**	Steam uncapping knife
8.	Rectangular queen cage	**17.**	Uncapping basket
9.	Conical queen cage		

Diseases of honeybees: i) Nosema disease. It is caused by a protozoan, *Nosema apis* which attacks lining of the stomach causing dysentery. The contaminations spreads through faeces of infected bees and eaten up by workers mostly in winter season. Sterilization of brood boxes and frame hives with glacial acetic acid fumes (soaked in cotton) or with 40% formalin fumes only after the queen and the bees have been transferred to new foundation.

ii) Amoebic Disease. It is caused by protozoa, *Malpighamoeba mellificae* which infest the malpighian tubules. It can be treated in the same way as *Nosema.*

iii) Acarine disease. It is caused by a parasitic mite, *Acarapis woodi* which enter through the tracheae and feeds upon the body fluids. It can be controlled by exposing the affected colony to a mixture of safrol oil (1 pt) nitrobenzene (2 pt) and petrol (2 pts).

iv) Brood disease: The brood o honey bee is attacked by various bacteria, fungi and viruses which take a heavy toll. The symptoms of a brood disease are discoloured larvae, dark, punctured and sunken capping and discontinuously scattered brood in odd positions inside the cells.

Enemies of Honeybees: A brief account of the bee enemies is as follows:

1. **Moths:** They can be divided into robbers and breeders. The robber is Death's head hawk moth, *Acherontia styx* which enters the hives at night and drink up the honey. The breeders are the greater waxmoth, *Galleria mellonella* lay their eggs in the combs and the larvae burrow through the wax, feeding particularly on pollen and weaving tunnels of silk and destroy the comb. The use of paradichlorobenzene in stored combs gives protection against this moth and also against hive beetle.
2. **Wasp:** They catch bees from blossoms or even from inside their hives, sometimes finishing off the entire colony. To protect destroy their papery nests by burning them or spraying insecticide.
3. **Ants:** Several ants visit bee colonies and take away honey, brood, pollen, dead bodies and other debris. In the apiaries, the hive should be placed on stands whose legs should be wrapped with tapes soaked in corrosive sublimate, a good ant repellent.

4. **Others enemies:** Lizards, toads and frogs, birds, and mammals are insectivorous and protection against them could be had by keeping the hives on stands and being watchful.

C) Bee Product

Honey: Honey is made from nectar, a sugary fluid, secreted by the nectar glands (nectaries) presents on the bases of flowers of trees, shrub and herbs. Honey when fully ripened consists of the following substances:

Sl. No.	Substances	Percent (Approximately)
1.	Levulose (Fructose)	41.0
2.	Dextrose	35.0
3.	Sucrose	1.9
4.	Dextrins	1.5
5.	Minerals	2.0
6.	Water	17.0
7.	Undetermined (enzymes, vitamin, A, B, and C, acids, pigments etc)	3.4

Use: Food and medicine

Bee wax: It is an important by product of the Apiculture industry produced from old combs, capping collected after honey extraction, and combs affected by wax moth. It is an yellowish solid, insoluble in water used in the manufacture of many cosmetic items like, beauty lotions and creams, lipsticks, ointment, polishes of boots, floor and furniture, ink varnishes and electrical insulating apparatus etc.

Propolis: It is a resinous substance used by bees for sealing cracks and unwanted spaces.

Scope: Beekeeping can be a profitable occupation in area with good floral pasturage. Possibility for the development beekeeping in Bihar and India is tremendous due to its diverse environment and inexhaustible floral resources obtained from natural vegetation and cultivated crop. According to recent statistics, about 50 million hectares of land is under the cultivation of oilseeds, pulses, orchards and other crops useful to bees and benefitted by bee pollination. In addition, there is about 60 million hectares of forest area with beekeeping potential. This vast area of agriculture and forest may easily sustain at least one crore bee colonies.

Beekeeping can profitably be pursued by men, women and children, by farmers, orchardists, and by those who are landless or unemployed. Beehives can be kept to the backyard or on house tops. A subsistence farmer can get higher income from beekeeping than from other avocations. Those who have the time and interest can manage a number of beehives and make beekeeping a profitable enterprise by selling the surplus honey and wax. Several people in a village or group of villages may join, together and start a cooperative, generating work and income, since the manufacture of the basic beekeeping equipments such as hives, frames, smokers, extractors and containers, as well as the processing of honey and wax can be done locally.

India has about eight lakh bee colonies, considering the modern beekeeping which arrived in India only three decades ago with the advent of the *Khadi* and village industries commission (KVIC), today the number of bee colonies and beekeepers cooperatives are 8, 10, 807 and 169 respectively. It has made a spectacular achievement. Kerala, Tamil Nadu, West Bengal, Bihar, Orissa, Himachal Pradesh, Kashmir, Punjab, Meghalaya, Andman and Nicobar Island are the important states in which beekeeping cooperatives are active.

Problem:

Problem associated with bee keeping are

I) Non availability of honey boxes to the beekeepers.
II) Lack of honey marketing facilities and
III) In adequate training in the management of Apiary.

A viable proposition in this regard is to strengthen the beekeeping cooperatives and establish the bee industry as a whole and national beekeeping farms on forest land.

Recycling of within farm renewable resources: An entrepreneurial opportunity for woman folk

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Women in India number nearly 500 million constituting 49% of total population of which 70 % lives in villages. In rural India, agriculture and allied industrial sectors employ as much as 89.5% of the total female labor. Women constitute 51% of the total employed in forest-based small-scale enterprises. Farm-women carry out 75-80% farm work with 50-66% of them contributing to agricultural labor. In case of livestock more than 90% of the work is done by women (Sridhara et al., 2009). Nevertheless, it is estimated that presently women entrepreneurs comprise about 10 percent of the total entrepreneurs in India. However, this percentage is growing every year. First prime minister of India Jawahar Lal Nehru has remarked "when a woman moves forward, the family moves, the village moves and the nation moves." When a man is educated, he alone is benefited, but when a woman is educated her family and society are benefited. In fact, women co-operatives are known to be run more efficiently than those run by men. Women entrepreneurs can play powerful role in confidence building and creating awareness in other women to promote self-reliance. With majority of woman in rural India, it is important to develop entrepreneurship skills in rural environment. Entrepreneurship development among rural women helps to enhance their personal capabilities and increase decision making status in the family and society as a whole. They are engaged in starting individual or collective income generation programme with the help of self-help group. This will not only generate income for them but also improve the decision-making capabilities that led to overall empowerment. Several surveys conducted in different parts of the world regarding women entrepreneurship management show that women have provided to be good entrepreneurs for the following reasons:-

- Economic independence.
- Establishing own credit idea.
- Social Identity.
- Achievement of excellence.
- Confidence.
- Status in society.
- Greater freedom and mobility.

When an enterprise is established and controlled by a woman, it not only boosts economic growth, but also has many desirable outcomes. Growth of entrepreneurship and setting up new industries has been the prime focus of governmental bodies, NGO', social scientist, researchers, international agencies in today's expanding economy and woman can play a vital role in this revolution. Use of recyclable resources and developing this into a business will play a big role in generating jobs and revenue for rural women. This seems to regain performance because of their environmental considerations.

Keeping in view the conservative population estimate of 1.4 billion by 2025 and minimum caloric requirement of food, the country will need to produce at least 300 m t of food grain. For this purpose, it will be necessary to use 30 to 35 m t of NPK from various sources. In addition, according to National Academy of Agricultural Science (NAAS, 1997), the experts on horticulture, vegetable, plantation crops, sugarcane, cotton, oilseeds and potato have projected that by 2025, the demand for fertilizers for these high value crops, which also have high export potential and claim fertilizer use on priority basis, will rise to 3.0, 2.0, 3.2, 0.9, 3.1, 1.5 and 1.0 m t respectively. This adds to the total

nutrient needs by another 14 to 15 m t NPK, in addition to the other secondary and micronutrients. Thus, the country will be required to arrange for the supply of about 40 to 45 m t of nutrients by 2025. It has been estimated that the total available nutrient value of organic resources in India is 12.796 m t (Bhattachacharya, 2007). Harnessing the nutrient energy of within farm renewable resources include crop residues, farm wastes. They are valuable sources of plant nutrients and humus. In tropical and sub-tropical soils found in India, there is a general deficiency of organic carbon and plant nutrients due to rapid loss of these components by biodegradation. To make up for these losses, extensive utilization of organic residues in agriculture is essential. In addition they also protect the soil from erosion. The manurial value and quality of these wastes could be improved by composting and enriching these organic sources along with inexpensive materials such as rock phosphate. In India, there is great potential for utilization of crop residues / straw of some of the major cereals and pulses. Approximate availability of straw is to the tune of 141.2 m t, which contributes about 0.7, 0.84 and 2.1 m t of N, P_2O_5 and K_2O respectively, after deducting 50% quantity utilized as animal feed. (Sharma, 2009). Farm manures should be returned to the fields. As a rule, organic matter fit for soil application should not be burned. In India, the estimated production of dung and urine from bovine population works out to 1002 and 658 m t respectively. They contribute about 5.71 m t of N, P, & K. Cow dung is an important input for biogas plants having dual advantage of providing both fuel (gas) and fertilizer (slurry) (Sharma, 2009). Agro – forestry systems can lead to more nearer to the nutrient cycling than agriculture.

The following renewable resources in farm can be utilized by women to develop business set-up in small and eventually in big scale easily in rural environment.

Vermi compost

Vermi compost, also called as worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by an earthworm. These castings have been shown to contain reduced levels of contaminants and a higher saturation of nutrients than do organic materials before vermi composting. Practice of vermi compost production and selling/or for own use will increase the family income substantially. To start with on average single farm-women may have 2 tanks of 3x2x10 ft size from which they will get Rs. 10,000/annum. Generally, Vermi compost yield is around 350 - 450 kg from 1.5 tons fresh herbs/pits in 100 days

Estimated cost of vermi compost production:

			Rs./Ton
Particulars	**Cost of Vermi compost Production**		
	Units	**Quantity**	**Value (Rs)**
Variable Costs			
I. Material Costs	Rs.		1500
1. Agricultural Wastes and Cow Dung	Tons	1.5	1000
2. Earthworms	Kgs.	2	550
II. Labor Costs	Rs.	3	400
1. Pit Filling	Work Days	1	100
2. Worm Separation	Work Days	0.5	50
3. Watering	Work Days	0.5	50
4. Collection of wastes	Work Days	0.3	50
5. Sieving	Work Days	0.75	50

III. Interest on working capital	Rs.		100
IV. Total Variable costs (I+II+III)	Rs.		2000
Fixed Costs	Rs.		
1. Land Rent	Rs.		200
2. Working Shed	Rs.		300
3. Tools and Machinery	Rs.		300
V. Total Fixed Costs	Rs.		800
VI. Total production costs (IV+ V)	**Rs.**		**2800**

Estimated Cost and profit from the sale of Vermi compost

		Rs./Ton
A.	**Production Cost**	2800
B.	**Marketing Cost**	300
i.	Plastic Bags	100
ii.	Packing	50
iii.	Transportation Cost	100
iv.	Loading & unloading	50
C.	**Price Realized per ton**	8000
D.	**Net Profit/ Ton (C-A-B)**	**4900**

Farmyard manure (FYM)

Almost all the women in villages prefer to sell cow dung cakes, but it is high time to train them make available alternate sources of firewood so as to prevent use of cow dung directly for burning. Subabul tree can be used as an alternate in place of cow dung cakes as fire wood in household usage. Being a fast growing tree, Subabul, should be advocated for plantation on their North-West sides of field boundaries (to avoid shading on their farm). FYM also contains plant material (often straw), which is used as bedding for animals absorbing the feces and urine. Agricultural manure in liquid form, known as slurry, is produced by more intensive livestock rearing systems where concrete is used, instead of straw bedding. Manure from different animals has different qualities and requires different application rates. For example horses, cattle, pigs, sheep, chickens, turkeys, rabbits, all have different properties. For instance, sheep manure is high in nitrogen and potash, while pig manure is relatively low in both. Horses mainly eat grass and a few weeds so horse manure can contain grass and weed seeds, as horses do not digest seeds the way that cattle do. Chicken litter, coming from a bird, is very concentrated in nitrogen and protein and is prized for both properties.

Processing of farm yard manure is also not up to mark by the rural people. Women being more receptive than men should also be trained on scientific method of preparing farm yard manure. This will help in propagating the right usage of FYM.

Farm Compost

Compost is the decomposed remnants of organic materials – usually of plant origin, but often including some animal dung or bedding.

Green Manure

Green manuring crop such as dhaincha, glyricidia, cowpeas should get place in crop rotation. These green manuring crops enriches the fertility of soil

Azolla Culture

Azolla is a water fern that can be grown both at farmstead and homestead by resource poor farmers for meeting organic cattle feed supplement in addition to use azolla as dual culture in rice farming and bio-manure for crops, vegetables and plants for environmental conservation and economics.

Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc. Azolla, on a dry weight basis, is constituted of 25-35% protein content, 10-15% mineral content and 7-10%, a combination of amino acids, bio-active substances and biopolymers. Carbohydrate and oil content in Azolla is very low.

Thus the bio composition of Azolla, makes it one of the most economic and efficient feed substitutes for livestock. Moreover, Azolla can be easily digested by livestock, owing to its high protein and low lignin content.

Azolla is useful as a "soybean plant in rice field", because it can assimilate atmospheric nitrogen gas owing to the nitrogen fixation by cyanobacteria (blue green alga) living in the cavities located at the lower side of upper (dorsal) lobes of leaf. Azolla can, therefore, grow on the water deficient in nitrogen compounds, and is high in nitrogen and protein. It fixes nitrogen as high as 3-5 kg N per ha per day under the optimum condition. In the tropics, annual nitrogen gain amounts to 500-1000 kg per ha, when grown throughout the year. It doubles its biomass within 2-3 days. The maximum biomass contains 30-80 ton fresh weight, 1.5-4.0 ton dry weight, and 50-150 kg N per ha. Generally, Azolla multiplies vegetatively.

Azolla covering water surface reduce light penetration to soil surface, resulting in the depression the germination of weeds. Thus, growth of azolla reduces occurrence aquatic weeds in flooded rice fields. Azolla has been used as feed for pig, duck, and fish. A. microphylla is the best, and palatability by fish is better than other species. On dry weight basis, azolla can be mixed up to 10% of the purchased animal feed.

To cultivate azolla, an artificial water body is made, preferably under the shade of a tree, with the help of a silpauline sheet. A pit of the size of 2M X 2M X 0.2M is dug as a first step. This pit is covered with plastic gunnies to prevent the roots of the nearby trees piercing the silpauline sheet, which is spread over the plastic gunnies. About 10 – 15 kgs of sieved fertile soil is uniformly spread over the silpauline sheet. Slurry made of 2-kg cow dung and 30 gms of Super Phosphate in 10 litres water, is poured onto the sheet. More water is poured to make the water level reach about 10 cm. About 500 gms to 1kg of fresh and pure culture of Azolla is inoculated in the pit. Azolla will rapidly grow and fill the

pit. Within 10-15 days about 500 gms – 600 gms of Azolla can be harvested daily. Thereafter, a mixture of 20 gms of Super Phosphate and about 1 kg of cow dung should be added once in 5 days. This is done to keep the Azolla in rapid multiplication phase and to maintain the daily yield of 500 gm. /pit. Micronutrient mix containing magnesium, iron, copper, sulphur etc., can also be added at weekly intervals to enhance the mineral content of Azolla. In this method the cost of production of Azolla is less than 65 ps. /kg.

Sr. No.	Particular	Amount (Rs.)
1	Cost of 120 Gauge Silpauline 2.8mX1.8m (Production in 1sq.m /day is 300gm) Cost of 4 units Silpauline is Rs. 80 X 5	400
2	Labor Charges for Bed Preparation	100
3	Cow Dung 1 X 4 - 4 Kg, Rs. @ X 73	146
4	Superphosphate @4 X 4 = 200g X 73 = 1400gms	7.5
5	Magnesium Sulphate 1 Kg	4
6	Micro-nutrients 73 X 5 = 365gms	15
7	Cost of inoculation material 200 X 8 = 1600gms	5
	TOTAL COST OF PRODUCTION (Rs.)	677.5
	Total Production 350 days in 4 units	1050
	(4Kg/Day for 350 days for 1 yr) kgs/Annum	
	Unit Cost of Production (Rs/Kg) (Rs 677/1050)	0.65/Kg

NADEP Compost

The NADEP Compost is unique compost that can be prepared in certain time frame and with less human effort. The process of making the compost involves layering of several combustible materials in a mud-sealed structure with bricks and water. Approximately, the method converts 1 kg of animal dung into 40 kg of rich compost which can then be applied directly to the field. The NADEP Compost making process was first invented by a farmer named N.D. Pandharipande (also popularly known as “Nadepkaka”) in the state of Maharashtra. Due to its simplicity and ease of applicability in fields, the method became popular among the farmers in Western India and now bears his name. Rural women can easily use this method to generate good quality of compost for their farm usage.

Biogas Plant

Biogas is a methane rich flammable gas that results from the decomposition of organic waste material. It is produced by the anaerobic digestion or fermentation of biodegradable materials such as biomass, manure, plant material, and crops. In Biogas plant digester is an important part. It is an airtight circular pit made of concrete with a pipe connection. The manure is directed to the pit, usually directly from the cattle shed. The pit is then filled with a required quantity of wastewater. The gas pipe is connected to the kitchen fireplace through control valves. Owing to simplicity in implementation and use of cheap raw materials in villages, it is one of the most environmentally sound energy sources for rural needs.

There are two models -- floating and fixed type–which are being propagated in India. Of these Deenbandhu model was popular with people and there are various variations of this model such as biogas model re-enforced with Bamboo. An important innovation for the construction of bio gas plants, using bamboo reinforced cement mortar (BMRC) of 2 cubic meter (2 m^3) capacity had already been experimented and field tested jointly by WAFD (Women's Action For Development) and INSEDA (Integrated Sustainable Energy and Ecological Development Association). The use of bamboo baskets had brought down the price of this biogas plant "Grameen Bandhu" (meaning friend of the rural people) so that it was at least 15% cheaper as compared to the existing most popular fixed dome plant, the "Deenbandhu model", while also ensuring the participation of women in the weaving of bamboo structures for constructing this model. Women can use bio-gas not only for cooking and lighting but can have regular income by utilizing biogas slurry. This slurry is good manure for their kitchen gardens and farms. Bio-gas is also reducing the drudgery of collecting fuel apart from providing a clean kitchen. Positive impact on deforestation; relieves a portion of the labor force from having to collect wood and transport coal; helps conserve local energy resources. Income-generator and apt example of self-reliance and self-sufficiency Inexpensive solution to problem of rural fuel shortage; improvements in the living and health standards of rural and village communities; provides employment opportunities in spin-off small-scale industries

Water hyacinth compost

The water hyacinth (Eichhornia crassipes) is a floating "obligate" (requiring a wet habitat) plant belonging to the family Pontederiaceae. This alien species grows in all types of freshwater ecosystems. Water hyacinth varies in size from a few inches to over three feet tall with showy lavender flowers. Its leaves are rounded and leathery, attached to spongy and sometimes inflated stalks. The plant has dark feathery roots. It is very efficient in utilizing aquatic nutrients and solar energy for profuse biomass production. Depending on the time of the year and location, the plants double in number and biomass every 6 to 15 days. Between 400 and 1700 tones fresh weight are produced per hectare per year. Given that the dry weight is about5-7% of fresh weight, one hectare yields between 20 and 120 tons of dry water hyacinth per year, containing nitrogen (N), phosphorus (P) and potassium (K) as well as other plant nutrients. It makes sound economic sense to utilize this species as an organic input to soils. Water hyacinth waste provides mulch that assists in both water retention and weed suppression...Till recently water hyacinth was considered to be alterable environmental hazard is now considered a golden weed.

If we see the utilization aspect of the water hyacinth from over the world, it can be very helpful in meeting some of the most urgent needs such as in food production; as leaf protein concentrate; as a substrate for mushroom cultivation; by purifying water; through the production of silage; through vermin culture; in regenerating degraded soils; as mulch; as compost; as fertilizer; in energy production; as biogas; as briquettes; in providing employment and income. Therefore, Water hyacinth supports not only in the socio-economic aspects of the local people but also in reducing the environmental problems.

Methodology to prepare Hyacinth compost*:*

Heap/Pile can be used for composting of Water hyacinth. The accessories used for making compost in these methods are: Black colored plastic sheet, Black Plastic Drum, small wooden stick and some stones to press the covered plastic sheet. Water hyacinth can be chopped in small pieces and sun-dried for about 8 hours before applying to field. Composting of water hyacinth biomass is completed in 55 days, whereas the composting of agricultural waste is completed only in 70 days. The yield of horticultural crops can be increased by about 10-25 per cent by applying 2.5 tons of water hyacinth vermi compost as a fertilizer.

Solar Energy- Solar Thermal and Solar Photovoltaic

Solar Energy is the oldest source of energy to be used on earth. Even today, this is used to dry tons of material – mostly in rural areas. India is a tropical country and has many sunny days. According to estimates, 35 MW of power could be generated from 1 sq km. With such potential, solar energy is going to be the future. Many researches are already in progress to make solar energy become one of the front runners that can be set up using cheap technology and low capital. Rural women can easily get engaged in tapping this energy form in small sized agricultural purposes like irrigation and household lighting.

Cooking, lighting, water heating and open air drying applications are common now-a-days, using solar energy. There are other applications like solar vehicles, desalination, agriculture, etc. which are coming up. It will take time to catch up because of the high cost involved in it.

Bio fuel

Women can generate income through growing seedlings for bio-fuel plants in waste land. India has more than 50 million hectares of wasteland, which could be utilized for cultivating plants. Jatropha is the common plant used for producing bio-fuels. Jatropha can grow on arid land and rain fed uplands with low water consumption.

Rice Husk

Rice husk power systems, generates electricity through rice husk in 250 villages in Bihar, maintains that biomass is a well-proven technology globally. In the next three to five years, it will realize 10-15% of its potential.

Similarly women may be trained for production, utilization and marketing of vermi wash (a liquid foliar spray), Panchagavya, bio pesticides and herbal pest repellents using locally available plant materials/ from farm wastes. Production and distribution of efficient biological inputs such as bio-fertilizer with indigenous inoculums are produced with a network of trained small and marginal farmers for improved farm productivity and income generation. Introduction and testing of post harvest technologies for value addition of organic products with aim to enhance livelihood options for poor rural tribal women through introduction of post harvest energy saving technologies in processing of local fruit is an important approach. Alternative vocation for income generation, small-scale (household level) scientific rearing of small animals such as goat, poultry and pig, sustainable utilization of natural resources and value addition, mechanized processing of bamboo furniture and product applications, diversified cropping systems, agro- technology for improving the land use, fisheries, cultivation of horticultural produce by using organic/bio-fertilizers, value addition in banana fibers, etc. are very lucrative enterprises.

The women of Nagla Banjara (Rajasthan) now weave the bamboo baskets and other woven bamboo structures and earn a small amount of Rs.1000/-per woman. Spinning and weaving of cotton, silk and woolen textiles, Kauna Grass mat manufacturing, bee keeping etc. also account for income generation to the women in India.

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Mushroom Production: An alternate income generating activity

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Mushrooms are the fruiting bodies of macro fungi. Human body needs protein, carbohydrates, fats and vitamins. A fresh mushroom has moisture content 70 - 95% and 10 - 13% in dried mushrooms. The protein content in cultivated species ranges from 3 to 5.9 % of fresh weight. The protein content of edible mushrooms is about twice that of onion (1.4%) and cabbage (1.4%), and four times and 12 times those of oranges (1.0 %) and apples (0.3%), respectively. Whereas the protein content of common meats is as follows: pork, 9-16%; beef, 12-20 %; chicken, 18-20 %; fish, 18 -20 %; and milk, 2.9- 3.3 %.On a dry weight basis, mushrooms normally contain 19 -35 % protein, as compared to 7.3 % in rice, 12.7 % in wheat, 38.1 % in soybean and 9.4 % in corn. Mushroom protein contains all the nine essential amino acids required by man. In addition to their good proteins, mushrooms are a relatively good source of fat, phosphorus, iron, and vitamins including thiamine, riboflavin, ascorbic Acid, ergosterine and niacin. They are low in calories, carbohydrates and calcium. The total lipid content varying between 0.6 and 3.1 % of the dry weight is found in the commonly cultivated mushrooms. At least 72 % of the total fatty acids are found to be unsaturated in all the four tested mushrooms (Huang et al. 1985). It should be noted that unsaturated fatty acids are essential and significant in our diet and to our health. In addition to nutritional value, mushrooms have some unique color, taste, aroma, and texture characteristics, which attract their consumption by humans.

Fungal biotechnology has become an integral part of the human welfare (Manoharachary *et al.* 2005). Hawks worth (1997, Chang ,2006) reported that out of 270,000 plant species about 70,000 fungal species have been described and suggested that around 14,000-15,000 species considered as macro fungi producing fruiting bodies and the total number of fungal species have been reported to be 1.5 million. Among them 14000 fungal species 50% i.e. 7000 species possess varying degree of edibility. Now more than 3000 species were reported under 31 genera which have edible characteristics. Around 5–10% of fungi can be cultured artificially. Only 200 of them are cultured, 100 economically cultivated, approximately 60 commercially grown and about 10 have reached an industrial scale (Chang and Miles, 2004).Furthermore, about 1,800 are medicinal ones. The poisonous mushrooms is relatively small (approximately 10%), of these some 30 species are considered to be lethal (Miles and Chang, 1997).Whereas over 2000 species of edible fungi known to man out of a total of 10,000 species of macro fungi reported to be growing in the world (Dhar and Singh, 1999).Archaeological evidences reveal that edible species are associated with people living 13000 years ago in Chile (Rojas and Mansur, 1995) but in China where the eating of wild fungi was first reliably noted several hundred years before birth the of Christ (FAO, 2004).Hobbs (1995) stated that many cultures have been identified that certain mushrooms could have profound health-promoting benefit.

In India, 914 species have been reported .One third of fungal diversity of the globe exists in India. The people used to go the forests to collect wild species based on their personal knowledge of edible and poisonous mushrooms they used to collect the edible ones and sale in local market and also eat them. Jain (2005) reported that mushroom cultivation in India was started by Dr S.S.Jain (First Mycologist) in early 1950 who have grown *Agaricus* and other species successfully on rotting apple tree

twigs and branches, cow dung and wheat straw etc., popularized among the farmers of Himachal Pradesh. Now 100 countries are growing mushroom previously, the edible mushrooms were grown in France and Japan. Several reports on wild edible mushrooms have been collected and consumed by people since thousands of years.

The mushroom industry can be divided into three main categories: edible mushrooms, medicinal mushroom products, and wild mushrooms. Anonymous (2003) reported that producer. Production of mushrooms worldwide has been steadily increasing; mainly due to contributions from developing countries (Fig.1, Table 1) such as China (46%), India (3%), and USA (10%).India produces about 600 million tones of agricultural byproducts, which can profitably be utilized for the cultivation of mushrooms. Currently, 0.04% of these residues are used for producing around 1.2 lakh tons of mushrooms of which 85% are button mushroom. India contributes about 3% of the total world button mushroom production. Even if we use 1% of the residues for mushroom production, we can produce 3.0 million tons of mushrooms, which will be almost equal to current global button mushroom production (current world productions per FAO Stat. is 3.4 million tons).The mushroom production is increasing based evidence to support centuries of observations regarding the nutritional and medicinal benefits of mushrooms. However, harvests of highly prized edible mycorrhiza mushrooms are continuously decreasing. Technological developments in the mushroom industry in general have witnessed increasing production capacities, innovations in cultivation technologies, improvements to final mushroom goods, and utilization of mushrooms' natural qualities for environmental benefits. The challenge is to recognize opportunities such as increasing consumption capabilities with the increase in world population and to take advantage of this by promoting the consumption of mushrooms.

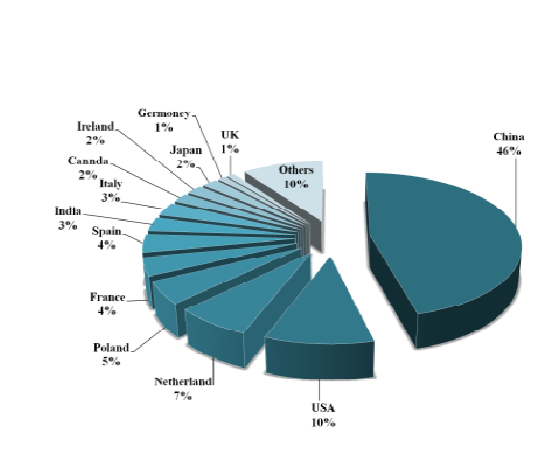

Fig.1: World mushroom production (2008) and Comparative mushroom production chart of World and India's share

Table1: Mushroom production and China's contribution since 1978 (QiTan and Hui Cao, 2010)

Year	Total Production (x1000 tones)	China Production (x1000 tones)	China Contribution (%)
1978	1060.0	60.0	5.7
1983	1453.0	174.5	12.0
1990	3763.0	1083.0	28.8
1994	4909.0	2640.0	53.8
1997	6158.4	3918.0	63.6
2002	12250.0	8650.0	70.6
2006	-	14000.0	-
2008	26000.0	18200.0	70.0

Table2: State wise mushroom production (tons) in India (Wakchaure, 2010)

SN.	States	Button	Oyster	Milky	Others	Total
1	Andhra Pradesh	2992	15	15	0	3022
2	Arunachal Pradesh	20	5	0	1	26
3	Assam	20	100	5	0	125
4	Bihar	400	80	0	0	480
5	Chhattisgarh	0	50	0	0	50
6	Goa	500	20	0	0	520
7	Gujarat	0	5	0	0	5
8	Haryana	7175	0	3	0	7178
9	Himachal Pradesh	5864	110	17	2	5993
10	Jammu &Kashmir	565	15	0	0	580
11	Jharkhand	200	20	0	0	220
12	Karnataka	0	15	10	0	25
13	Kerala	0	500	300	0	800
14	Maharashtra	2725	200	50	0	2975
15	Madhya Pradesh	10	5	0	0	15
16	Manipur	0	10	0	50	60
17	Meghalaya	25	2	0	0	27
18	Mizoram	0	50	0	0	50
19	Nagaland	0	75	0	250	325
20	Orissa	36	810	0	5000	5846
21	Punjab	58000	2000	0	0	60000
22	Rajasthan	100	10	0	10	120
23	Sikkim	1	2	0	0	3
24	Tamil Nadu	4000	2000	500	0	6500
25	Tripura	0	100	0	0	100
26	Uttaranchal	8000	0	0	0	8000
27	Uttar Pradesh	7000	0	0	0	7000
28	West Bengal	50	50	0	0	100
Union Territories						
1	A&N Island	0	100	0	0	100
2	Chandigarh	0	0	0	0	0
3	Datar &Nagar Haveli	0	0	0	0	0
4	Daman&Diu	0	0	0	0	0
5	Delhi	3000	50	20	0	3070
6	Lakshadweep	0	0	0	0	0
7	Pondicherry	0	0	0	0	0
	Total	100683	6399	920	5313	113315

The button (*Agaricus bisporus*), oyster (*Pleurotus* spp.), milky (*Calocybe indica*) and paddy straw mushroom (*Volvariella volvacea*) are commonly cultivated throughout India. Mushroom cultivation is done on agricultural wastes in less area which is an attractive proposition for income generation which is leading to solution to malnutrition, pollution abatement and diversification of agriculture. Mushroom cultivation produces about 32 tons of dry protein per year in per acre of land while by fish farming only 3 quintals of proteins can be produced.

The agriculture wastes which are burnt and cause environmental pollution, if can be used for mushroom cultivation will not only check pollution but will also play an important role in carbon sequestration and proper utilization of waste products. Among them oyster mushroom production is more profitable than other mushroom. There is ample scope to earn more from mushroom cultivation using some innovation like attractive packaging for longer shelf-life, processing units for canned items, value addition and new products such as mushroom nuggets (*burries*), biscuits, *papads*, pickles, soup powder, etc.

Food security

Mushrooms are of excellent food value as they provide a full protein food containing all the twenty one amino acids besides containing useful amount of fats, vitamins and minerals. Mushroom protein being easily digestible (70-90%) is considered superior to vegetable proteins. Two essential amino acids lysine and tryptophan are enormously present in mushrooms which are not found in cereals. Being low in caloric value (300 – 390 Kcal/100 g dry wt), low fat and high protein, they are considered as 'delight of diabetic patients'. Folic acid and Vitamin B-12 which are normally absent in vegetarian foods are present in mushrooms (3 g fresh mushroom can supply 1 micro g vitamin B12, recommended for daily uptake).

Sustenance from wild edible mushrooms: The variety which had been exported in dried form i.e. Moral or Black mushrooms (*Morchella spp.*) are commonly known as 'Guchhi' is collected as wild growth from coniferous forests of Himachal Pradesh, Jammu and Kashmir and Uttar Pradesh. Morels (gucchhi) growing only in wild, are the most valued wild mushroom in Western Europe particularly France, Germany, Italy and Switzerland. The international trade in dried morels is estimated to 225 tons annually. The suppliers are India, China, Turkey, Pakistan, North America and Eastern Europe. Pakistan alone exports nearly 65 tons annually. It is claimed that 2,89,000 persons are engaged annually in Pakistan in morel mushroom hunting on part time basis including 33% women, 27% men and 40% children from March to July months. The price for one kilogram dried morels is US $ 50 for the collector, $ 166 for wholesaler, $ 216 for exporter $ 330 for the importer. The global trade for yellow chanterelle mushroom (*Cantherellus* spp.) is much more lucrative than for morels, 200000 metric tons are bought and sold annually worldwide ranging from 1.25 to 1.4 billion US dollars every year. Germany is largest importer, followed by France and other Western Europe. In Himachal Pradesh and Jammu & Kashmir *Morchella* spp. are collected systematically during the growing seasons (spring and sometimes after rainy season) and sold to established markets both fresh and as dried mushrooms. In Madhya Pradesh, Chhattisgarh and north eastern states wild mushrooms are sold in the local markets and provide sustenance to the tribal people and forest dwellers during the lean period (rainy season) when other non-wood forest products are not available in the forests. In the north-east of India some commonly wild mushrooms used in food are *Auricularia auricula, Schizophyllum commune, Lentinus* spp., etc. Thirty six wild edible species have been reported from Jharkhand (Sharma *et al*. 2011, 2012). There is scope to tap the potential in and outside of the forests for providing sustained livelihood and profit to the people through systematic collection and processing of wild mushrooms, which is till today limited to the collection of morels only.

Mushroom growing is a profitable business in low cost and less time in which oyster is one of them which more beneficial to other mushroom. Here we discussed the details of cultivation technique and economics which are as follows:

Steps of Cultivation of Oyster Mushroom

(i) Preparation or procurement of spawn
(ii) Substrate preparation
(iii) Spawning of substrate
(iv) Crop management

(i) Spawn Preparation: A pure culture of *Pleurotus* sp. is needed for inoculation on sterilized substrate. It takes 10-15 days for mycelial growth on cereal grains. It can be procured from a reputed spawn laboratory or university.

(ii) Substrate Preparation

Production in Bags: Oyster mushroom can be cultivated on various agro-wastes which contains cellulose and lignin which helps in more enzyme production of cellulose that is correlated with more yield. These include straw of paddy, wheat and ragi, stalk and leaves of maize, millets and cotton, used citronella leaf, sugarcane bagasse, saw dust, jute and cotton waste, dehulled corncobs, pea nut shells, dried grasses, sunflower stalks, used tea leaf waste, discarded waste paper and synthetic compost of button mushrooms etc. The oyster mushroom can be cultivated on any of the by the following methods:

(a)Hot Water Treatment**:** The substrate (2.5 to 5.0 cm size) is soaked overnight. Next day the substrate are taken out to drain excess water followed by soaking in warmed water (>80^{0}C) for one hour, then dry to 50-65% moisture. For commercial mushroom farms, ingredients are fed into revolving mixers, water is added to the desired level, and live steam is injected into the mixer while in operation. The moistened, mixed substrate is filled into galvanized metal boxes with perforated floors. The substrate is pasteurized with aerated steam at 65 ^{o} C for 1 hour by passing the air-steam mixture through the substrate from top to bottom.

(b) Chemical Sterilization: The substrate is soaked in water with Bavistin (7.5g to 10g/100litre water) and formaldehyde (50 to 125 ml/100litre water) over night. Next day it should be taken out to dry till 50-65% moisture to retain in the substrate.

(iii) Spawning: Before spawning all the utensils and hand should be properly cleaned with dettol or spirit and proper sanitation should be followed. The pasteurized straw is spawned and filled into clear or perforated 30x45cm poly propylene bag (PPbag) in four layers of spawn and each layer should be pressed and incubated at 23 ^{o} to 25 ^{o} C (substrate temperature) for 20 days. Mushrooms then begin to form around the edges of bag perforations and they are harvested from the substrate approximately 7 to 10 days or after spawning depending on strain, amount of supplement used, and temperature of spawn run.

Spawning and spawn rate. The spawning is done in freshly prepared (20-30 days old) grain spawn is best for spawning. Old spawn (3-6 months) stored at room temperature (at 20 to 30^0 C) forms a very thick mat like structure due to mycelium aggregation and sometimes young pinheads and fruit bodies start developing in the spawn bottle itself. The spawning should be done in a pre-fumigated room (48hrs.with 2% formaldehyde). The spawn used (up to 5 percent of the wet weight of the substrate) has resulted in increased yields. Increasing spawn rates from 1.25 percent substrate wet weight to 5 percent may result in yield increases of nearly 50 percent.

(iv) Crop Management:

(a) Incubation**:** Spawned bags, trays or boxes are arranged in a dark cropping room on raised platforms or shelves for mycelium colonization of the substrate. Although mycelium can grow from 10 to 33^0 C, but the optimum temperature for spawn running lies between 22 to 26^0 C.

(b) Fruiting**:** When the mycelium has fully colonized the substrate, the fungus is ready for fruiting. Contaminated bags with moulds may be discarded while bags with patchy mycelial growth may be left for few more days to complete mycelial growth. While various species require different temperature regimes all require high humidity (70-85%) during fruiting. Frequent spraying of water is required in the cropping room depending upon the atmospheric humidity at least 3 times a day. Fruit body produced under humid conditions (85-90%) is bigger with less dry matter while those developed at 65-70% relative humidity are small with high dry matter. CO_2 concentration during cropping should be less than 600 ppm or 0.6%. Sufficient ventilation has to be provided during fruiting.

(c) Plant Protection Measures**:** The crop is suspected to attacks from flies (sciarid, cecid) spring tails and mites. Timely spraying with insect specific insecticides is needed or a yellow light trap may be used in cultivation room dully supported by a transparent PP bag on which greased with oily material to protect from laying of eggs in the substrates .The crop is prone to fungal diseases. Several competitor moulds e.g. black mould (*Aspergillus* sp)., Green mould *Penicilliun* sp.) Or inky mushroom weed mushroom (*Coprinus* spp.) has been found to occur in the substrate used for cultivation. Spraying with bavistin (carbendazim) 0.1% is a recommended control measure. The crop is also subject to diseases like yellow blotch, brown spot and bacterial rot, control measures which are needed include (a) Proper management of temperature and humidity (80%) during growing period and (b) Regular application of chlorinated water containing 100 – 150 ppm of freely available chlorine at an interval of 3 – 5 days.

(D) Harvesting and Yield: The fruit bodies should be harvested before spore release, by twisting so that the stubs are not left on the beds (straw). It is advisable to pick all the mushrooms at one time from a cube and the next flush will appear at one time. 500 kg to 1ton and more of fresh mushrooms per ton of dry wheat or straw can be obtained in case of crop produced in 45-60 days.

Postharvest Handling and Marketing

Marketing of oyster mushrooms typically are packaged and sold at retail in 200 grams. Often oyster mushrooms are used to highlight the common cultivated mushroom that may be sold whole. The right shape for picking can be judged by the shape and size of the fruit body.

Spawn Production: Spawn production is also a good profitable business which can be evident from their economics described below. Spawn is prepared from mycelium on a base of steam-sterilized cereal grain. This cereal grain/mycelium mixture is called spawn and is used to seed mushroom substrate. The commercial spawn is produced in polyethylene bags. The steps involved in spawn preparation are described here.

Spawn Production Cycle

1. Preparation of mother spawn

Step-1: Select healthy and clean cereal grains
↓
Step-2: Boil grains in water (15-20 min.)
↓
Step-3: Remove excess water on sieve
↓
Step-4: Dry grains in shade (4 h)
↓
Step-5: Mix $CaCO_3$ (0.5%) and $CaSO_4.2H_2O$ (2%) on dry wt. basis
↓
Step-6: Fill 300 g grains in glucose/milk bottle
↓
Step-7: Plug and autoclave at 22 p.s.i. for 1.5 to 2 h
↓
Step-8: Inoculate growing mycelium of desired strain using laminar flow
↓
Step-9: Incubate in BOD at 23+2^{0}C for 20-25 days (shake bottles after 10 days)
↓
Step-10: Master spawn is ready

2. Preparation of commercial spawn

Step-1: Use polypropylene bags instead of bottle
↓
Step-2: Up to autoclaving (Step 1 to 7) is same as of mother spawn
↓ Spawn Production 3 to 7
Step-8: Inoculate with 10-15 grams of mother spawn per PP bags
↓
Step-9: Incubate at 23+2^{0}C in incubation room (Shake bags after 7-8 days
↓
Step-10: Commercial spawn is ready in 2-3 weeks

Economics for Spawn Production of at Least 1, 00,000 kg Spawn Per Year

1. Fixed cost Cost	**Amount (Rupees**
A Land procurement and development (300 m^2)	Available
B Cost of construction:	
i. Cost of construction of 152 m^2 area @ Rs. 8000/- per m^2	1 2,16,000.00
ii. Cost of insulation of incubation room and cold store (250 m^2) @ Rs. 500/- m^2)	1, 25,000.00
Total:	**13, 41,000.00**
C Cost of machinery	
i. Autoclave (2 no.)	2, 00,000.00
ii. Cost of 4 ACs of 1.5 ton capacity-2no	6, 00,000.00
iii. Laminar flow	1, 50,000.00
iv. BOD Incubator	75,000.00
v. Refrigerator	10,000.00
vi. pH meter	5,000.00
vii. Gas stove	3,000.00
viii. Weighing balance	2,000.00
ix. Iron racks	1, 00,000.00
Total	11, 45,000.00
2. Recurring expenditure	
a Salary	
Labor (2 No.) @ Rs. 3000/- month/person	72,000.00
Technical Assistant (1 No.) @ Rs. 6000/- month/person	72,000.00
Total	1, 44,000.00
b Raw materials	
i) Cost of grains (600 q) @ 1500/q (Considering 1.8 kg spawn/kg wheat and 5-10% contamination) for Spawn Production 41Rs.	7,50,000.00
ii) Cost of calcium carbonate (3 q) and calcium sulphate (10 q) @ 5000/q	65,000.00
iii) Cost of non-absorbent cotton 10 q @ Rs. 6500/q	25,000.00
iv) Cost of rings	65,000.00
v) Cost of 7 quintal of polypropylene bags @ Rs. 6500/q	45,500.00
vi) Energy consumption/year	2, 00,000.00
vii) Miscellaneous (cost of disinfectants, gloves etc.)	1, 00,000.00
Total	12, 50.500.00
Total recurring expenditure	13, 94,500.00
3. Interest and depreciation	
1. On Building (Rs.13, 41,000) (5% depreciations Rs 67050/- and Interest @ 12%Rs 160920/-)	2, 27,970.00
2. On machinery (Rs.11, 45,000.00) (10% depreciation Rs 114500/- and 12% InterestRs 137400/-)	2, 51,900.00
Total (a+b)	4, 79,870.00
4. Cost of production and return	
a Raw materials	12,50,500.00
b Wages and salary	1,44,000.00
c Interest and depreciation	4,79,870.00
Total	18, 74,370.00
5. Return	18, 74,370.00

a Income from sale of 1 lakh spawn bags @ Rs. 50/kg	50,00,000.00
Net profit per year Rs. (50, 00,000 -18, 74,370)	**31, 25,630.00**

Economics of oyster mushroom cultivation by chemical sterilization technique in Poly house 3.5 to 4 TPA

(a) Non Recurring Expenditure	**Amount (Rupees)**
i) Building cost: High density polythene sheet growing room of 20' x 15' x 10' (300 ft^2) Rs 18,000 per unit-2no	36,000.00
ii) Sprayer pump (1 no.)	2000.00
iii) Galvanized tubs or empty diesel drums painted inside (3 nos.)	1,200.00
iv) Nylon ropes for hanging bags	2,000.00
v) Thermometers (max. & minimum, dry & wet bulb thermometer & bed thermometers)	500.00
vi) Industrial coolers (2 nos.)	20,000.00
Total non-recurring expenditure	**61,700.00**
(b) Recurring expenditures (cost of raw materials)	
i) Wheat straw or paddy straw 8 q @ Rs.300.00	2,400.00
ii) Cost of 800 polythene bags (125-150 gauze thick of 60 x 45 cm @ Rs.100/kg (12 kg)	1200.00
iii) Cost of spawn @ Rs.50.00/kg (80 kg)	4,000.00
iv) Labor wages for @ Rs.100.00/day for 2 persons (1 crop)	8,000.00
v) Chemicals	
(A) Bavistin @ 7 g for treating 10 kg straw (the solution will be reused for treating straw on the next day(Bavistin requirement 560 g)	350.00
(B) Formaldehyde 3.5 liter (100 ml for 10 kg straw) @ Rs.40.00 per liter(commercial grade)	320.00
vii) Miscellaneous charges (water, electricity, pesticides, small polythene bags for packing, etc.)	2,000.00
Total	**18,270.00**
viii) (a) Building depreciation 10%(3600/-) + interest 15%(5400/-) = (Rs 9000) and Machinery Depreciation 10%+ interest 15%=	6425.00
Total for one year	15,425.00
For one crop	2,570.80
Total expenditure for one crop (Rs 18,270+2,570)	20, 840.00
Mushrooms: Cultivation, Marketing and Consumption	
Expected yield (70% BE) = 700 kg fresh mushrooms	
Income from sale @ Rs. 50.00 kg	35,000.00
Net profit from one crop	14,160.00
Annual Profit from 6 crops	**84,960.00**

Thus oyster mushroom production as well as spawn production is a profitable business for livelihood because it required less expenses and more profit.

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Livelihood Support through Vegetable Production System to Women Folk

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Introduction

Any part of crop consumed as fresh or after cooking is called as "vegetable". Still definition is incomplete. There cannot be any single definition covering all characteristics. In case of fruits only flower or fruit is consumed While in vegetable all parts from roots to fruits are consumed (roots / leaves / stem / flower / fruit / seed / buds). Fruits are consumed fresh without cooking eg. Banana, apple, guava while vegetables are consumed fresh as salad and also after cooking few are eaten both way fresh and after cooking eg. tomato, onion, cucumber etc.

Importance of Vegetables

1) Nutrition: Vegetables are rich and comparatively cheaper source of vitamins. Consumption of these items provides taste, palatability, increases appetite and provides fiber for digestion and to prevent constipation. Their consumption in plenty fair amount of protein. They also play key role in neutralizing the acids produced during digestion of pretentious and fatty foods and also provide valuable roughages which help in movement of food in intestine. Some of the vegetables are good sources of carbohydrates (leguminous vegetables, sweet potato, potato, onion, garlic and methi) proteins (peas, beans, leafy vegetables and garlic), vitamin A (carrot, tomato, drumstick, leafy vegetables), Vitamin B (peas, garlic and tomato), Vitamin C (green chillies, drumstick leaves, Cole crops, leafy vegetables and leaves of radish) minerals (leafy vegetables, drumstick pods). As per dietician, daily requirement of vegetables is 75 - 125 g of green leafy vegetables, 85 g of other vegetables and 85 g of roots and tubers with other food.

2) Importance as Food: Food production is increasing. It is essential to sustain increased production besides nutritional standard of people. It can be increased by increasing production of vegetables which will help to solve food problem as yield of vegetable crops is 4 to 10 times more than cereals. Thus, vegetables play a vital role on food front as they are cheapest-sources of natural foods and can admirably supplement the main cereals of the country.

3) Importance to a grower: Nature has provided us-with all kinds of vegetable crops that can be grown in different seasons of the year in region. Different kinds of vegetables provide leaf, stem, flower, fruit or seed for consumption. Considering vividness in the requirement of soil and season, farmers can grow vegetable crops throughout the year for earning regular and steady income to meet the daily expenditure. There are vegetables of very short duration that can be grown as rain fed and intercrops in either agronomical crops or vegetable crops. There are vegetables which improve soil and also provide fodder to cattles. Thus, farmer has wide choice to select suitable crop to adjust in his cropping pattern in given situation provided the climate and soil conditions of the region are conducive to grow different vegetables.

4) Employment: Since cultivation of vegetable crops involves intensive cultural operations starting from sowing to marketing, it provides more and regular employment opportunities in rural areas.

5) Industrial importance: The perishable nature of vegetables demand comprehensive planning for movement, storage, processing and distribution of vegetable products. The growth of vegetable industry as a commercial proposition largely depends on the allied enterprises like storage, processing marketing and maintenance and service enterprises to encourage vegetable growing.

Vegetable Gardening

a. Home or Kitchen Gardening

The main purpose of the kitchen or home vegetable gardening is to provide the family daily with fresh vegetables rich in nutrients and energy. In kitchen gardening emphasis is usually placed on a great variety of crops according to season. The concept of Home gardening is spreading among the people due to the increasing awareness among about the nutritional relevance of the vegetables. The cost of raising vegetables in the kitchen gardening through ones owns labor is far less than what a family spends on vegetables in the market. Also, the vegetables grown, in the kitchen gardens are fresh and are not liable to infection with germs occurring in unsanitary markets.

b. Market Gardening

It is that branch of vegetable growing whose object is to produce vegetables for the local market. It is one of the most intensive types of vegetable gardening where the most skillful methods for growing of vegetables for commercial purpose are employed. It is developing day by day to meet the vegetable requirement of growing population. Due to transport facilities, consumers can get vegetables from distant places during off-season.

c. Truck Gardening or Farming

It is the method of growing special vegetable crops in relatively large quantities for distant markets by the employment of intensive methods.

d. Vegetable Forcing:

It is the method of growing of vegetables out of their normal season. Vegetable produced give premium price to the farmers.

e. Vegetable growing for Processing:

Low cost with high quality and convenience in storage and use, have given rise to vegetable processing in India. But this industry is still not well-developed. People also in general, have not yet developed liking for the canned and processed vegetables in India. Still we need vegetables of good quality for canning, dehydration and freezing in our existing factories. Vegetables for processing are generally grown around vegetables processing factories, for the regular supply of vegetables to the factories.

f. Vegetable Gardening for Seed Production:

As the vegetable cultivation is increasing day by day need for good vegetable seed is also increasing. To meet this demand, State Government Department of Organizations like National seeds Corporation of India is producing certified seeds at their own farms or on cultivator’s fields.

g. Floating Vegetable Garden:

This is also a type of vegetable gardening generally seen in Dal and other lakes of Kashmir Valley. For this type of garden, first of all a floating base is made from the roots of various grasses and weeds growing wild in the lake. After this leaf compost and wild vegetation's of the lake are spread over them and then seedlings are transplanted. Irrigation and other subsequent operations are done by with the help of boats.

Method of cultivation of different vegetable crops

A. Tomato (*Lycoperscion esculentus* Mill)

Climate and Soil Requirement

Tomato is warm season crop. Grows well in those regions that are free from frost. The optimum temperature required for its cultivation is 15 - 27^{0}C. At higher temperature the blossoms drop off. The damage is severe when high temp is combined with dry wind. The content of lycopene is highest at 18 to 26^{0}C while production of this pigment drops off rapidly above 30^{0}C and ceases above 40^{0}C. Carotene is developed rapidly at high temperature. If fruits are exposed to direct sunlight, their tops may turn whitish yellow & become leathery in texture. This is common in late varieties during summer season. This condition is known as sun - scald. A warm, sunny weather is most suited for proper ripening, color, quality & high yield.

Sandy loam soil with a well drained clay sub-soil is best suited. Light soils are good for early variety. It grows at pH 6.0 to 7.0 satisfactorily. The soil should be well prepared & leveled by ploughing the land 4 - 5 times.

Sowing Time and Seed Rate:

Tomato can be grown throughout the year. Sowing is done in May - June for kharif crop, August -Sept for Rabi Crop and December - January for summer crop. The seeds are sown in well prepared nursery beds. 500 gms to 600 gms seed are enough for planting one half of land. When the plants are about 3 to 4 weeks old, they should be transplanted.

Layout and spacing:

Ridges and furrow type of layout is used. The spacing recommended for tomato crop is 60cm to 75 cm x 60 cm.

Manures and Fertilizers:

30-50 tons of FYM or compost should be applied in the soil & incorporated in it during field preparation. 75 to 100 kg P and 50kg K should be applied for getting better yield of tomato.

Improved Varieties:

Swarna Lalima, Swarna Naveen, Swarna Sampada, Swarna Vijaya, Arka Abha

Irrigation:

It should be so arranged that the soil remains continuously moderately moist. Avoid excessive irrigation as it induces the plants drop the blossoms off. There is no need of irrigation during rainy season if, there is a proper distribution of rainfall. When the rainy season is over, the crop may be irrigated twice or thrice in a month. The crop planted during the winter season will need irrigation once in about 20 day. While the crop is transplanted during spring season, it will need irrigation more frequently. During the winter season, whenever there is a danger of frost, the crop must be irrigated so that the temperature may not go down too low and damage the plants. Tomatoes, that have been growing when moisture is low, may split severely after a rain. The crop should be irrigated carefully during the fruit ripening stage.

Intercultural Operations, Pruning and Staking/Training in Tomato Cultivation

Frequent inter-tillage and cultivation should be done in the field to keep it free from weeds. As the plants grow bigger, all the intercultural operations should be shallow, so that the roots which spread unto a depth of 5 cm below the surface soil may not be injured. Though pruning and staking in the tomato increase cost of cultivation, both these operations make a tomato-plant grow better and larger tomatoes resulting in a higher yield per hectare.

Harvesting:

Tomato fruits are picked up from the plants by grasping them by the hand and dislodging them from the vine by twisting keeping the thumb pressed against the vine.

According to the use of fruits, they are harvested in following stages:

1) Green Stage:

About a fortnight before turning (development of a trace of redness at the styler end of the fruit), the fruits develop normal color of the vine. Though they are still green yet they may be fully developed. These fruits are picked and sent to distant markets.

2) Pink Stage:

At this stage red or pink color on the fruits varies from a trace at the blossom end to a considerable extent covering the surface. Though at this stage most of the fruits are red, yet they are not fully ripe. They are picked for local markets.

3) Ripe Stage:

At this stage the surface of most of the fruits is red and the softening of the fruits begins. They may be picked for home or table use.

4) Full Ripe Stage:

At this stage the fruits have approached maximum color development and may feel soft to the touch. Now the starch is changed into sugar. They are ordinarily used within 24 hours of picking and are consumed or used for canning and pickling.

Yield:

It varies 250 to 400 quintals per hectare according to season and variety planted. Duration of crop ranges from 160 to 180 days.

Insect Pest:

1. Fruit Borer:

Damages leaves shoot & fruits. Fruits become unfit for consumption.

Control:

Spray carbaryl 50 WP @ 0.3% or Carbaryl Dust 10% @ 35kg/ha. Infested shoot & fruit removed & destroyed.

2. Jassids:

They suck the sap from tender part & leaves.

Control:

Spray Endosulfan 35EC @ 0.5%orPhospomidon 85 @ 0.2%.

3. Mealy Bug:

A scale insect that covers up the whole plant and suck the sap from the plant

Control:
Removal of infected shoots and spraying the plant with Malathion (Cythion 50 EC, Malathion-50 EC) @ 2ml per litre of water is the best method of controlling this pest.

Diseases:

1) Early blight:
Dark brown to black spots are form on leaves & stem with concentric rings on them. Plant growth is affected, fruit size & yield is also affected. Control measures: Spray copper Oxy-chloride 50 WP @ 0.30% or Zineb 75 WP 0.2%.
2) Damping Off:
Affected seedling rots at collar region in nursery bed due to stagnation of water in nursery.
Control measures: Treat seed with 1% Mercuric fungicide @ 2.5—3.0 gm/kg. of seed before sowing.
3) Fruit rot:
Brownish -spot appear on fruit at the point of contact between fruit and soil. Fruit decay rapidly and become unfit for consumption.
Control Measures:
i. Support the plant properly, plant on ridges in irrigated soil.
ii. Don't plant on poorly drained soil,
iii. Spray Bordeaux mixture.
4) Virus diseases:
Tomato mosaic is the most common virus disease. It causes light and dark green mottling hi the foliage followed by slight curling and some malformation of the leaflets. The plants become somewhat stunted in the beginning. and later on-fruit setting is also reduced.
Control measures:
i. Uprooting and burning the disease affected plants as soon as they are noticed is the best method to check the spread of this disease.
ii. The insect vector should be controlled by spraying the crop with Dimetnoate (Rogor 30 EC) or Oxy dernition methyl (Metasystox-25EC) @ I ml or phosfamidon (Dernicron-1 OOEC) @ 0.5 ml per liter of water.

B. Brinjal or Eggplant (*Solanum melongena*)

Climate and soil requirement
Brinjal is a warm season crop and is very susceptible to frost. It requires a long growing season with the high average day and night temperatures. A daily mean temperature of 13-21^{0}C is most favorable for successful production.

Though it can be grown on different types of soils, yet it is grown with considerable success in fine and rich loam soils that are deep and well-drained. As the crop remains in the field for a number of months therefore, the soils should be well prepared by being ploughed 4-5 times before transplanting the seedlings. When the field is well prepared and leveled, the beds of suitable size are made in the field before transplanting.

Sowing Time and Seed Rate:
Brinjal can grow twice during the year. The sowing time is May-June, August- September and December-January, The 700 gms to 1000 gms seed required to raise the seedlings for 1 half, area.

Layout and Spacing:
Ridges and furrow type of layout is used. Seedlings are raised on raised bed. Spacing is 75 x 60 cm. to 75x75 cm.

Manures & Fertilizers:
30 to 50 cartloads of FYM or compost is applied at the time of field preparation. In brinjal 60 kg N, 50kg P. should be-applied per hectare.

Improved Varieties:
Swarna Shyamli, Swarna Pratibha, Swarna Ajay, Swarna Abhilamb, Swarna Shakti, Swarna Shobha, Swarna Neelima

Irrigation:
Irrigate the field after every third or fourth day during the summer season and after 12 to 15 days during the winter season. Timely irrigation is very important for high yields of brinjal. Brinjal fields should be regularly irrigated to keep the soil moist during frosty days.

Intercultural Operations:
Inter-tillage or hoeing with some hand drawn implement .should be done in the crop to check the weeds. These operations should be fairly deep and close when plants are very small, but they should be made shallow as plants develop. Fruit set can be increased with plant growth regulators. These chemicals are either used for seed treatment or sprayed over the plants. Para-chlorophenoxyacetic acids, 2, 4, dichlorophenoxy-acetic acid and napthaleneacetic acid, have been found effective for this. These treatments give about 50 per cent earlier and higher fruit set.
Harvesting:
Fruits are harvested when they are immature. They should be severed from the plant by cutting with small shears or a knife. Fruits are allowed to attain a good size and color till they do not lose their bright, glossy appearance and become dull.

Yield:
Depending upon the cultivar, the yield of brinjal ranges between 250 to 400 quintals / ha.

Insect Pests of Brinjal:
1) Brinjal Fruit and Shoot Borer:
It is one of the major and serious insect pests of brinjal. A short pinkish caterpillar bores into the terminal shoot and eats internal tissue; it bores into the young fruit through the calyx .leaving on visible signs of infestation. The large holes usually seen on the fruits are the exit holes of caterpillar. The insect affected fruits become unfit for consumption.

Control Measures:

i) The insect affected plant parts should be clipped along with insect and destroyed.
ii) The affected crops should be sprayed with phosphamidon (Dimecron-100 EC) @.0.5 ml or Diochlorovos (Sumthion-50 Ec, folilhion-50 ECc) @1 ml per litre of water at fortnightly interval.
2) Brinjal Stem Borer:
A pale white caterpillar bore into the stem and kills the plant.
Control measures: Same as for brinjal fruit and shoot borer.

3) Leaf Eating Beetle:

The beetle and grub feed on the leaves and other tender parts leading to a considerable reduction in the .yield of the egg plant.

Control Measures:

i. Hand picking of egg and larvae is the best method for controlling this pest

ii. This insect can effectively be controlled by spraying crop with Endosulphan (Thioden -35 EC) or Phentrothion (Sumithion-50 EC) @ 2 ml or Fenthion (Lebacid-IOOO EC) or Thiomiton (Ekatin-25 EC)@ I ml per litre of water.

4. Other pests

The egg plants are also affected by mite, Jassids, Aphids and Mealy bug. They suck the sap from the leaves and in severe cases the whole plantation looks yellowish and leaves drop down prematurely. These insects except mites can effectively be controlled by spraying the crops with Methyl parathion (Metacid 50 EC) or Oxidemiton methyl (Metassystox 25 EV) @ 1 ml or Malathion-50 EC @ 2ml per liter of water at fortnightly. The mites can be controlled by spraying the crop with Dicofol (Kelthane-18.5EC) @ 2 ml or Morocite-40 EV @ 1 rnl per liter of water.

Diseases of Brinjal:

1) Damping off:

It is a serious disease of brinjal seedlings and mainly occurs in nursery bed. The disease infected seedlings rot at ground level and then the plants fall over ground. The seedlings die in patches.

Control Measures:

The seed bed should be treated with Formalin before sowing of seeds. The seeds should be treated with hot water (30 minutes at 52^0 C) or Cerasan or Agrosan G.N. before sowing of seed. The seedlings in the nursery should be sprayed with any fungicides at a regular interval.

2) Phomopsis Blight and Fruit Rot:

It is a serious disease of brinjal. The fungus attacks all parts of the plants above ground. Dark brown lesions appear on the stem and round to oval spots are formed on the leaves. Diseased fruits show short and watery lesions which later on become black and mummified.

Control Measures:

i. Use of disease free seeds, seeds treatment with some fungicide and long crop rotation are the most common remedial measures of this disease.

ii. The disease can effectively be controlled by weekly spraying of nursery and field with Zineb (Dithane-Z-78) or Mancozeb (Dithane M-45) @ 2.5 gm per liter of water.

3) Little Leaf of Brinjal:

The affected plant produces numerous tinny yellow leaves and does not bear fruits. The disease is transmitted by leaf hopper.

Control Measures:

The disease affected plants should be destroyed. The insect vector should be controlled by spraying the crop with Dimethoate or Monocrotophos (Monocil) @ 1 ml per litre of water to check the spread of this disease. Disease resistant variety such as Pusa purple Cluster should be cultivated.

C. Chilli or Capsicum (*Capsicum Annum* or *Capsicum frutescens*)

Climate:
The chili is a plant of tropical and sub -tropical region. It grows well in warm and humid climate with a temperature of 20^0C to 25^0C. Low moisture in soil during blossom development and fruit formation causes the bud, deblossom and fruit drops. Excessive rainfall is detrimental to the crops, because it brings about defoliation and rotting of the plant. As a rained crop, it is grown in areas receiving an annual precipitation of 25-30 inches.

Chilli can be grown in all type of soft but the sandy - loam, clay loam and loam soils are best suited for it. The soil must be well drained and well aerated.
The land is prepared by giving 2-3 ploughings and clod crushing after each ploughing. Compost or FYM @ 150-200 quintals should be spread and mixed well in the soil at least 15-20 days before sowing.

Sowing Time and Seed Rate:
In case of chilli crop, for kharif it sown in May - June and for summer crop, it is sown in the month of January. 1 to 1.5 kg seed is required for 1 ha.

Layout & Spacing:
Ridges and furrow type of .layout is used. Seedlings are raised on raised bed. Spacing for rained crops is 60 x 45 cm & for irrigated crops is 60 x 60 cm.

Manures & Fertilizers:
FYM @ 9 to 10 tones / hectare is applied at the time of field preparation. In chilli for rained crop 50 kg N and 25 kg P should be applied 1/2 dose of N full dose of P applied at the time of transplanting. Remaining dose of N should be applied 30 days after transplanting. For irrigated crop 100 kg N, 50kg P & 50 kg K should be applied per hectare. Fertilizers should be applied in four equal doses. First applied at the time transplanting remaining doses are applied at 4th, 11th & 13th week after transplanting.
Improved Varieties of Chilli or Capsicum
N.P. 46, Pusa Jwala, G-3, CA-960, Parbhani Tejas, Achalpuri, Bhavapuri, Malkapuri.

Irrigation:
Chilli is grown both as rain fed and irrigated crop. First irrigation is given after the transplanting and subsequent irrigations are given 5-7 days interval depending on weather and conditions of soil during summer and rainy season and after every 10 to 15 days in winter. The maintenance of uniform soil moisture is essential to prevent blossom and fruit drops.
Intercultural Operations:
2-3 shallow hoeing should be given to the soil to kill the weeds and provide soil mulch during early stages of growth. Application of weedicides for controlling the weeds is found effective. Application of Lasso @ 1.5 litre per hectare with one hand weeding or Tok-E 25@ 2 litres per hectare with one hand weeding are effective in controlling the weeds.

Harvesting:
1. Chillies which are used for vegetable purposes are generally harvested while they are still green but full grown.
2. Chillies are harvested at red stage for caning purpose. Chillies used for drying are harvested at full ripe-stage.
Yield:

The yield varies according to the system of cultivation. The yield of dry chillies of rain fed crop is 200 - 400 kg and that of irrigated crop is 600 - 1000 kg per acre.

Diseases:

1) Damping Off:
It is a serious disease of chilli seedlings and mainly occurs in nursery bed. The disease infected seedlings rot at ground level and then the plants fall over ground. The seedlings die in patches.
Control Measures:
1. The seed bed should be treated with Formalin before sowing of seeds.
2. The seeds should be treated with hot water (30 minutes at 52^0 C) or Cerasan or Agrosan G.N. before sowing of seed.
3. The seedlings in the nursery should be sprayed with any fungicides at a regular interval.
2) Bacterial Leaf Spot:
Small dark, greasy spots are formed on leaf, petiole and tender parts, of the plant. Water soaked spots appear on green fruits. In severe cases the leaf may drop off which cause considerable loss to the crop.
Control Measures:
Spraying Agrimycin - 100 k at 200 ppm plus copper oxychloride 0.3 per cent controls the disease effectively.
3) Anthracnose:
Dark sunken spots are formed of fruits and pink or dark colored dots appear in the centre of the sunken spots. Due to this spots, the fruits rot and fall. The fungus may cause "Die back" of the twigs also. Die back disease attacks mainly the upper portion of the plants spreading gradually from the top to downward; as a result the branches dry up.
Control Measures:
The control measures are treatment of seed with Cerasan before sowing, removing and burning of attacked plants or branches and spraying the disease affected crops with Mancozeb (Dithane M-45) @ 2.5 gm per litre of water.
4) Leaf Curl:
The disease affected leaves becomes small in size accompanied by downward curling. The leaves may fall off in case of severe attack. The disease usually spreads through insect vectors such as thrips and aphids etc.
Control Measures:
Control of insect vectors by spraying the crop with Dimethoate (Rogor -30 EC) or Monocrotophos (Monocil) @ 1 ml per litre of water indirectly helps to check the spread of this disease.

D. Pumpkin (*Cucurbita moschata*)

Climate and soil requirement:
It is warm season crop. But it can withstand cool weather. The plant is also tolerant to partial shade.

Pumpkin is grown on all types of soil. But loam, sandy loam and clay loam soils are considered best for its cultivation. The soil should be thoroughly prepared. It does best at a pH of 6.0 or 6.5.

Sowing of Seed:

Two crops are raised commonly in the plains during January – March and June – July. Seeds are sown in well prepared pits at a spacing 3 X 3 m. about 4-6 kg of seeds are required for 1 ha.

Manures and Fertilizer:
30 to 50 tons of well decomposed FYM should be added at the time of soil preparation. 50 kg N, 25 kg P/ha should be given at the time of sowing seeds and remaining 50 kg of N should be given 30 days after sowing.

Intercultural Operation:
One or two weeding may be done during early stage of growth. No irrigation is given to rainy season crop. The summer season crops should be irrigated after third or fourth day.

Harvesting and Yield:
Pumpkin is harvested either in green or mature stage according to market demand. The fruits can be stored for a few months provided they are dept in well ventilated rooms. The yield may range from 15 to 25 t per ha.

Varieties:
Swarna Amrit, Arka Suryamukhi, Arka chanada

e. Bottle Gourd (*Lagenaria siceraria*)

Climate and soil requirement:
Hot and moist climate is favorable for its cultivation. It cannot withstand frost.
Bottle gourd can be grown in any types of soil. But sandy loam soils are best suited for its cultivation. The land should be prepared thoroughly by five to six ploughings.

Time of Sowing and Layout:
The seed is sown from January to end of February for summer crops. June – July for rainy season crop in the plains and April in the hills.

Seed Rate:
The seed rate is 3 to 6 kg/ ha.

Methods of Sowing and Spacing:
The seed is sown by dibbling method at spacing of 2 to 3 X 1.0 to 1.5 m. Generally three to four seeds are sown in a pit at 2.5 to 3.0 cm depth. Manures and fertilizer same as for pumpkin.

Intercultural Operation:
Two to three hoeing is given to keep down the weeds during the early stage of growth. The rainy season crop is usually stalked, often trained on a bower made of bamboos and sticks.

Irrigation:
The summer crop requires frequent irrigation at an interval of 4 to 5 days. The winter crop is irrigated as and when needed.

Harvesting:

The fruits should be harvested when they are still green. Delay in harvesting causes the fruit to become unit for marketing.

Yield:
The average yield is 90 to 120 quintal / ha.

Varieties:
There is some varieties of bottle gourd, viz summer prolific Round, summer prolific long, Pusa Navven, Arka Bahar, Pusa Manjari, Pusa Meghdoot etc.

f. Bitter Gourd (*Momordica charantia*)

Climate and soil requirement:
It is a warm, season crop. Hot and moist weather is favorable for its growth and development. Low temperature in habit the germination of seeds. It grows best at temperatures between 18^0C and 24^0C. Bitter gourd can be grown in all types of soil. But loam and silty loam soils are more suitable for its cultivation. It grows well on silty soil on river beds. The land should be well prepared.

Sowing of Seeds:
The seed is sown from January to March for summer season crop, June-July for rainy season crop in the plains and March to June in the hills. The seed rate is 4 to 5 kg/ha. The seed is sown by dibbling method at a spacing of 120x90 cm. Generally three to four seeds are sown in a pit at 2.5 to 3.0 cm depth. The seeds are soaked in water over night before sowing for better germination.

Manuring:
30 to 50 tons of well decomposed FYM should be added at the time of soil preparation. 25 kg N, 25 kg P/ha should be given at the time of sowing seeds and remaining 25 kg N should be given 30 days after sowing.

Intercultural Operation:
Two to three hoeing are done to suppress the weeds during the early stage of growth. The rainy season crop is usually staked, often trained on a bower made of bamboos and sticks.

Harvesting:
Harvesting is done when the fruits are still young and tender at every alternate day. Picking should be done carefully so that the vine may not be damaged. The fruits should not be allowed to mature on the vines. The harvested fruits may be stored for 3 to 4 days in-cool condition. The yield is 60 to 100 quintal/ha.

Varieties:
There are some varieties of bitter gourd viz. Pusa Domousmi, Coimbatore, Long, Arka Harit, Long green etc.

g. Ridge Gourd (*Luffa acutangula*)

Soil and its Preparation:

Ridge gourd can be grown in all kinds of soil. Loam, clay loam and silt soils are best suited for its cultivation. The land is prepared by ploughing for three to four times, followed by planking.

Sowing of Seed:
The seed rate is 4 to 5 kg/ha. The seed is sown by dibbling method at a spacing of 1.5 to 2.0 X 1.0 to 1.5 m. Two to three sees are sown in each pit. Layout is ring and basin.

Manuring:
30 to 50 tons of well decomposed FYM should be added at the time of soil preparation. 25 kg N, 25 kg P/ha should be given at the time of sowing seeds and remaining 25 kg N should be given 30 days after sowing.

Intercultural operation:
Shallow cultivation should be done during the early stage of growth. The plants should be provided with suitable support made of bamboo sticks.

Irrigation:
The summer crop should be irrigated just after sowing and subsequent irrigation is given at four to five days interval. No irrigation is given in rainy season crop.

Harvesting:
The fruit become ready for harvest from 55 – 60 days of sowing. The full grown tender fruit should be harvested at weekly interval by cutting them with a knife. The yield is about 75 to 100 quintal/ ha.

Varieties:
Pusa Nasdar, Swarna Manjari

h. Cucumber (*Cucumis sativus*)

Climate and soil requirement:
The cucumber is a warm season crop and grows best at a temperature between 18^0C and 24^0C. It does not withstand even light frost.
Cucumber can be grown in all types of soil from sandy to heavy soils. Loam, silt loam and clay loam soils are considered best for getting higher yield. Soil pH between 5.5 and 6.7 is favorable for its cultivation. The land should be prepared thoroughly before sowing of seeds.

Sowing of seed
The cucumber is cultivated both as a summer and rainy season crop and the seed is sown according to type of crop. For summer crop, sowing should be done in January to February and for rainy season crop sowing should be done in June-July. The seed of cucumber is sown in April in the hills. The seed rate is 2.5 to 4 kg/ha. The seed is sown by dibbling method at a distance of 1.5 to 2.5 meters (row to row) x 60 to 90 cm. (Plant to plant). Two to three seeds are sown in each pit.

Manuring:

30 to 50 tons of well decomposed FYM should be added at the time of soil preparation. 25 kg N, 25 kg P/ha should be given at the time of sowing seeds and remaining 25 kg N should be given 30 days after sowing.

Intercultural Operations:
Shallow cultivation should be done during the early stages of growth to control the weeds. Herbicides (such as Glycophosate, Paraquat) may be used to control weeds.

Irrigation:
The summer crop cultivated as an irrigated crop requires enough soil moisture during its growth and development. So irrigation should be given as and when needed. No irrigation is given in rainy season crop.

Harvesting:
The tender fruits should be harvested at an interval of two to four days. Timely picking is more important in regard to quality. Yield: The average yield is about 60 to 15 quintals/ha,

Varieties:
Swarna Poorna, Swarna Sheetal, Japanes Long green, Pusa Sanyog,

Pest Management of Cucurbitaceous Crops

Red Pumpkin Beetle:
It is the most serious insect pest of cucurbits. The larvae and adult of this pest cause damage by eating away the young leaves and flowers at the seedling and flowering stage respectively. The grub bores into the roots and fruits lying on the ground and pupates in the soil.

Control Measures:
i) Hand pickling and dusting keratinized ash is the most common method of controlling this pest.
ii) Spraying the crop with Malathion 50 EC or Dichlorovus (Nuvan, Vapona etc) @ 2 ml per liter of water can control this pest.

Fruit Fly:
The maggots of this pest enter into the fruit and feed on the pulp, as a result of which the fruit starts rooting.

Control Measures:
i) Collection and destruction of all infested fruits in the field will help in minimizing the damage to the crop.
ii) Dusting the crop with Malathion or Dipterex Powder in the affected filed will help in controlling adult fly.
Iii) Use of bait traps prepared from protein hydrolyzate @ 450 gm, Malathion or Dipterex water dispersible powder (25 %) @ 450 gm and water @ 1 gallon is most effective of controlling of this pest.

Disease management of cucurbitaceous crops

Powdery Mildew: Tiny white superficial spots appear on leaves and stem and they become powdery on enlarging. Due to attack of this disease, premature defoliation occurs and plants remain stunted in growth. The fruit too do not set or remain smaller in size. This disease can be controlled by dusting sulphur (sulfex) or spraying Karathane or Moresta @ 2 ml per liter of water.

Downy Mildew:
Purplish spots appear on lower surface and yellow spots on upper surface of leaves; fruit do not mature or do not contain right flavor. Application of fungicidal spray such as Dithane Z-78, Dithane M- 45, Blitox etc once a week helps to control this.

Anthracnose:
Watermelon muskmelon and cucumber is mainly affected by this disease. Light brown spots are formed on leaves which turn to dark brown and then to red, and the leaves present a scored appearance. Circular to oval sunken lesions develops on the disease infected fruits a d the fruit rot later on. Crop rotation with non – cucurbit crops, use of disease free seeds, seed treatment and spraying of ducting of fungicides are the recommended control measures of this disease.

Fusarium Root Rot:
Sudden mid season wilting, base of stem becomes dark brown, with a soft mushy cuticle wilt, fruit rot, and young seedling damp off. Crop rotation and seed treatment with hot water at 55^0C for 15 minutes followed by treatment with chloride (1 in 1000) are the recommended control measures of these diseases.

Mosaic:
Mottled leaf with roughened surface occurs. The green color completely lacking in fruit. In severe cases the plants are yellow and dwarfed and bear little or no fruit. Aphids transmit this disease. Growing resistant variety and spraying the crop with Dimithoate (Rogor-30 EC) or Methyl parathion (Metacid – 50 EC) or Oxidomition methyl (Metsyton – 25 EC) 2 1 ml per liter of water for controlling the insect vector are the recommended control measures

i. Garden Pea (*Pisum sativum*)

Climate:
Garden Pea is a cool season crop and performs best at 10^0C to 18^0C. The flower and young pods are badly affected by frost. The germination of seeds takes place at 3.3 ^{0} C soil temperature. As the temperature increases during the growing season the yield declines sharply. The optimum mean monthly temperature for pea is 12.8 ^{0} C to 18 ^{0} C.

Sowing:
In India, garden pea is generally sown in rabi season from the beginning of October to mid of November in the plains and from middle of March to end of May in the hills. Sowing of seed during the first week of November is proper time to get higher yield. The optimum seed rate is 25 to 30 kg/ha. The pea is generally sown by broad casting. But it may also be sown by dibbling or behind the plough. The seeds are soaked in water overnight before sowing for better germination. Seeds treated with Rhizobium culture give higher yield. Flat bed layout is used. Spacing is 45 X 20 cm.

Manuring:

30 to 50 tons of FYM should be applied at the time of soil preparation. 25 kg N, 50 kg P and 50 kg k/ha should be applied should be applied at the sowing. Remaining 25 kg nitrogen should be applied one month after sowing.

Intercultural Operation:
it is very difficult to control the weeds of pea field by mechanical methods as the crops are sown in rows in closed spacing. Use of herbicides has been proved very such effective. Atrazine, propazine and simazine at 0.54 kg per acre gave good broad leaf weed control and late control of wild oats damage the peas.

Irrigation:
Water requirement of garden pea is generally high which depends largely on Agronomic condition of the locality. The crop may be irrigated at 10 days interval. Where rainfall is low, irrigation is necessary at flowering and grain development stage.

Harvesting:
Peas are harvested for table use when the pods are filled and the young tender peas changing in color from dark to light green. Peas may be picked in 45 to 60 days, 75 days and 100 days according to early or mid season or late cultivars, respectively. 3 to 4 pickling are done within the interval of 2 to 10 days. Fresh unshielded peas may be kept two at 0 ^{0}C and 90- 95 percent relative humidity.

Yield:
The yield of per hectare varies according to the variety viz. early Variety: 25 to 40 Quintals, mid season and late: 50 to 60 Quintals.

Varieties:
Early Variety: Early Badgar, Arkel.
Mid season Variety**:** Swarna Mukti, Swarna Amar**,** Bournevilla, Jawahar.

j. French Bean (*Phaselous vulgaris*)

Climate and soil requirement:
French bean is day neutral crop. It is very sensitive to high temperature and frost. Soil temperature approximately 32.2 ^{0} C (90 0F) is essential for maximum vegetative growth.
French bean can be grown on almost all type of soil. The optimum soil PH for getting good crops is 5.3 to 6.0. The land is prepared thoroughly by 5-6 ploughing.

Sowing of Seed:
The seed is sown in June – July and January- February in the plains and from March to the beginning of May in the hills. The seed rate is 40 to 50 kg/ha. The seed may be sown by dibbling, drilling and broad casting at a depth of 2.0 to 3.0 cm; the seeds should be inoculated with rhizobial culture before sowing. The flat bed layout is used. Spacing of 45 X 20 cm is recommended.

Intercultural Operation:

Shallow cultivation is given to keep the crop free from weeds. Herbicides such as dinitomaterial 2 – 3 kg per acre and sodium salt of pentachlorophenol @ 6 kg per acre as per- emergence treatment have been effective in controlling the weeds.

Irrigation:
The soil must have sufficient moisture. Irrigation should be given just prior to blooming, during flowering and pod development stage.

Harvesting:
The green pods become ready for harvesting after 45 to 75 days of sowing according to the variety and they should be picked as and when they are ready. A Yield level of 40 – 50 quintal green pods/ ha can be obtained.

Varieties:
Bush bean variety: Swarna Priya, Arka Komal, Contender, Pusa Parbati
Pole bean variety: Swarna Lata, Kentuky Wonder

k. Cowpea (*Vigna sinensis*)

Climate and soil requirement:

Cowpea is a warm season crop and cannot stand cold weather. Warm and moist climate is favorable for this crop. It cannot tolerate heavy rainfall. Cowpea can be grown in all types of soil. But sandy and sandy loam soils are best suited for it. The soil should be rich in organic matter. The land is prepared by giving four to five ploughing.

Sowing of Seed:
The time of sowing varies according to type of crop. i) Kharif crop: May – June, Ii) Rabi crop: October-November, iii) Spring crop: February – March. The seed rate is 15 to 20 kg/ha. The seed is sown by dibbling method. A spacing of 40 X 30cm or 65 X 45 cm is recommended.

Manuring:
30 to 50 tons of FYM or compost should be applied at the time of sowing preparation. 25 kg N, 50 kg P, should be applied at the time of sowing and remaining 25 kg nitrogen applied one month after sowing.

Intercultural Operation:
No weeding is needed for this crop. It covers the land very soon and kills the weeds by smoothing. In early stage of growth, one weeding has been found beneficial to this crop.

Irrigation:
No irrigation is given in rainy season crop. But if grown earlier, the crop is irrigated whenever it is required. About three to four irrigation may be given before rainfall.

Harvesting:
The crop becomes ready for harvesting in 90 to 105 days for short duration crop and 135 to 150 days for long duration crop. Frequently tender pods should be harvested before they become fibrous. Cowpea yield about 50 to 80 quintal green pods/ ha.

Varieties:
Swarna Harita, Swarna Sweta, Swarna Suruchi, Pusa phalguni, Pusa Dofasli, Pusa komal.

Insect and Pest Management of Legume Vegetables
Aphids:

It is most destructive pest of legumes vegetable. These are very small insect and infest the leaves, stem and pods and suck the cell sap. In case of severe infestation, the infested parts dry up and there may not be any pod formation. This insect can be controlled by spraying the crop with Dimethoate (Rogor 30 EC) or Oxidomition Methyl (Metasystox – 25 EC) or methyl Parathion (Metacid 50 EC) @ 1 ml or Phosphamidon (Demicron – 100 EC) @ 0.5 ml per liter of water when the infestation is noticed.

Pea Pod borer:
The insect bore into pods and feed on the grains inside. Spraying the crop with Fenthion 0.05 percent and Phosphamidon 0.03 % can control this pest.

Disease Management of Legume Vegetable

Seedling Blight:
Pre- emergence and post emergence damping off of seedling occur and the fibrous root being infested. The seeds should be treated with Cerasan or Arasan or Speragon @ 2.5 gm per kg of seed before sowing.
Powdery Mildew:
Small, white, circular powdery spots appear on the upper surface of leaves which gradually cover the entire leaves, stems, petiole and the pods. They increase gradually resulting in the death of the leaves and fruits. Dusting the crop with sulfur @ 11.25 kg per acre or spraying Wet table sulfur @ 2 kg %, starting just on the appearance of the disease have been found effective in controlling this disease.

Downey Mildew:
Symptoms are downy growth on lower surface of leaves which is white first, but later changes to violet and appears black is advance stage. Brown lesions are formed on pods in case of severe infector. This disease can effectively be controlled by spraying the crop copper Oxychloride (Blitox, Phytolan tc) @ 5 gm per liter of water.

Wilt:
Symptoms are premature yellowing and whitening of leaves and finally the diving of the entire plant. Plant may continue to wilt in patches in quick succession till the maturity period. The diseases affected plants can easily be pulled out. The diseases cause considerable damage when the crop is sown early and in light soil. Early sowing should be avoided in badly infested areas. The seed should be treated with cerasn @ 2.5 gm or captan @ 2.3 gm per kg of seed.

I. Cauliflower (*Brassica oleracea* var. botrytis)

Climatic and soil requirements:
Cauliflower thrives best in a cool and moist climate. Cauliflower withstands so low temperature or so much heat as cabbage does. Dry weather and low humidity are not suited from it. For good seed germination, temperature of 50 to 70^0F is required. High temperatures produces poor quality curds viz Ricey, leafy, fuzzy, loose and yellow curds. Temperature below the optimum during growing period delays maturity and undersized, small unmarketable heads or buttons may be formed. Dry hot weather may give rise to small hard heads.

It can be grown on a wide range of soil provided they are rich in nutrients and have adequate soil moisture, possess a good drainage and also contain plenty of organic matter. Sandy loam soil are preferred for early crops, while loam and clay loams for late crops. Cauliflower grows best on a neutral to slightly acid soils i.e. at pH 6.0 to 7.0. If the soil is below pH 5.5 liming at the rate of 5 to 10 quintal per ha should be done for successful raising of cauliflower. Higher pH than 7.0 decrease the availability of boron. The soil must be thoroughly prepared to make it loose and friable, and retentive of moisture. Basic organic manures should be applied during the field preparation. It requires better prepared soil than cabbage. 1 to 2 corrosive ploughing by a soil turning plough followed by 3 to 4 ploughing with desi plough are enough for it.

Seed rate and Time of Sowing:
The seed are sown in nursery bed in May- June for early, July – August for mid season (main crop) and September – October for late varieties. In cauliflower seed rate for early crop is 600 to 750 gm and for late crop 400 to 500 gm /Ha

Layout and Spacing:
Ridges and furrow type of layout is used for crop. Before that seedlings are prepared in nursery bed (Raised bed) and transplanted in main filed after 3 – 4 weeks. Spacing for early crop is 45 X 45 cm and late crop it is 60X 60 cm.

Cultivars or Varieties:
In cauliflower various varieties are grown. They are season bound. Therefore, almost care should be taken while sowing the seeds. There are early mid season and late varieties, according to maturity in particular season.
Varieties suitable to be grown in rainy season (June – July) are Pusa Katki, Early Kunwari. The curds are available in September- October. Aghani matures in November, Possi in December and maghi in January. Early cultivars produce short plant. The leaves are bluish green and produces small to medium and loose curd. Pusa Deepali is also early and curds mature in November. Curds are white. Pusa Synthetic is another variety suitable for planting in September and curds are available in December – January.
The late cultivator is snow ball which can be planted in October – November and curds are available in February- March. The curds are white, compact and therefore yield is more. They also fetch more prose in the market for all these varieties optimum temperature ranges for curd initiation and development varieties.

Manures and Fertilizer:
For best result 15 to 20 tons of FYM or compost should be incorporated into the soil about 4 weeks before transplanting. In cauliflower 100 kg N, 50 kg P2O5 /ha, should be given.
Irrigation:

It may be given to the crop every 5 – 6 days to the early planting and 10- 15 days for late crop. At the time of head formation, there should be enough moisture in the field, so irrigate at this time and when cauliflower is raised late in the season, it should be watered closely.

Intercultural Operation:
Shallow frequent cultivation should be given in the cauliflower field by khurpi or hoe to kill young weeds and provide soil mulch. Avoid deep cultivation, for it may destroy the plant roots located top 3 to 6 mater in the soil. Weeding should be started as soon as plants are set in the field. Four to five weeks after transplanting, the plants should be slightly earthen up in the field.

Harvesting:
Cauliflower should be harvested when the head has developed the proper size and is at right stage of maturity. The head should be compact but it should not be broken into segments. The plant is cut off well below the head so that the stub has left the head from damaging during transporting to the market. The plants are cut as and when curds are well developed. As curds do not develop uniformly, so only those which are full developed are removed but not over matured ones after inspecting the whole filed each second or third day. Harvesting the filed during morning or evening so that the produce may be kept cool for the market.

Yield:
In case of early cauliflower crop 200 to 250 quintal / ha yield is obtained. While in case of later crop it is 250 to 300 quintal / ha.

Disorders in Cauliflower

Various disorders are observed in Cole crops. These are physiological disorders. Some disorders are also caused by climate and injury to growing bud.

Buttoning:
The buttoning means production of small button like curds. This is due to sudden check in the vegetative growth. The reasons attributed are over aged seedlings, poor nitrogen supply, planting early varieties in late season and change in temperature.

Richness:
Premature initiation of floral bud is characterized by richens. Such curds are poor in quality for marketing. Richness result due to unfavorable temperature for a given variety.

Browning:
This is caused due to deficiency of boron in soil. In serious cases stem becomes hollow with water soaked tissues. In advanced stage pinkish or brown area develop on surface of the curd. This can be controlled by applying sodium borax 20 kg/ ha or spraying of boron 0.25 to 0.50 % solution.

Whiptail:
This is caused due to molybdenum deficiency. Young plants turns white particularly along the leaf margins and also become cupped and whiter and dies. Apply molybdenum @ 1 kg/ ha to control the malady. Leaf blades do not develop properly, only midrib develops.

Blindness:
Blind cauliflower plants are those without terminal buds. The leaves which develop are large, thick leather and dark green. Blindness is supposed to be due temperature or injury due to cultural operation, insect and pest disease.

m. Cabbage (*Brasslike oleracea* var. Capitata)

Climate and soil requirement

It grows best in cool moist climate and is very hardy to frost. In areas with comparatively dry atmospheres, its leaves tend to be more distinctly petiole than in the more humid areas. In hot dry atmosphere, its quality becomes poor and much of its delicate flavor is lost. Its germination is best at a soil temperature of about 55 °F to 60 °F. Temperatures below this and above this are not suited for it. Well hardened seedlings can tolerate temperature of2Q °F to 25 "F. It is grown mainly as rabi crop during winter. But in and around Nasik (Maharashtra), Ootacamond (Madras), and in semi parts of Kerala, it is grown as kharif crop also.

It can be grown almost in all types of soil ranging from sand to heavy soils. But small quick growing cabbage varieties do well in sandy soils, while large and late maturing varieties in heavy soils. Soils intended for cabbage growing, should have good drainage. The best PH range for cabbage is between pH 5.5 to 6.5. Lime may be added in acid soil to make it neutral or alkaline for growing good crop of cabbage. Land is prepared by ploughing it 3 to 4 times. The first ploughing should be done by soil turning plough, and the bulky organic manures should be spread in the field. Then the land should be ploughed and leveling the land, beds of suitable size and irrigation channels are made.

Seed Rate & Sowing:

Cabbage is grown mainly as Rabi crop during winter (Sept.-Oct.). However, it is grown as kharif crop also. The seed rate for early crop (September) is 500 gm & for late crop is 373 gm.

Ridges & furrow type of layout is used for crop. Before that seedlings are prepared in nursery bed (Raised bed) & transplanted in main field after 3-4 weeks. Spacing for early crop is 45x45 cm and late crop it is 60x60 cm.

Manures & Fertilizers:

150 kg N, 50 kg P2O5 should be applied per hectare.

Irrigation:

Irrigation at the time of transplanting is essential. Steady supply of moisture is necessary for good growth and development. Interval between two irrigations depends upon climate, soil and plant growth. In winter season irrigation at an interval of 8-10 days is sufficient.

Harvesting and Yield:

In cabbage harvesting is done depending on the maturity of the head and demand in market. Normally harvesting is done when heads are firm. If prices are high in the market harvesting is done earlier when heads are ax small and loose Heads are cut with a knife with little stalk arid some leaves. The yield of cabbage depends upon the variety, growing season and management practices. Hybrid cabbage yields up to 50 tonner per hectare the yield of early varieties ranges between 12 to 15 tones/ha. The yield of late season varieties is about 20 to 25 tones /ha.

Cultivars or Varieties of Cabbage

Cabbage cultivars are classified on the basis of color of head and maturity. In India white cabbage is important. Common cabbage varieties grown are

Early varieties: Golden Acre, Pride of India, Copenhagen Market

Late Varieties: Pusa Drumhead

Insect Pest Management of Cole Crops

1. Mustard Saw- Fly:
The blackish caterpillar that attacks all cole crops and feed on leaves of young seedling in the early stages. The infested leaves become curl and falls on the ground when touched.

Control Measures:

i) If infestation is light and number of attacked plant is small, hand picking of caterpillar is the best method of controlling the larvae.
ii) Spraying of sevin @ 5 gm per liter of water is also effective to control this insect.

2. Mustard Aphids:
A greenish white small insect that attack cabbage and other cole groups when there is a cloudy weather. They suck the sap from the plants. The affected leaves get curled and plants wither and die's.

Control Measures:
Spray Phosphamidon 85 @ P 0.02 % or Dimathoate 30 EC @ 0.5 %

3. Diamond Black Moth:
A small slender pale green caterpillar that feeds on leaves and makes holes in them. The infested crops become unsuitable for marketing.
Control Measures:
This pest can effectively controlled by spraying the crops with Malathion (Cythion- 50 EC, Folithion – 1000) /2 2 ml per liter of water or Dichlorovus (Nuvan – 1000, Vapona Agrosan etc) or Monocrotophos (Monocil, Nuracron, Suphos etc) @ 1 ml per liter of water.

Diseases Management of Cole Crops

1. Leaf Spot and Bight:
Small dark colored spots which spread rapidly to form circular lesions and concentric rings of dark conidiophores' appear in humid weather due to which cauliflower develops brown discoloration and cabbage after harvests acquires black mouldy appearances.
Control Measures:
i) Hot water treatment of seeds at 50 ^{0} C for 30 minute helps to check the spread of this diseases.
ii) Spraying the crop with Zineb (Dithane Z – 78) or Mancozeb (Dithane M – 45) @ 2.5 gm per liter of water or copper oxychloride (Blitox, Blucopper, Phytolap, cupravit etc.) @ 5 gm per liter of water at an interval of 10- 15 days according to incidence of diseases is very effective to control this disease.
2. Black Rot:
The margin of disease affected leaves turn yellow, vein becomes dark and vascular discoloration takes place in the main stem.
Control Measures:
The disease can be controlled by seed treatment with hot water at 50 ^{0} C for half an hour before sowing and adopting crop rotation with non- cruciferaceuous crops for three years.

3. Club Rot:
The rots of affected plat enlarge to from clubs secondary invasion by soft root bacteria follows forming material toxic to plant. The foliage of affected plants with on sunny days and recovers towards evening.
Control Measures:

The seedlings at transplanting time should be treated with mercuric chloride @ 125 c.c (about 113.4 gm).

4. Damping Off:
It is a common problem in the nursery bed of vegetable crops. The affected plants fall down and die due to shrinking of cortical tissue of hypocotyls.
Control Measures:
Drenching the nursery bed with formaldehyde or brassicol about 3 -4 weeks prior to sowing, seed treatment with mercurial fungicide @ 2 gm per kg of seed, avoiding thick sowing and spraying the seedlings with Dithane M – 45 or Dithane Z- 78 @ 2.5 gm per liter

n. Onion (*Allium cepa*)

Climate and soil requirement:
Onion is a cool season crop. It is grown during winter and harvested before the real hot season begins. Onion can be grown under a wide range of climatic condition. But it succeeds best in mild season without extremes of heat and cold. It can be grown as a rained crop even at elevation of 1500 to 2000 m between April and August.

Onion can be grown on various soils. But sandy loam, silly loam and deep friable soils are best suited for onion crop. The land is prepared by giving 5-6 ploughings. The optimum pH range is between 5.8 and 6.5.

Seed rate & Sowing:
In onion 10 to 12 kg seeds require/ha.For kharif it is sown in June & for rabi sown in October-November. Ridges & furrow type of layout is followed and a spacing of 15x10 cm. is maintained. Flat beds are used because
1. Flat beds plants accommodate more plants than ridges & furrow.
2. In flat bed (leveled) there is equal distribution of water & fertilizers.
3. In percentage of twines is less in flat beds than ridges & furrow.

Manures & Fertilizers:
25 to 30 tons of well rotten FYM or compost applied at the time soil preparation per hectare. For onion 50 kg N, 25 kg P^Os & 25 kg Potash should be applied.

Intercultural, Weeding and Other Operations:
Cultural Operation keeps the field absolutely free from weeds to produce a good crop of onion. Weeds, if not controlled in early stage but removed later on, will injure the onion bulbs and the out-turn will be poor. 2-3 hoeing and weedings are enough for the crop. After 2 to 3 irrigations, earth up the poor plants.

Irrigation:
The root system of onion is restricted to top 8 cm and roots penetrate seldom deeper than 15 cm. Water requirement of the crop at the Initial growth period is less. Irrigation should be stopped 15-20 days before attaining maturity for improving the keeping quality of bulbs. Frequent irrigation delays maturity. In kharif season, depending upon the rains and time of planting 6-10 irrigations are enough. In rabi, 10-15 irrigations are given at bulb formation, irrigation is necessary and moisture stress at this stage results in low yield.

Harvesting, Curing, Yield and Storage:
Harvesting of onion bulbs should be done at right stage of maturity. It is important in deciding storage life of onion as bulbs. The onion bulbs, reach maturity when the plants cease to produce new leaves and roots. In onion, neck fall is the indication of maturity. In general, when about 50 percent neck fall is seen crop is harvested. Onion for storage should be fully developed. Thick-neck bulbs which result due to premature harvesting do not store well. Late harvesting leads to increased respiration, subsequent susceptibility to diseases and excessive sprouting during prolonged storage and left in field sunburn is also noticed. Bulbs are harvested by hand pulling if soil is light; they are also harvested by hand implements. In rabi season, yield of onion is around 25-30 tons per hectare, while in kharif season it is comparatively low. Y

Improved Varieties of Onion
Arka Niketan, Pusa red, Pusa Ratnar,

Insect Pests Management in Onion

1) Onion Thrips:
. It is a small sucking insect that feed on leaves and lacerate tissue.
Control Measures:
This pest can be controlled by spraying the crop with Dimethoate (Rogor-30 EC) or Methyl Parathion (Metacid - 50 EC) or Oxydemiton methyl (Metasytox - 25 EC) @ I ml per liter of water.

2) Lear Eating Caterpillar:
This caterpillar is occasionally found cutting the leaves damage the crop.
Control Measures:
Spraying the crop with Lindatie 20 EC or Methyl Parathion (S) 1 ml per liter of water can control this pest.

Diseases Management in Onion

1) Blight:
Small white sunken lesions with purple centre appear on leaves and they enlarge rapidly, girdling the leaves and flower stem which fall over and the bulb decay follows in the storage.

Control Measures:
This disease can be controlled by spraying the crop with one per cent Bordeaux mixture or Mancozeb (Dithane M-45) @. 2.5 gm per liter of water or Copper Oxychloride (Blitox-5Q) @ 5.0 mg per liter of water.

2) Onion Smut:
Dark, slightly thickened area appears on cotyledon of young seedlings with numerous raised blisters near base of scales of older plants, which on rupturing expose black and powdery mass of spores.
Control Measures:
The disease can be controlled by seed treatment with Thiram @ 45 gm for 0.45 kg of seed (Larson and Walker, 1953) .and spraying formaldehyde solution in the furrow.

Post Harvest Technology & Value addition: Profitable venture for Women

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It is well accepted that women work force is the backbone of Indian agriculture including horticulture and other related sectors. Looking on the food production sequence, it is a combination of several activities as: primary crop production, food crop production, crop and livestock production, food processing, preparation & preservation, marketing etc. Each and every activity has a different picture of the contribution of women. Women participation is more in horticultural sector than the food grain production; however most of the post harvest activities either related to food grains, horticulture, livestock and fishery is dealt by women labors. The research efforts at the ICAR institutes have been tried to relieve her of the drudgery involved in these agricultural activities by providing time and labor saving tools and techniques. Vocational trainings are also being conducted at several institutes, farm science centers and NGOs, to impart skills to undertake different avocations. In extension activities the women is now the centre point and activities are being planned keeping her in view. Under the project *Standardization of women specific field practices in rice in Orissa revealed* women of family contributed highest hours per season (61.7) in harvesting and post harvesting operations of rice and participated lowest in land preparation.

Post harvest activities are much related to the women's day to day activities which they performed at their homes either in kitchen or in homestead. Keeping the food material either in fresh form or in processed form for family consumption resembles to an extent of commercial post harvest activities. Women can do both primary and secondary processing of cereal, pulse, spice, oilseed, fruit, vegetable, flowers, meat and poultry, dairy etc. to supplement family income. Post harvest operations are comparatively less labor intensive than the food production operations.

Food processing industry either of cottage level or at commercial level is an enterprise that processes the product of plant or animal origin into the form of consumption. Following table reveals that our country is not able to process the food due to inadequate infrastructure and lack of trained manpower in the field of food processing and preservation, as a result a huge quantity of raw food materials is going waste. Therefore, post harvest management of food should be an integral part of production and marketing.

Table-1: Level of Fruits & Vegetables Processing in different country

Country	% of processing
Malaysia	83
South Africa	80
Philippines	78
Thailand	72
Brazil	70
USA	65
India	05

The primary post harvest operation includes: Cleaning or washing, sorting or grading, packaging & storage, marketing. Similarly secondary post harvest operations are manufacturing processed products, packaging in convenient serving sizes and proper marketing. Level of processing through which nature and degree of transformation differ may be described as:

Level I - Cleaning, Grading, Storage
Level II - Ginning, Milling, Peeling, Cutting
Level III - Cooking, Pasteurization, Canning, Mixing
Level IV - Chemical alteration, Dehydration, Extraction

There are several operations are performed in a particular food industries where women are more comfortably work. Following is the list of food processing industries/operations where involvement of women seems to be more justified:

- **Minimal processing**: Minimally processed Fruits and Vegetables where women involvement is more important. Minimally processed fruits and vegetables is nothing but prepared and packaged in the form of ready to consumption or cook. Minimal processing of fruits and vegetables means peeling, cutting, washing, surface drying and packaging of these products, in order to extend the shelf life and maintain the freshness and nutritional quality of the products. The shelf life of packaged fruits and vegetables is prolonged by hygienic processing, low storage temperature and suitable permeability of the packaging material. The demand of minimally processed fruits and vegetables are increasing day by day as more and more people spent most of the time outside their homes for sake of doing job and better earnings. Minimally processed and frozen food products are now becomes necessary in the life of urban masses. There are several reasons for the increasing demand of minimally processed products such as; Consumer convenience and saving precooking time; Fresh-like quality containing only natural ingredients; Longer shelf life in case of frozen; Peeled, sliced, grated or shredded; Fresh apple slices, fresh pineapples, mango slices, cauliflower florets, dressed meat, chicken, green peas, green chickpeas, etc.,

- **Fruit and vegetable processing industry:** Processing (canning, drying, freezing, and preparation of juices, jams, and jellies) increases the shelf life of fruits and vegetables. Processing steps include preparation of the raw material (cleaning, trimming, and peeling followed by cooking, canning, or freezing. Fruits and vegetable processing plant operation is often seasonal, however other agricultural produce can be processed to make the plant economically viable.

- **Dried food products including osmotically dried fruits:** Drying removes the moisture from the food so bacteria, yeast and mold cannot grow and spoil the food. Drying also slows down the action of enzymes (naturally occurring substances which cause foods to ripen), but does not inactivate them. Because drying removes moisture, the food becomes smaller and lighter in weight. When the food is ready for use, the water is added back, and the food returns to its original shape after reconstitution. Foods can be dried in the sun, in an oven or in a food dehydrator by using the right combination of heated air temperatures, low humidity and air flow. In drying, hot air temperatures cause the moisture to evaporate from the food items. Low humidity allows moisture to move quickly from the food to the air. Air flow speeds up drying by moving the surrounding moist air away from the food.

- **Pickles, sauce and soups industries:** This is one of the major food processing activities where almost all operation is being done by women worker. Preparing raw materials by peeling, cleaning, cutting and drying, mixing etc. which is required to develop pickles, sauces and soups are done by the women. Therefore working women should have the basic knowledge of technology behind the food preservation through pickling etc.

- ***Papad*** **and Ba*d*i industry:** *Papad* and *Badi* are prepared from cereals and pulses. Now days it emerged as a largest cottage industries in the field of food processing involving most of the women worker.
- **Soybean processing for milk, tofu etc:** Soybean processing by women even at household level has good scope for income generation for women. Soybean with its high productivity and protein content can make a fourfold impact on malnutrition as compared to pulses. It is the most appropriate options for India as it can be made available at an affordable price to the poorer section of the population. Processed soybean has several health benefits.

- **Food-grain milling industry**
- **Edible oil industry**
- **Dairy industry:** One of the most productive and important aspects of women's farm work in India is dairying. Women performed most of the actual dairy work and were primarily responsible for most dairy production. However, as various aspects of dairying moved from the farm to the factory, women's participation is now shifted from farm to dairy industries.

- **Drinks and beverages**
- **Meat & meat products**
- **Fish Processing**
- **Bakery & confectionary**
- **Malt extract, protein isolate, high protein food, weaning food and extruded food products**
- **Beer, including non alcoholic beer**
- **Alcoholic drinks from non-molasses base**
- **Aerated waters and soft drinks**

- **Specialized packaging of food materials for longer shelf life**: Polymeric film bags are the predominant material for consumer packaging of fruits and vegetables. Besides cost effective materials, automated packaging machines further reduce packing costs. One of the newest trends in produce-packaging is the shrink wrapping of individual produce item with polymeric film. Individual shrink wrapping has been studied to package peaches, citrus, tomato, pomegranate, papaya, guava, apple and a variety of tropical and temperate fruits and vegetables. Shrink wrapping with an engineered plastic wrap can reduce shrinkage, protect the produce from incidence of fungal disease, reduce mechanical damage and provide a good surface for stick-on labels. The use of shrink wrap with polymeric film has a major advantage in reducing moisture losses from the fruit. It also protects the fruit from some damage by abrasion during transport.

- **Ready to eat (RTE), Ready to serve (RTS) & Ready to cook (RTC) Foods**
- **Functional foods and Neutraceuticals industry:** In the pursuit of advanced food processing to obtain high value produce in view to prevent a particular disease or disorder apart from its natural nutrition, the terminologies like functional foods and nutraceuticals derived and has come into focus of recent research on food science and engineering worldwide. Nutraceuticals is

a broad term used to describe any product derived from food sources that provides extra health benefits in addition to the basic nutritional value found in foods. Products typically claim to prevent chronic diseases, improve health, delay the aging process, and increase life expectancy.

Following table gives a glance of availability of horticultural produce for processing in the eastern region:

Fruits/ Vegetables	Availability period	Processing methodology	Processed product
Aonla	October - January	Pulping, Drying, segmentation and shredding	Chawanpras, Preserve, Candy, Beverage, Jam, Pickle and Dehydrated fruits
Mango	March - August	Pulping, Drying and pickling, powder	Pickle, Beverage, Pulp, Pectin from peel, Kernal powder
Litchi	May-July	Pulping, Drying, Canning	RTS, Quash, Dried nuts, Canned litchi
Guava	August - February	Pulping	Jelly, Beverage, Toffee/leather
Jackfruit	February - July	Canning, drying and pickling	Dried flakes, Pickle, Canned, Roasted seed
Pear	June - August	Canning and pulping	Jam, Slice, Canned fruits
Custard apple	September - October	Pulping and freeze drying	Custard paste, Dried custard pulp powder, seed powder
Tamarind	April - May	Pulping, dying and kernel processing	Dehydrated pods, Pulp, Kernel powder
Bael	March - May	Pulping and slicing	Beverage, Preserve, Slice
Tomato	November - June	Pulping, drying	Ketchup, Puree, Pulp, soups, tomato powder
French bean	September - December	Canning	Canned beans, Pickle, frozen
Cauliflower	Round the year	Freeze drying and pickling	Canned, Dehydrated, Pickle, frozen
Cabbage	September - May	Freeze drying, canning	Canned, Dehydrated, Sauerkraut
Pea	December - April	Canning, freezing, drying	Canned peas, frozen peas, dried peas
Elephant Foot Yam	August - December	Slicing and pickling, drying, canning	Pickle, powder, canned soups
Lime and lemon	February - December	Pickling, juice extraction	Pickle, Beverage, Marmalade
Mushroom	Round the year	Pickle, Canning and drying	Canned and dehydrated products like soups

It may be concluded that processing of the food products must be in the line of availability of the raw material in the region. Processors must choose their products very carefully. It is not enough to assume that processing can be a successful business simply because there is plenty of cheap food produce is available. There must be a good demand for the processed food and this must be clearly identified before a business is set up. The best types of products for small-scale production are those that have a high 'added-value' as well as have a good demand. A high added value means that cheap

raw materials can be processed into relatively expensive products. It also means that this can be done at a small scale of processing using equipment that is affordable. Skill development training in the field of food processing is highly essential for the women for overall development of this sector. Appropriate assessment of technological needs is a pre-requisite for developing relevant technologies for women. This should be done at local, regional and global level involving community's concern. Substantial emphasis has been now placed on the handling of fresh fruits and vegetables. Canning has become practically obsolete and methods such as aseptic packaging, cryogenic freezing, deep freezing, accelerated freeze drying, controlled and modified atmosphere storage, shrink wrapping etc. have been increasingly used in extending the shelf life of fruits and vegetables. These technologies must be adopted if our country is to keep pace with the rest of the World.

Training of rural women folk for skill development on papad, tomato sauce, mushroom pickles

Role of Women Folk in Nursery Management

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The demand for high quality planting material is steadily increasing due to interest in fruit tree cultivation, social forestry, agro-forestry and plantation crops. The need of setting up plant nurseries to meet the demands of the people has been felt by small and marginal farmers as well as by gardeners and farm house owners. In order to meet this demand, there is ample scope for introduction of small nurseries which will serve to augment the incomes of needy sections of rural society. Setting up of a fruit nursery is a long term venture and needs lot of planning and expertise. Thus one should give utmost attention and care when nursery is to be established particularly with respect to site selection, progeny trees, irrigation arrangements, management of skilled manpower and materials.

Site selection

The locality where fruit growing is being practiced already provides ideal site for setting up of nursery. However, with the operationalization of a number of centrally sponsored or state govt. developmental schemes for promotion of horticulture in different states, setting up of fruit plant nurseries in newly emerging horticultural regions can also be profitable venture. Nearness to cities, railway station or metalled roads are some of the other favorable factors for establishment of fruit nurseries. Nursery stock and young plants need frequent irrigation to make them grow well. Therefore provision of satisfactory irrigation arrangements is essential for success of fruit nursery.

Establishment of mother plant block

A mother plant block having true-to-type progeny trees is the first requirement for establishment of any nursery. The saplings to be used for mother plants should be procured only from reliable sources like nurseries of ICAR institutes, State Agriculture Universities or State govt. farms. The nursery should only produce saplings of those varieties which have commercial values in the market. For the establishment of mother plants and successful nurseries, both soil and sub-soil should be suitable. A fertile loamy soil is good for fruit nursery. In case of nurseries with newly established mother plant blocks, the requirement of scion material during the initial 6-8 years can be fulfilled from properly identified plus trees growing in the region. Therefore, venturing into nursery business by orchardists having sufficient number of grown up mother plants is a highly profitable venture from the first year onwards.

For establishment of mother plant block, the saplings should be planted at a spacing of 5m x 5m in case of plants like mango, litchi and aonla whereas saplings of guava and lime should be planted at a spacing of 2.5m x 2.5m. For a nursery with a production capacity of 1 lakh plants per year (mango – 40000 nos, litchi – 20000 nos, guava – 20000 nos, lime – 20000 nos) an area of 1.0 ha need to be delineated for mother plant block having 100 mango plants, 100 litchi plants, 400 each of guava and lime plants. In case of orchardists already having grown up plants to be used as mother plants for their newly established nurseries, it is important to bring back the canopy of the plants to a workable size by

pruning. Otherwise, it will require lot of human labor for collection of scion-sticks or making of air-layers in the bigger sized plants. Pruning of plants will also help in production of large number of healthy shoots which can be used for production of healthy planting material

Infrastructure development

A total area of 1.0 ha (excluding the area under mother plant block) is essential for carrying out different operations for production of 1 lakh quality planting material of different fruits. The allotment of the total land under different functional units of the nursery should be as follows;

- Area under primary nursery bed (seedbed):0.20 ha
- Area under secondary nursery:0.30 ha
- Area under protected structures:0.35 ha
- Area under potting shed, stores and miscellaneous uses:0.14 ha
- Area under vermin composting unit: 0.01 ha

Young saplings produced in the nurseries are highly prone to adverse weather conditions like low temperature, high temperature and drought. For successful nursery establishment, it is essential to create infrastructure to counteract the adversities of weather. Setting up of shade-net houses (low cost or high-cost) is the first step in this regard. Low cost shade-net houses can be prepared by using locally available materials like bamboo or wooden poles and green colored shade-net (50%). These low cost shade nets can be used effectively for a period of three to 4 years. A shade net house of size 30 m lengths x 36 m width x 3 m height can accommodate 36,000 numbers of saplings. While making shade net houses it is important to put the shade net at least 1 ft. above the ground to allow increased ventilation inside the structure.

A potting shed of size 15 m x 20m size is essential for carrying out different operations like bag filling, grafting etc. A low cost structure can be made by using locally available materials. Vermin compost unit is an essential part of any nursery for preparing good soil media for filling the bags. The vermin compost unit can be prepared by using locally available material.

For assured supply of irrigation water provision has to be made for bore well fitted with submersible pump and sprinkler irrigation systems.

Method of propagation of different fruit crops

Mango: Mango is commercially propagated by top grafting the scions on rootstocks. For raising the rootstock, stones are collected and sown in the bed soon after removing from fruit. Before sowing, the stones should be immersed in water and only those stones are sown which sink in water as these are considered to be viable. Stones are sown on beds which are prepared on the soil well mixed with farmyard manure. 8-10 tons of FYM per ha is recommended for sowing the mango stones. The beds on which stones are sown should be made 60 cm apart and stones are sown in lines 10 cm apart at a depth of 5 cm. The stones after sowing are covered by mixture of sand and FYM. Mulching of beds with paddy straw or local grasses helps in increased germination. The beds are irrigated regularly to keep the soil moist and avoiding too much wet conditions. The germination of stones takes place after 3 weeks and seedlings of 10-15 days old (having copper colored leaves) are transferred to polythene bags (black colored, UV-stabilized alkathane bags of size 15 cm x 20 cm) filled with soil mixture. The soil mixture for bag filling in mango is prepared by mixing soil, FYM and oil cake in the ratio of 600g: 375g: 25g. After

transplanting the seedlings in the polythene bags, they are arranged secondary nursery till October. During November the seedlings are shifted to the sunken beds (10 m length, 2m width and 15 cm depth) prepared in the area which was used for seed bed. The plants should be regularly irrigated in the secondary nursery through the sprinklers to keep the soil moist and avoiding moisture stagnation. Regular plant protection practices should be adopted for damage caused by diseases like anthracnose, leaf eating insects and termite. Although the seedlings can be used for grafting after attaining an age of two months, due to low success rate of grafting during the winter months, the grafting operations are carried out starting from the month of March.

Grafting operation in mango can be successfully carried out during March and June to September. The scions to be used for grafting should be taken from healthy shoots of last matured flush in mother plants. Before actual grafting, the scions should be prepared carefully. The shoots are defoliated 7-10 days before they are detached from the mother tree for grafting. While defoliating, the stalk of leaves are left intact. The drop of these stalks and swelling of the terminal buds in week's period is good judgment of preparation of scion wood. After top grafting of the scion on the rootstock, the newly grafted saplings are capped with 2 cm wide polythene tubes having closed top end. The capping of the grafts help in maintaining higher humidity and helps in sprouting of the buds in the scion. The caps should be immediately removed after sprouting of the buds. The caps can be reused after their removal from one graft. The grafted plants should be shifted inside the shade net houses immediately after grafting.

Inside the net house, optimum care should be taken for proper growth of the saplings. The plants should be irrigated regularly and regular plant protection measures like spraying of fungicide and insecticides should be carried out. Drenching the soil with 0.012 ml humic acid (100 ml of 2% solution of 6% humic acid) per sapling has been found to be beneficial in improving the plant vigor. Similarly two times foliar application of micronutrient solutions (1ml per ltr) has also been found to be beneficial. The saplings will be ready for sale, one after grafting.

Litchi: Litchi is commercially propagated by air-layering. Air layering can successfully be done just after fruit harvest in the month of May-June when plants are in active phase of growth. In the mother trees maintained exclusively for propagation purposes, the layering should be done during the spring with optimum water and nutrient management. Usually Sphagnum moss is used as rooting media. The best season for air layering with high success of plants is monsoon season.

For preparation of air layers, healthy terminal branch receiving good sun shine with a thickness of about 1.2-1.5 cm is selected. Better the branch used for layering, better the root system obtained. Preference should be given to branches that are erect and in satisfactory physiological conditions. The newly flowered/fruited shoot which has exhausted its food material generally produces poor roots, thus should not be selected for air layering. A cut is made in the terminal branch and 2.5 cm ring is prepared by removal of bark about 45-60 cm below the apical growth. Further the cambium layer is rubbed off and woody portion is exposed properly. For early and proper rooting pasting of 1000 ppm IBA may be done immediately. Applying 5000 ppm IBA in lanolin paste at the upper end of the ring also improves the root formation in air layers. A layer of moist sphagnum mass is placed and wrapped with a piece (20 x 25 cm) of 400 gauge polythene sheet and tied properly on both end to ensure supply of proper moisture and facilitates development of roots.

At ICAR Research Complex for Eastern Region, Research Centre, Ranchi, in the place of sphagnum mass, a decomposed mixture containing pond silt 40 kg, FYM 40 kg, well rottened jute bag or leaf mould 10 kg, castor/karanj/neem cake 2 kg, urea 200 g, 200g SSP/ bone meal and 100g

Chloropyriphus dust have been found most ideal media for root initiation, development and better survival of the plants. The above mixture is heaped after proper mixing and covered with black/white UV stabilized polythene for 45 to 60 days under open sun. The soil lump is prepared by adding sufficient quantity of water at the time air layering and a ball of approximately 200g is prepared for each air layers. The ball of rooting media is placed over the ringed portion covering about 2 cm from the upper end of the ring. After about 50-60 days the adequate root system is developed from the upper end of the ring which is visible through the polythene film.

The air layers should only be removed when the color of 6 to 8 roots can be seen through the polythene to be changing from white to creamy brown, but not during the period of active growth. Special care must be taken to avoid damaging the young root system when transplanting which moreover must not be done in dry weather. The detached layers are planted in partial shade preferably under the litchi tree. At the time of planting excess vegetative growth may be removed to maintain balance between the top and newly developed root system. The young plants must be kept in individual bags (15x15x25 cm) filled with FYM: Soil: Sand in 1:1:1 proportion. The layers must be kept in the nursery in shade or semi-shade condition and watered abundantly for a period of about 6 months so that a good root system is developed. Two or three vegetative flushes must appear before the plants hardened off in the open air prior to final planting. Planting of detached air layers in the root trainer of 350 ml cup size facilitate the better root development in the litchi air layers. The air layering process takes about 12 to 14 months period from layering operation to transplanting in the field. To improve the survival rate of the litchi saplings, the media to be filled in polythene bags should be prepared by composting FYM, paddy husk mixed with DAP, Lime, Trichoderma. After decomposing for 1 year Phosphorus Solublizing Bacteria should be added to the compost at a rate of 100g per 20 kg compost. Dipping air layers in 0.2% solution of 6% Humic acid before putting in root trainers also increases the rooting.

Guava and Citrus (Acid lime/Kaghzi Kalan): Guava and Acid lime/Kaghzi Kalan are generally propagated by air layering following the same procedure as explained in case of litchi. Top grafting is also a promising method of propagation of guava.

Cost of establishment of nursery for production of saplings of mango, litchi, guava and acid lime (Plant production capacity- 1 lakh numbers per year)

Land required: 2.0 ha (1 ha as mother plant block and 1 ha for nursery)

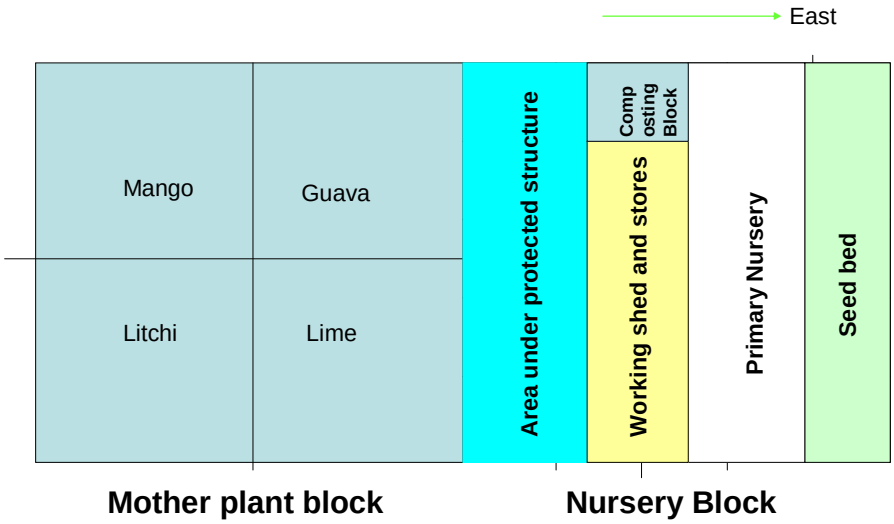
Expenditure (Excluding cost of establishment of mother plant block)			
Fixed cost	Net house (3500 sq m area) (longevity of shadenet-2-3 years)	Low cost (Wooden pole and Bamboo frame, longevity 3-4 years)	Rs. 150000
		High cost (iron frame, longevity 10-12 years)	Rs. 350000
	Potting shade (15m x 10m)		Rs. 20000
	Irrigation systems	Water source (well + Diesel pupm, 5 HP capacity)	Rs. 300000
		Sprinklers along with cost of laying out	Rs. 15000
	Total fixed cost for low cost nursery		Rs. 485000
	Total fixed cost for high cost nursery		Rs. 635000
Recurrent cost	Materials	Mango stone (cost Rs. 150/- per 1000 no)	Rs. 15000
		Polythene bags 1.2 lakh numbers(15x20 cm size black alkathane UV-stabilized, about 250 bags per kg and Rs. 105/kg)	Rs. 40000
		FYM for potting mixture(Rs. 1600/- per 200 cft) (1.4 kg mixture per bag, composition of 1 kg of mixture:600g soil, 375g FYM, 25 g Karanj cake)	Rs. 10000
		Fertilizers (SSP), oil cake (Karanj cake), humic acid, micro nutrient solutions, plant protection chemicals, polythene caps and strips	Rs. 30000
	Manpower	Grafting (Rs. 3/- per successful graft, 80-90% success rate)	Rs. 180000
		Bag filling (Rs.1/- per bag)	Rs. 80000
		Maintainance (weeding, cleaning, shifting of bags etc)	Rs. 250000
	Total recurrent cost per year		Rs. 600000
Total cost	Low cost nursery		Rs. 1085000
	High cost nursery		Rs. 1635000
Income			
	Sale of plants mango and litchi- Rs.25/- per plant, guava and lime- Rs. 15/- per plant		Rs. 2100000

Calendar of nursery operation

Month	Mango	Litchi	Guava	Citrus
January	Maintaining regular irrigation	Maintaining regular irrigation	Maintaining regular irrigation and	Maintaining regular irrigation
February	Maintain irrigation	Maintain regular irrigation, cutting of air layers from mother plants and their planting in root trainers	Maintain regular irrigation, cutting of air layers from mother plants and their planting in root trainers	Maintain regular irrigation, cutting of air layers from mother plants and their planting in root trainers
March	Initiation of grafting, spray of insecticide and fungicide to protect newly emerging leaves, Maintain irrigation, application of nutrients, removal of sprouts below graft union	Spray of insecticide and fungicide to protect newly emerging leaves in, Maintain irrigation, application of nutrients	Initiation of air-layering, spray of insecticide and fungicide to protect newly emerging leaves in, Maintain irrigation, application of nutrients	Initiation of air-layering, spray of insecticide and fungicide to protect newly emerging leaves in, Maintain irrigation, application of nutrients
April	Light frequent irrigation should be given to all the nursery plants and weeding and hoeing to keep the nursery area free from weeds	Light frequent irrigation should be given to all the nursery plants and weeding and hoeing to keep the nursery area free from weeds	Air layering and Light frequent irrigation should be given to all the nursery plants and weeding and hoeing to keep the nursery area free from weeds	Air layering and Light frequent irrigation should be given to all the nursery plants and weeding and hoeing to keep the nursery area free from weeds
May	Regular irrigation to young plants, tying material on grafted stock should be removed, sprouts from the stock portion on the budded plants should be removed carefully, weeding and hoeing to be continued	Layering in litchi initiated towards end of May , regular irrigation to young plants, weeding and hoeing to be continued	Layering continued, regular irrigation to young plants, weeding and hoeing to be continued	Layering continued, regular irrigation to young plants, weeding and hoeing to be continued
June	Removal of sprouts from stock portion, grafting operation in can be initiated towards end of June, preparation of raised seed bed for sowing of mango stone	Layering continued	Layering continued	Layering continued
July	Grafting intensified, collection of mango stones and sowing in bed, transfer of 10-15 days old seedlings to polythene bags, spraying of plant	Layering intensified, preparation of soil media to be used for air layers in the next year, spraying of plant	Layering intensified, spraying of plant protection chemicals, sale of plants	Layering intensified, spraying of plant protection chemicals, sale of plants

	protection chemicals, sale of plants	protection chemicals, sale of plants		
August	Continue grafting, Spraying of plant protection chemicals, nutrient management, Sale of plants	Spraying of plant protection chemicals, nutrient management, Sale of plants	Continue layering, Spraying of plant protection chemicals, nutrient management, Sale of plants	Continue layering, Spraying of plant protection chemicals, nutrient management, Sale of plants
September	Grafting continued, drenching of humic acid, plant protection, removal of sprouts below stock	Plant protection	Plant protection	Plant protection
October	Plant protection and drenching of humic acid	Plant protection and drenching of humic acid	Plant protection and drenching of humic acid	Plant protection and drenching of humic acid
November	Irrigation and weeding	Irrigation and weeding	Irrigation and weeding	Irrigation and weeding
December	Irrigation and weeding	Irrigation and weeding	Irrigation and weeding	Irrigation and weeding

Layout of a nursery of size 2.0 ha



Standards for planting material of fruit crops
(Source: Handbook of Seed And Planting Material Testing Manual For Horticultural Crops, Published By Division Of Horticulture Indian Council Of Agricultural Research)

Standards for Veneer grafting in mango
1. Method of propagation -Veneer grafting
2. Type of rootstock- Straight & vigorous growth
3. Raising rootstock- In polyethylene bag
4. Size of polyethylene bag - 20 x 10 cm / 10 x 25 cm
5. Age of rootstock- One year old
6. Diameter of rootstock - 0.5 - 0.7 cm
7. Age of scion shoots- 3 - 4 months old
8. Diameter of scion- 0.5 - 0.7 cm
9. Length of scion stick - 15 - 18 cm
10. Plant height- 60 - 70 cm
11. Stem girth - 2.5 - 3.5 cm
12. Root type / Architecture: Tap root, Root should not be overgrown, Coiling of root should not be there
13. Uniformity of grafting- Union Smooth, and union of graft 15 - 20 cm above ground level/upper surface of polyethylene bag
14. Foliage - Healthy and green
15. Disease / Pest incidence - No attack of leaf eating beetle, No die back symptom, No nutrient deficiency symptom

16. Precautions- Regular watering for long transportation, in the absence of polyethylene

bag, the earth ball should not develop cracks, ball of earth should be properly covered with grasses

Standards of soft wood grafting in mango

1. Method of propagation - Wedge grafting
2. Type of rootstock - Straight & vigorous growth
3. Raising rootstock - In polyethylene bag
4. Size of polyethylene bag- 20 x 10 cm / 10 x 25 cm
5. Age of rootstock- 7 to 9 months
6. Diameter of rootstock- 0.5 - 0.9 cm
7. Age of scion shoots - 3 - 4 months old
8. Diameter of scion- 0.5 - 0.9 cm
9. Length of scion sticks- 15 - 18 cm
10. Plant height - 60 - 65 cm
11. Stem girth - 2.5- 3.0 cm
12. Union height (grafting height): Union of graft 18 - 20 cm above ground level
13. Root type/ Architecture- Tap root
14. Foliage - Healthy and Green
15. Disease/Pest incidence No attack of leaf eating beetle, No die back symptom, No nutrient deficiency
16. Precautions when grafts are set out in the nursery, always handle them by holding the rootstock. Do not bump the scion, because this may disturb the callus tissue, causing the graft to die

Standards of air-layers of litchi

Age of the elite mother tree : >10 years and above, should be a stable yielder and free from pest and diseases.
Type of planting material used for propagation: Vegetative shoot
Method of propagation: Vegetative (air layering)
Age of the shoot: > 10-12 months
Diameter of the shoot: 1.0-1.25 cm
Length of the shoot: 25-35 cm
Age of the rooted cutting: 2.5-3 months from date of air layering and planting in the nursery bed
Height of the air layered plants: 30-45cm
Diameter of the air layered plants: 1.5-2 cm
Growth of the plants: Vigorous
Root system: Well developed
Condition of the earth ball: Intact and moist
Varietal purity: Varietal purity must be maintained
Insect- pests observed in nursery

Standards of patch budding in Guava

1. Method of propagation- Patch budding
2. Type of rootstock - Straight & active growth stage
3. Raising rootstock - In polyethylene bag
4. Size of polyethylene bag - 20 x 10 cm / 10 x 25 cm
5. Age of rootstock- 10 to 12 month old

6. Diameter of rootstock - 1.25 – 2.50 cm
7. Age of scion shoots - 4 - 5 months old
8. Diameter of scion - 1.25 – 2.50 cm
9. Size of patch - 1 X 1.5 cm
11. Budding height- 15-20 cm above the soil/ground
12. Stem girth- 3.5-4.5 cm
13. Bud union - Smooth
14. Plant height - 40-60 cm
15. Root type/ Architecture Well developed root system without coiling
16. Foliage Healthy and green foliage having 3 to 4 branches
17. Disease/Pest incidence - No attack of leaf eating beetle, No die back symptom, No nutrient deficiency
18. Precautions - When grafts are set out in the nursery, always handle them by holding the Root stock. Do not bump the scion, because this may disturb the callus tissue, causing the graft to die

Standards of patch budding in aonla

1. Method of propagation - Patch budding
2. Type of rootstock- Straight & active growth stage
3. Raising rootstock - In polyethylene bag
4. Size of polyethylene bag - 20 x 10 cm / 10 x 25 cm
5. Age of rootstock - 5 to 7 month old
6. Diameter of rootstock - 0.80 – 1.25 cm
7. Age of scion shoots - 3 - 5 months old
8. Diameter of scion - 0.80 – 1.25 cm
9. Size of patch - 1 X 1.5 cm
11. Budding height- 15-20 cm above the soil/ground
12. Stem girth - 3.5-4.5 cm
13. Bud union -Smooth
14. Plant height - 40-60 cm
15. Root type/ Architecture Well developed root system without coiling
16. Foliage Healthy and green foliage having 3 to 4 branches
17. Disease/Pest incidence- No attack of leaf eating beetle, No die back symptom, No nutrient deficiency
18. Precautions - When grafts are set out in the nursery, always handle them by holding the Rootstock, Do not bump the scion, because this may disturb the callus tissue, causing the graft to die.

Intensive Cropping System for Economic Efficiency in Irrigated Ecosystem

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Introduction

Crop and crop sequences in an ecosystem, apart from soil and climatic parameters, depends primarily on the availability of the water resource. In an irrigation command, water availability remains high in upper reaches of the canal and becomes limiting at the tail end. Water less than the optimum requirement of crops is termed as limited water supply. The limited water can be grouped as (a) Irrigated areas receiving less water than the requirement of the crops. (b) Rainfed drylands (c) Rainfed wetlands. In case of first category, this problem is mainly encountered in tail ends of irrigation command areas. In rainfed dryland areas, there is often negative balance between the annual rainfall and evapotranspiration rate. The total area affected by inadequate rainfall is about 100 million hectares, out of which 51.12 mha spread ever 74 districts were identified as drought area. Rainfed wetland farming generally refers to condition where rains are adequate and relatively well distributed during the crop season. These rainfed wet land areas also face moisture deficit in later parts of winter season. In India, 40 million hectare is flood prone out of which about 8 million-hectare areas is affected every year. This acted as constraint, while adopting a sequence in a particular region. An efficient utilization of available irrigation water is, therefore, essential in an assured crop production programme. Mismanagement of water (like improper scheduling, over application, lack of proper drainage, etc.) often leads to reduction in crop yields, waterlogging, salt imbalance, etc. In some cases vast agricultural lands have been rendered unproductive due to these problems. Water is a very important resource in crop production but huge quantity, i.e. 97.5% of the global water is not usable. Of the remaining 2.5% two thirds is held in the form of ice, in north and south poles and only one third is available for agriculture, domestic use, industries, power etc. it is therefore, very important to make efficient use of this one-third water as a major portion of water is diverted in agriculture sector.

The constraints of limited water supply are different in canal irrigation system than the rain fed dry lands. In irrigation commands poor conveyance, application and distribution efficiencies coupled with untimely and limited supply of water are the major problems whereas in rain fed area, water is the limiting factor and improved crop production should be aimed at optimizing its use. High temperature associated with high wind speed and advective energy enhances the water demand of the atmosphere. Therefore, water being a natural resource that too under limited condition must be well managed to increase water use efficiency without any deterioration in the quality of the environment. To sustain productivity in paucity of water coupled with low and erratic rainfall is a big challenge for research workers, planners and executors. To meet this challenge the following measures are suggested.

♦	Basin wise planning	♦	Water shed management
♦	Improved soil and moisture conservation practices	♦	Off season tillage
♦	Mulching	♦	Inter terrace land treatment
♦	Recycling of harvested water	♦	Use of chemical for higher water use efficiency
♦	Suitable irrigation method & efficiency	♦	Improved crop management technology

The agricultural production in India had a quantum jump from about 50.82 million tons in 1950-51 to 233.78 million tons in 2010-11. During the period the cropping intensity increased from 111 to 140 %. The per capita availability of food grains also improved substantially. The rapid increase in production also brought about a change in the composition of food basket. As a consequence, better alternative crops and new systems emerge out for adoption by the farmers at macro level. The change in cropping pattern is clearly reflected in per capita availability of food grains. The details of land use pattern, major crops grown in irrigated and un irrigated agro-ecosystem, gross cropped area under various crops, area under major crops, targets and achievements of production of major crops during recent past, suggested alternate crops in place of rice and wheat in major growing states and suggested crop strategy based on conserved soil moisture storage in the profile have been depicted in different tables.

Table 1.The gross cropped area under various crops in India (Million hectare)

Crop	1950-51	1960-61	1970-71	1980-81	1990-91	1998-99	2010-11
Total cropped area (Gross cropped area)	131.89	152.77	167.41	172.63	185.74	192.62	194.00
Rice	30.81	34.13	37.59	40.15	42.69	44.80	43.66
Wheat	9.75	12.93	18.24	22.28	24.17	27.52	26.48
Coarse cereals	37.67	44.96	45.95	41.78	36.32	29.34	26.44
Pulses	19.09	23.56	22.53	22.46	24.66	22.87	22.39
Oilseeds	10.73	13.77	16.64	17.60	24.15	26.23	27.89
Cotton	5.88	7.01	7.32	7.82	7.44	9.34	8.68
Sugarcane	1.71	2.42	2.61	2.67	3.69	4.05	4.20
Potato	0.24	0.38	0.52	0.73	0.94	1.32	1.40
Total for above crops	115.88	139.76	151.40	155.49	164.06	165.47	161.14
Others	16.01	13.01	16.01	17.14	21.68	27.15	

The major crops grown in irrigated and un irrigated agro-ecosystem of India comprising of cereals, millets, pulses, oilseeds, fibre crops, forage and sugar crops are presented in Table 1. Most of the crops are grown in kharif, rabi and summer seasons. The water requirement of the crops varies from crop to crop and season to season. There are twenty-one distinct agro-climatic zones in our country having distinct ecological responses to macro climate as expressed in the vegetation and reflected in soils, fauna and aquatic systems (FAO, 1983).

Crop water requirement

The crop water requirement under surface and sprinkler irrigation, primarily because the land area wetted is reduced resulting in less evaporation from the soil surface (Aljibury, 1974). Most methods of estimating crop water requirements presently utilized provide estimates of evapotranspiration, which probably contains a significant soil evaporation component. The evaporation of water from the soil surface is implicitly related to the method of irrigation and irrigation scheduling. Crop water requirements are usually expressed in unit of water volume per unit land area (depth) per unit time. The water requirement of plants is normally estimated by considering the stage of the crop, evapotranspiration (dependent on temperature, relative humidity, wind velocity and radiation) and the effective crop root zone.

Regular availability of water at a low tension, low weed problem and possibilities of feeding nutrients through water result in better growth and yield of crops. However, the physiological requirements of individual crops and also critical stages of crop should be kept in mind, to work out the best-suited irrigation schedule to get higher yield. All cultivated crops have their critical stages depending upon their relative importance.

Table 2. Major crops grown in irrigated and un irrigated agro-ecosystem in India

Sl. No.	Cereals and millets	Sl. No.	Oilseed crops
1.	Rice (*O ryza sativa* L.)	1.	Groundnut (*Arachis hypogaea* L.)
2.	Wheat (*Triticum aestivum* L.)	2.	Sesamum (*Sesamum indicum* L.)
3.	Maize (*Zea mays* L.)	3.	Castor (*Ricinus Communis* L.)
4.	Sorghum (*Sorghum bicolor* L. Moench)	4.	Rape Seed and Mustard (*Brassica* spp.)
5.	Bajra (*Pennisetum typhodes* L.)	5.	Linseed (*Linum ustiatissimum* L.)
6.	Barley (*Hordeum vulgare* L.)	6.	Safflower (*Carthamus tintorius* L.)
7.	Mandua (*Elesine Coracana* Gaertn)	7.	Sunflower (*Helianthus annuus* L.)
8.	Cheen (*Panicum miliaceum* L.)	8.	Cotton (*Gossyplum* spp.)
9.	Sawan (*Echinocholoa frumentacea* L.)	9.	Jute (*Corchorus* spp.)
10.	Kodo (*Paspalum scrobiculatum* L.)	10.	Sann-Hemp (*Crotalaria juncea* L.)
11.	Kakun or Italian Millet (*Setari italica* (L.) Beauv.)		
	Pulse Crops		**Forage Crops**
1.	Gram (*Cicer arietinum* L.)	1.	Oats (Avena sativa L.)
2.	Lentil (*Lens esculenta* Moench)	2.	Berseem or Egyptian Clover (Trifolium alexandrinum L.)
3.	Peas (*Pisum* spp.)	3.	Lucerne (Medicago sativa L.)
4.	Arhar (*Cajanus cajan* L. Missp.)	4.	Guar (Cyamopsis tetragonoloba L.)
5.	Green Gram (*Vigna radiata* L. Wilczek)	5.	Napier Grass (Pennisetum purpureum Schum)
6.	Black Gram (*Vigna mungo* L. Hepper)		
7.	Cowpea (*Vigna sinesis* L.)		
8.	Soybean (*Glycine max* L. Merril)		
	Sugar Crops		**Miscellaneous crops**
1.	Sugarcane (*Saccarum officinarum* L.)	1.	Potato (*Solanum tuberosum* L.)
2.	Sugarbeet (*Beta vulgaris* L.)	2.	Tobacco (*Nicotiana* spp.)

Table 3. Physiological stages of crops with respect to irrigations.

Sl. No.	Crops	Physiological stages
1.	Rice	Early tillering, panicle initiation, flowering, milk, dough
2.	Wheat	Crown root initiation (CRI), late tillering, late jointing, flowering, milk and dough
3.	Barley	Early vegetative stage, flowering and dough
4.	Potato	Sprouting, Stolonization, stolon development, early tuberisation, 20% of tuber weight, 40% of tuber weight, 60% of tuber weight and 80% tuber weight
5.	Gram	Pre-flowering and pod formation
6	Lentil	Pre-flowering and pod formation
7.	Peas	Flower initiation and pod formation
8.	Greengram/Black gram/Cowpea	Vegetative stage and flowering
9.	Berseem	Vegetative stage and flowering
10.	Soybean	Early seedling, pre-flowering, pod development
11.	Sorghum	Flowering, dough
12.	Maize	Early vegetative growth, tasselling and silking, dough
13.	Cotton	Branching, pre-flowering, boll formation
14.	Sugarcane	Sprouting, tiller initiation, tillering
15.	Groundnut	Emergence, flowering, pod formation, pod development
16.	Mustard	Vegetative growth, flowering

Frequency of irrigation

How often to irrigate depends upon several factors. A number of management factors have been discussed in previous sections of this chapter. The importance of optimum moisture content for crops at a given stage of growth also has been discussed. The available water supply has been shown to be important, making it necessary to irrigate at times to store surplus water in the soil. Also, the need to leach out excess salts and the need to cool the soil may govern the frequency of irrigation.

From the practical point of view, there are three major aspects of irrigation management, viz., (i) when to irrigate? (ii) How much water to be applied at each irrigation? and (iii) how best to irrigate?, which need careful considerations in an efficient irrigation water management programme. We are concerned with the problem of when to irrigate? and how much to irrigate? The amount of water to be applied at each irrigation will depend on the root zone depth, the soil type, the salt content in the soil and the water deficit before irrigation. This quantity can be measured. Hence, the scheduling of irrigation is the most recurring aspect in irrigation management of crops (Table 5).

Table 4. Critical stages of different crops.

Sl. No.	Crop	Critical stages
1.	Rice	Flowering, panicle initiation
2.	Wheat	CRI, Flowering, grain filling
3.	Maize	Tasselling, silking
4.	Barley	Tillering, heading
5.	Lentil	Pre flowering, pod formation
6.	Gram	Flower initiation, pod formation
7.	Peas	Flower initiation, pod formation
8.	Greengram/ blackgram/ cowpea	Flowering
9.	Pigeon pea	Flower initiation
10.	Rapeseed-mustard	Flower initiation, pod formation
11.	Linseed	Flower initiation, seed setting
12.	Sesame	Flowering, seed setting
13.	Sunflower	Flower bud initiation, seed setting
14.	Safflower	Flower initiation
15.	Potato	Stolonization, tuber formation
16.	Tobacco	Vegetative phase
17.	Groundnut	Peg formation, pod filling
18.	Soybean	Flower initiation, pod formation
19.	Sugarcane	Shoot elongation, tillering
20	Berseem	Flowering

Major crops sequences

The rice-wheat cropping system (RWCS) has contributed about 50 percent of the food grain production and more than 75 percent of the total food grain procurement during the mid-1990s in the country. It is characterized as the backbone of the public distribution system (PDS) and a strong base for the food security of the country. There are now reports that the system is showing signs of fatigue in terms of production. Despite being popular and profitable, decline in the annual growth in total factor productivity from about 3 percent during 1976-85 to (-) 0.4 percent during 1985-92. The productivity of rice and wheat in some parts has already ceased to increase and in few it has shown declining trends. Some regions have also shown that the cultivation of rice and wheat has become less profitable over time.

Crop cultivation goes on all the year round in India, provided water is available for crops. In northern India there are two distinct seasons, kharif (July to October) season or wet season and rabi (November to March) season usually dry season. Crops grown between March and June are known as Zaid or summer season crop. The climatic, edaphic and socio-economic diversity of Indian Agriculture provides the scope of large number of cropping patterns throughout the length and breadth of the country. Most of the farmers in India are small or marginal or landless and lease holders and grow food crop in the most suitable season and thus particular food crop is 'basic' to the cropping pattern followed by the farmers. So these cropping patterns are usually referred to as (i) rice based cropping patterns, (ii) jower based cropping patterns, (iii) bajra-based cropping patterns, (iv) groundnut based cropping patterns; and (v) wheat and gram based cropping patterns; (vi) soybean based cropping system (vi) maize based cropping system: A few cropping patterns are also based on commercial crops like (i)

cotton based cropping pattern, (ii) sugarcane based cropping pattern (iii) plantation crops based cropping pattern and (iv) vegetable based cropping patterns. With the increase in population, improvements in irrigation facility and technology of crop management for efficient use of water by different crops and crop sequences. In rainfed condition, in areas where the rainfall receipt is 1000 mm or more, two crops can easily be grown and in high rainfall areas with a bit of proper management and choice of crops even three crops can be grown (in areas where rainfall is 1500 mm or more spread over a longer period) in succession.

Table 5.Irrigation guide of important field crops.

Sl. No.	Crop	Irrigation schedule criteria		Irrigation		
		IW/CPE	Others	Depth (cm)	Number	Requirement (cm)
1.	Rice	1.0-1.4 (1.2)*	1-5 DDPW (IDDPW)	5 ± 2	8-26	49-129
2.	Wheat	0.8-1.50 (0.9)	(For dwarf) (For tall)	4-7 7-8	4-8 3.4	30-52 25-30
3.	Maize	0.75-1.2(0.9)		5-8	3-6	24-48
4.	Barley	0.5-0.9 (0.6)	50% DASM	4.5-8	2-6	15-24
5.	Lentil	0.4-1.0(0.6)		6-8	1-3	8-20
6.	Gram	0.4-0.8(0.6)	50-75% DASM	6-8	1-4	8-24
7.	Peas	0.6-0.8(0.6)		5-8	1-3	8-24
8.	Greengram/ blackgram/ cowpea	0.6-0.9(0.6)	80-300	5-8 mm CPE	2-4	15-30
9.	Pigeon pea	0.25-0.9(0.6)		6-8	1-4	8-30
10.	Rapeseed-mustard	0.6-1.05(0.7)	75% DASM	6-8	1-4	8-24
11.	Linseed	0.5-0.8(0.6)		6-8	1-4	8-20
12.	Sesame	0.5-0.9(0.6)	60-75% DASM	5-8	1-5	8-30
13.	Sunflower	0.8-1.05(0.9)	40-50% DASM	5-8	2-6	15-40
14.	Safflower	0.2-0.6(0.4)		6-8	1-5	8-30
15.	Potato	1.0-2.0(1.2)		3-6	6-9	30-45
16.	Tobacco		0.4-0.5 bar tension	4-6	1-10	6-45
17.	Groundnut	0.4-0.9(0.6)	50-75% DASM	5-8	2-8	15-50
18.	Soybean	0.4-0.8(0.6)		5-6	3-7	18-35
19.	Jute		50-60% DASM	6-8	1-3	8-20
20.	Sugarcane	0.6-0.9(0.8)	50% DASM	6-10	5-20	60-200
21.	Berseem	0.9-1.2(1.0)	80-300	5-8 mm CPE	2-4	15-30

DDPW = Days after disappearance of ponded water, DASM = depletion of available soil moisture, * Most common index.

Cropping Patterns based on irrigation water availability

Development of appropriate cropping patterns which can suit the irrigation supplied available at the farm is crucial for achieving higher production and profits. It is essential for crop planning in making more efficient use of water. Such planning is important because: (i) crops differ markedly in timings and amounts of their irrigation needs, (ii) they exhibit a wide range of photosynthetic efficiency for similar water requirements, and (iii) they exhibit differential sensitivity to water stress imposed at various growth stages. Short-season species grown during rainy season generally need less irrigation than the long-duration and summer-season species. Reduction of growing season by even a few weeks during summer can bring about a saving of 1 or 2 irrigations. Similarly, plant species show genetic variations in photosynthetic efficiency and structure of canopy. Crops with deeper and more profuse root systems utilize greater amount of profile-stored water and can stand drought better than the shallow- rooted crops. In some crops, better tolerance of water deficits arises from higher physiological adaptation through adjustment in osmotic-potential. The major rain depended crops grown in different seasons in existing cropping systems and state-wise shifts in the cropping pattern for profitability and efficiency are presented in Table 6 and 7.

Table- 6.Major efficient food crop based double cropping system for different rain dependent regions of India (Based on water availability periods).

Water availability period (days)	Rainy season crop	Post rainy season crop
110-150	Cowpea/blackgram	Safflower/chickpea
	Soybean	Mustard/safflower
	Greengram	Mustard
	Pearlmillet	Chickpea/barley
150-175	Green gram	Sorghum
175-200	Cowpea	Sorghum
	Green gram	Safflower
	Blackgram	Barley/mustard
	Pearlmillet	Chickpea
	Maize	Wheat/ wheat + chickpea /mustard
	Rice	Chickpea/wheat
	Sesame	Chickpea
200-250	Sorghum/groundnut/maize	Safflower
>250	Soybean	Wheat
	Soybean/maize	Safflower/chickpea
	Rice/maize/fingermillet/ groundnut	Wheat/chickpea/linseed/lentil/ horsegram /barley
	Soybean	Fingermillet
	Pearlmillet	Wheat

Table 7. Suggested crop strategy based on conserved soil moisture storage in the profile

Conserved soil moisture (mm)	Suggested crops
More than 300	Wheat, chickpea, field pea
200-300	Wheat, barley, lentil, chickpea
150-200	Chickpea, barley, raya (Brassica juncea)
120-150	Sarson (B. campestris Var. Brown sarson), Chickpea
75-120	Raya, Chickpea-in better catchment area
50-75	Taramira (Eruca sativa)

Cropping systems under upland situations

Different cropping systems (Maize-wheat, Maize-sunflower, Maize + blackgram-wheat, Maize + blackgram-sunflower, Pigeonpea-wheat, Pigeonpea-sunflower, Pigeonpea + blackgram-wheat and Pigeonpea + blackgram-sunflower) were evaluated for their production potential and economic returns. Results indicated that intercropping blackgram with maize or Pigeonpea (1:1) adversely affected productivity of main crop but considerably benefited succeeding wheat crop. Substitution of wheat with sunflower in rabi and maize with pigeonpea in kharif improved system's productivity equivalent to 0.35 and 1 t/ha, respectively.

Table 8. Suggested alternate crops in place of rice and wheat in major growing states.

Sl. No.	State	Main crop	Kharif alternate crop	Main crop	Rabi alternate crop
1.	Punjab	Rice	Maize, Moong/Urad	Wheat	Mustard, Chick Pea, Lentil, Field Peas
2.	Haryana	Rice	Maize, Moong/Urad	Wheat	Mustard, Chick Pea, Lentil
3.	Uttar Pradesh	Rice	Arhar (short duration) Moong/Urad	Wheat	Mustard, Chick Pea, Field Peas, Lentil
4.	Bihar	Rice	Not suggested as most of Rice area is waterlogged	Wheat	Maize, Mustard, Lentil
5.	Chhattisgarh	Rice	Soybean	Wheat	Chick Pea, Lentil, Chick Pea
6.	Madhya Pradesh	Rice	Soybean, Arhar, Moong/Urad, Seasame	Wheat	Mustard, Linseed

Economic Efficiency of Intensive Cropping System

Different experiments were conducted on cropping system in irrigated ecosystem at ICAR-RCER, Patna since 2001-02 to 2011-12. Results of three year experimentation revealed that supply of optimum level of irrigation and nitrogen fertilization gave higher gross return in both cropping system (rice-wheat-green gram and rice-lentil-green gram). Maximum gross return was obtained under rice-wheat-green gram system with optimum irrigation and nitrogen fertilization. In respect of net return, it showed different trend. Highest net return was obtained from rice-lentil-green gram (Rs.29, 639 ha^{-1}) with optimum supply of irrigation and nitrogen fertilization while minimum net return was obtained from rice-wheat-green gram (Rs. 24,543 ha^{-1}) under sub-optimum supply of irrigation and nitrogen

fertilization. The benefit: cost ratio was higher under rice-lentil-green gram than rice-wheat-green gram irrespective of irrigation and nitrogen fertilization. Maximum benefit: cost ratio was obtained from rice-lentil-green gram with optimum irrigation and fertilization while minimum benefit: cost ratio was recorded from rice-wheat-system with optimum level of irrigation and fertilization. This may be due to variation in cost of cultivation as it showed lower the cost of cultivation, higher the benefit: cost ratio**.**

Table 9. Economics of rice based cropping system under optimum and sub-optimum level of irrigation and nitrogen fertilization (mean data of 3 years).

Cropping system	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit: cost ratio	Production efficiency (Rs/ha/day)
Rice-wheat –green gram					
Optimum	29936	57031	27095	0.91	76.75
Sub-optimum	26465	50965	24500	0.93	69.40
Rice-lentil-green gram					
Optimum	22671	52310	29639	1.31	86.15
Sub-optimum	19650	47933	28283	1.44	82.21

Second study conducted on diversified cropping systems, results revealed that maximum net profit was recorded in rice-tomato-bottle gourd (Rs.1, 59,904 ha^{-1}) followed by rice-coriander-lady's finger (Rs. 98,683 ha^{-1}) and rice-mustard-tomato (Rs. 88,976 ha^{-1}) respectively. Similar trend was observed in case of benefit cost ratio (Rs. 2.89, 2.59 and 2.54). The maximum profitability (Rs. 484.6 $ha^{-1}day^{-1}$) and relative economic efficiency (490.2 %) was recorded in rice-tomato-bottle gourd followed by rice-mustard-tomato (Rs. 288.5 ha^{-1} day^{-1} and 328.4 %), rice-coriander-ladies finger (Rs. 281.2 ha^{-1} day^{-1} and 264.2%), while lowest in rice-pea-green chillies (Rs. 72.2 ha^{-1} day^{-1} and (- 9.38 %), respectively. One US $ is equivalent to Indian Rs. 45.00 only. This may due to higher productivity and sale price of mustard and tomato as compared to coriander and ladies finger. It is interesting to note that vegetable dominated cropping systems were more remunerative than cereal and pulse dominated cropping systems.

Third study conducted on irrigation and nutrient requirement of best diversified cropping systems, results revealed that maximum net profit was recorded in rice-tomato-bottle gourd (Rs. 2, 54,265 ha^{-1}) followed by rice – cabbage – cowpea (Rs, 1, 39,949 ha^{-1}) and rice-potato-onion (Rs. 1, 33, 634 ha^{-1}) respectively. Similar trend was observed in benefit cost ratio (3.56, 2.96 and 2.35), respectively. Among levels of irrigation, maximum net profit was recorded at optimum level of irrigation (Rs. 1, 35,687 ha^{-1}) as compared to sub-optimum level (Rs.1, 24,405 ha^{-1}). Among levels of nutrient, maximum net profit was recorded at recommended level (Rs. 1, 34,319 ha^{-1}) followed by 50% of recommended level (Rs. 1, 27,141 ha^{-1}), respectively.

Table 10. Economics of diversified cropping systems (2004-2007)

Treatments	Rice yield equivalent (t/ha)	Productivity (kg/ha/day)	Gross income (Rs./ha)	Cost of cultivation (Rs./ha)	Net return (Rs./ha)	Profitability (Rs./ha/day)	B :C Ratio	Relative Economic Efficiency (REE)
Rice-Wheat-Black Gram	14.09	40.26	84540	57445	27095	77.41	1.47	-
Rice-Capsicum-Cucumber	16.06	49.72	96360	61608	34752	107.59	1.56	28.26
Rice-Carrot-Cowpea	24.59	77.57	147540	62401	85049	268.29	2.36	213.91
Rice-Mustard-Tomato	24.44	77.59	146640	57664	88976	288.46	2.54	328.39
Rice-Potato-Onion	28.47	94.27	170820	89982	80838	267.67	1.90	198.35
Rice-Cabbage-Bitter Gourd	21.00	72.66	126000	73504	52496	181.65	1.71	93.74
Rice-Coriander-Ladies Finger	26.79	76.32	160740	62057	98683	281.15	2.59	264.21
Rice-Tomato-Bottle Gourd	40.44	122.54	244440	84536	159904	484.56	2.89	490.16
Rice-Pea-Green Chilli	13.23	38.91	79380	54823	24557	72.22	1.45	(-) 9.38
Rice-Lentil-Sponge Gourd	19.37	61.49	116220	52605	63615	201.95	2.21	134.79
SE(m) ±	2.58		-	-	-	-	-	-
C.D. at 5%	7.66		-	-	-	-	-	

Table 11. Yield equivalence in terms of rice, net-return, cost of production and benefit cost ratio in different cropping systems (2008-11).

Cropping systems	Paddy yield equiv-alence (t/ha)	Gross return (Rs. /ha)	Cost of cultivation (Rs./ ha)	Net return (Rs/ ha)	Bene-fit cost ratio
Rice- Tomato – Bottle gourd (C_1)	41.60	3,53,600	99,335	2,54,265	3.56
Rice – Potato – Onion (C_2)	29.43	2,50,155	1,06,249	1,33,634	2.35
Rice – Mustard – Sponge gourd(C_3)	11.98	1,01,830	70,591	31.239	1.44
Rice-Coriander-L. Finger (C_4)	17.65	1,50,025	74,519	68,308	2.01
Rice – Cabbage – Cowpea(C_5)	26.13	2,22,105	74,913	1,39,949	2.96
SE m (±)	0.417	-	-	-	-
CD at 5%	1.38	-	-	-	-
Level of Irrigation (I)					
I_1	26.26	2,23,210	87,468	1,35,687	2.55
I_2	24.45	2,07,825	83,108	1,24,405	2.49
SE m (±)	0.188	-	-	-	-
CD at 5%	0.590	-	-	-	-
Level of Nutrient (N)					
F_1	26.13	222105	87763	134319	2.53
F_2	24.59	209015	81897	127141	2.55
SE m (±)	0.188	-	-	-	-
CD at 5%	0.590	-	-	-	-

To improve system productivity of irrigated upland 15 crop sequences were evaluated with emphasis on crop diversification for three consecutive years (2004-07) at Pusa. The highest net return was observed (Rs. 1,30,508 ha^{-1}), under cropping sequence when satawar, a medicinal and aromatic plant was intercropped with maize and followed by Rs. 80898 ha^{-1} under tobacco-summer maize – dhaincha (GM). The cost benefit ratio was highest when medicinal and aromatic plant was involve in cropping sequences i.e. 8.46 for Satawar + Maize and 5.58 for winter maize intercropping with muskdana (Table 12).

Table 12. Rice equivalent yield (REY-t/ha) of different cropping system (2004-05 to 2007-08)

Cropping systems	Rice yield equivalent (t/ha)					Water consumed (cm)	WUE (kg/ha-cm)
	2004-05	2005-06	2006-07	2007-08	Mean		
Rice-Wheat-Black Gram	16.74	14.25	12.12	13.26	14.09	189	74.55
Rice-Capsicum-Cucumber	16..93	13.36	12.84	21.11	16.06	234	68.63
Rice-Carrot-Cowpea	21.70	31.38	22.68	22.61	24.59	226	108.81
Rice-Mustard-Tomato	27.39	24.16	21.81	24.39	24.44	222	110.09
Rice-Potato-Onion	27.44	35.20	32.12	19.14	28.47	229	124.32
Rice-Cabbage-Bitter Gourd	19.56	15.80	17.41	31.22	21.00	236	88.98
Rice-Coriander-Ladies Finger	27.14	28.30	25.90	25.84	26.79	236	113.52
Rice-Tomato-Bottle Gourd	51.07	28.07	41.72	40.90	40.44	245	165.06
Rice-Pea-Green Chilli	12.15	11.23	11.57	17.96	13.23	214	61.82
Rice-Lentil-Sponge Gourd	20.96	20.86	13.19	22.46	19.37	203	95.42
SE(m) ±	0.82	0.54	0.65	1.14	2.58	-	-
C.D. at 5%	2.44	1.61	1.93	3.37	7.66	-	-

Price of rice grain-Rice 6000/ton taken for converting yield of different crops to the rice yield equivalent.

Twelve cropping systems were evaluated with pre rabi pigeon pea based cropping system to improve system productivity under flood and flood prone situations, at Pusa, Samstipur. Pigeon pea yield equivalence computed for all the cropping sequences. Results revealed that highest net return of Rs. 85,805 ha^{-1} was obtained in wheat – elephant yam + black gram system followed by tobacco – summer maize – dhaincha (GM) (Rs.71,737 ha^{-1}). The highest cost benefit ratio of 1.38 was recorded under mustard – green gram – black gram system followed by Rs. 1.25 under wheat – summer maize - dhaincha and 1.24 under wheat - elephant yam respectively.

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Irrigation Techniques for Efficient Water Management in Farming Systems

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Irrigation is one of the most important inputs for improving productivity of agricultural and allied sectors. Since independence, India is able to irrigate only 45% of our agriculture land. Rest of the 55% of cropped land in India is rain fed where delayed, deficient or erratic rains cause severe reduction in crop production. Recent concerns about, on the one hand, rising food prices and food security and, on the other hand, increasing water scarcity, climate change, and the high proportion of water used in agriculture are drawing attention to the urgent need to improve water management in both irrigated and rain fed agriculture. Therefore efficient technique of agricultural water management is need of the hour for improving productivity of farming system in general and by keeping gender perspective in particular. Women in the hills of Nepal were very positive about new irrigation facilities, since these considerably reduced the time they needed for fetching water for domestic use (Backer, 1992). In India, the unforeseen impact of canal irrigation on the growth of fodder was particularly beneficial for women, since it enabled them to increase their milk and ghee production through which they could earn some individually controlled income (Stanbury, 1981). But as far as irrigating the field through canal is concerned, it is difficult for women in comparison to men as sometimes the turn of irrigation fall in night. Therefore, women may be comfortable in more advanced technique of irrigation which requires less drudgery. Agricultural water management: This is the art and science of managing water resource in such a way that each drop of water is utilized to improve the productivity of agricultural and its allied systems. Irrigation technique/method is the most important component of efficient water management in farming system.

Irrigation methods: There are different methods of irrigation like flood irrigation, check basin irrigation, border irrigation, furrow irrigation, micro sprinkler irrigation, drip irrigation etc. But low efficiency is the main problem in adopting different irrigation methods. Generally, higher efficiency methods cost more and require more expertise. Experiments have shown that micro irrigation methods increase irrigation water use efficiency from 40 to 90% over check basin irrigation or furrow irrigation.

Flood Irrigation: In this system of irrigation water is allowed in a field without having any field bund in plot. Generally, 5 to 10 cm of water is applied in this method in one irrigation. But in this irrigation method more losses of water takes place in the field due to deep percolation, runoff, evaporation and over irrigation.

Border irrigation: In this method the plot is divided into different segment usually long, uniformly graded strips of land, separated by earth bunds. In Contrast to basin irrigation these bunds are not to contain the water for ponding but to guide it as it flows down the field. Border slopes should be uniform, with a minimum slope of 0.05% to provide adequate drainage and a maximum slope of 2% to limit problems of soil erosion. Deep homogenous loam or clay soils with medium infiltration rates are preferred. Heavy, clay soils can be difficult to irrigate with border irrigation because of the time needed to infiltrate sufficient water into the soil. Basin irrigation is preferable in such circumstances. The dimensions and shape of borders are influenced in much the same way as basins and furrows by the soil type, stream size, slope, irrigation depth and other factors such as farming practices and field or farm size. Close growing crops are preferred such as wheat, barley etc.

Check basin irrigation: This is another important method of surface irrigation. In this irrigation system, water is applied to a completely level or dead-level area enclosed by dikes or borders. This requires perfectly level field which becomes a limitation in many cases at field level. This method of irrigation is used successfully for both field and row crops. The check basin irrigation may be classified as rectangular, contour and ring type. Thus, the basins need not be rectangular or straight sided, and the border dikes may or may not be permanent. The floor of the basin may be kept flat, ridged or shaped into beds, depending on crop and cultural practices. These different names are based on its characteristics and shape. Furrow irrigation: This system is used in vegetables. It has advantage that water is not applied on the whole field rather water is applied in furrows. This saves water at the same time; plant is not in direct contact with water as some plant like that of vegetables are very sensitive to ponded water. Furrows are sloping channels formed in the soil. Infiltration occurs laterally and vertically through the wetted perimeter of the furrow. The plant gets water in its root zone; however, plant is not in direct touch with water. Irrigation furrows may be classified into two general types based on their alignment.

They are:
(a) Straight furrows
(b) Contour furrows

Micro irrigation methods are precision irrigation methods of irrigation with very high irrigation water efficiency. In many parts of the country there is decline of irrigation water and conventional methods are having low water use efficiency. To surmount the problem, micro irrigation methods has recently been introduced in Indian agriculture. These methods save a substantial amount of water and helps increasing crop productivity particularly valuable cash crops like vegetables. The research results have confirmed a substantial saving of water ranging between 40 to 80% and there are reports of two times yield increase for different crops by using micro irrigation. The other important thing is that this irrigation technique can be easily handled by women due to involvement of less drudgery involved.

Two main micro irrigation systems are:
(a) Sprinkler Irrigation
(b) Drip Irrigation
(c) LEWA Irrigation

Sprinkler irrigation: Water is delivered through a pressurized pipe network to sprinklers nozzles or jets which spray the water into the air. To fall to the soil in an artificial 'rain'. The basic components of any sprinkler systems are: a water source, a pump to pressurize the water, a pipe network to distribute the water throughout the field, sprinklers to spray the water over the ground and valves to control the flow of water. The sprinklers when properly spaced give a relatively uniform application of water over the irrigated area. Sprinkler systems are usually there are some exceptions) designed to apply water at a lower rate than the infiltration capacity of soil.

Drip irrigation: This is also known as *trickle irrigation* or *micro irrigation* is an irrigation method which minimizes the use of water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. It is becoming popular for row crop irrigation. This system is used in place of water scarcity as it minimizes conventional losses such as deep percolation, evaporation and run-off or recycled water is used for irrigation. Small diameter plastic pipes fitted with emitters or drippers at selected spacing to deliver the required quantity of water are used. Drip irrigation may also use devices called micro-spray

heads, which spray water in a small area, instead of dripping emitters. These are generally used on tree and vine crops with wider root zones.

Subsurface drip irrigation (SDI) uses permanently or temporarily buried dripper line or drip tape located at or Drip irrigation is the slow, frequent application of water to the soil though emitters placed along a water delivery line. The term drip irrigation is general, and includes several more specific methods. Drip irrigation applies the water through small emitters to the soil surface, usually at or near the plant to be irrigated. Subsurface irrigation is the application of water below the soil surface. Emitter discharge rates for drip and subsurface irrigation are generally less than 12 litres per hour. Bubbler irrigation is the application of a small stream of water to the soil surface. The applicator discharge rate (up to *250* litres per hour) exceeds the soil's infiltration rate, ***sb*** the water ponds on the soil surface. **A** small basin is used to control the distribution of water. Micro-spray irrigation applies water to the soil surface by a small spray or mist. Discharge rates are usually less than 120 litres per hour.

LEWA (Low Energy Water Application) Irrigation: In check basin and furrow irrigations a lot of water is wasted and uniformity of water applied in the fields are as low as 40%. To combat these short comings, drip and sprinkler irrigation system were invented. But in these two methods of irrigation a high operating pressure and large investments limits the use in an area where lower per capita farm holding and poor farmers of eastern India. To solve the above problems LEWA was invented by ICAR RCER, Patna. The LEWA system requires low operation pressure of 0.4 to 0.8 Kg/cm^2. It has larger discharge rate and therefore can be used in water loving and close growing crops like rice and wheat. Although surface uniformity coefficient is less than sprinkler system but subsurface uniformity coefficient is higher.

LEWA device is manufactured in the PIS lab of WALMI Farm, ICAR RCER Patna. Holes in the LEWA device are drilled through electric drill machine. Then the testing of the LEWA device is done in the indoor lab. And finally LEWA irrigation system is installed in the field for different crops and vegetables. The LEWA irrigation system costs for 1000 m^2 of land is approximately Rs. 15000 which is used in the bigger field on a shifting basis.

(a)

(b)

Demonstration of LEWA irrigation system in (a) leafy vegetable in Vaishali District (b) rice field of Buxar District

Solar Energy Application in Integrated Farming System

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Introduction

Farmers of India generally practice subsistence farming where they need to produce a continuous, reliable and balanced supply of foods, as well as cash for basic needs and recurrent farm expenditure. Integrated farming system (IFS) represents integration (a judicious mix) of various agricultural enterprises such as cropping systems, horticulture, animal husbandry, fishery, agro-forestry, apiary etc., a judicious mix of agricultural enterprises for optimal utilization of farm resources besides water. Integrated farming, a judicious mix of cropping systems suited to given agro-climatic conditions and socio-economic status of the farmers, shall be able to generate additional employment and income for the small and marginal farmers under both rain-fed and irrigated environment. In both, the rain-fed or the irrigated environment, water is an indispensible ingredient for all the components of IFS. In Integrated farming system groundwater is the main source of water. In India ground water mainly exploited through shallow or deep wells. The dependence on ground water can be realised by the facts that the number of shallow wells doubled roughly at every 3.7 years between 1951 and 1991, the total crossing 18.5 million wells nationwide (Moench Marcus, 2003). Out of this, 9.62 million are dug wells, 8.35 million are shallow tube wells, and 5.30 million are deep tube wells. Out of these, 81 per cent of dug wells are owned by individual farmers, 16.8 per cent by groups of farmers, and very few by others. In shallow tube wells, 94.6 per cent are owned by individuals, 4 per cent by groups of farmers, and very few by others. In deep tube wells too, 61.8 per cent are owned by individuals, 27.6 per cent by groups of farmers, and about 10 per cent by the government/cooperatives/ panchayats (Ministry of Water Resources, 2002). Thus, the ownership of tube wells and dug wells for irrigation has largely been with individual farmers. Water from these wells is being drawn for irrigation or drinking purposes either by the electric motor or by the diesel and kerosene operated pump sets.

In perspective of rural areas, India is a power deficit country, with associated power quality problems. Despite several policy initiatives taken by the Government, the national grid rural electricity supply has been lagging in terms of services as well as penetration. Only 31% of the rural households have the access to electricity, which further suffers from frequent power cuts and high fluctuations in voltage and frequency. State wise annual actual power supply position (2010-11) shows that there were severe power shortage in the states like the Uttar Pradesh, West Bengal, Jharkhand and Bihar during peak demand situation, particularly in rural areas. These states are largely been the part of Eastern Region and well equipped with natural resources besides groundwater and climatic conditions. In this region the concepts of IFS can be implemented as remedial measures of poverty and sufferings of rural mass by improving farm productivity. But, the lack of assured irrigation supply due to acute shortage of electricity in peak period and ever increasing diesel and kerosene prices, and environmental pollution, farmers are unable to run their pump(s) for require hours to fulfil water requirement. Therefore, the concepts of IFS cannot be implemented for its potential benefits if assured water supply is absent.

Under these situations solar energy operated ground water pumping system could be inappropriate decentralised systems for irrigation particularly in the regions endowed with abundant solar radiations throughout the year. Though, this technology requires high initial investment cost but in view of its payback time (four to five years) and being an environmental friendly technology, promotion and installation of solar powered pumps on community or individual basis under government sponsored schemes could be a prudent approach. To increase water use efficiency, farmers may use available pressurised irrigation systems viz. drip or micro sprinklers with solar pumps to increase overall system efficiency. India is located in the equatorial belt and hence receives abundant sunshine. Here, the average solar insulation varies between 4-7 $kWhm^{-2}day^{-1}$ (Fig.1). India endowed with 250 and 300 days of clear sunny days or 2200–3000 sunshine hours per year, depending upon location, gives the location for year round reliable source of energy (Sharma et. al., 2012; Jaswal, 2009). Though, the solar radiation map shows that although the highest annual global radiation is received in Rajasthan and northern Gujarat, but other regions including the Eastern Region receive fairly large amounts of radiation (6.0-4.5 $kWhm^{-2}day^{-1}$) as compared to many parts of the world including Japan, Europe and the US where development and deployment of solar technologies is maximum.

Solar photovoltaic technology

Solar energy can be converted into electrical energy by way of *solar cells* (also called a *photovoltaic cell*). Assemblies of solar cells, called solar module, is used to capture energy from sunlight. When multiple modules are assembled together, the resulting integrated group of modules all oriented in one plane is referred as *solar pane or array.* The amount of electricity generation depends upon the duration and amount of sunlight falling on the solar module. The efficiency and power output of a module is given for light condition corresponding to 1000 W/m^2 and at 25 ^0C temperature, known as Standard Test Condition (STC). The rated power of a module is referred as *Watt-peak* (Wp). The efficiency of photovoltaic modules of different technologies varies from8 to 16 % (Martin et.al. 2009). The costs of photovoltaic modules of different technologies are stated in terms of Rs/Wp. Currently the cost of PV modules depends upon the types of the technology and it varies from 80Rs/Wp to 90Rs/Wp. The cost of PV modules somewhat also depends on the volume of purchase. Higher the efficiency of a cell implies greater generation of electricity for a given unit area. However, solar module of a given Wp ata given location generate same amount of electricity no matter how efficient of inefficient it is. The only thing which matters is the size of module. A less efficient module will be relatively bigger than the high efficient module. In general efficiency of crystalline silicon module is much more than that of amorphous or thin film module. Therefore, the crystalline silicon module will require less area than amorphous or thin film modules for same energy output. Once the radiation is known one can determine electricity generation in terms of kWh/m^2/ day by the relation: electricity generation ($kWhm^{-2}day^{-1}$) = Efficiency of module daily radiation ($kWhm^{-2}day^{-1}$).For example If average daily global solar radiation of a place is 6.0 kWh/m^2/ day and efficiency of modules is12.1% the electricity generation per square meter of given module is 0.726 $kWhm^{-2}day^{-1}$. Similarly, electricity generation per square meter per day, per month or per year can be estimated for that particular area. In order to maximise the power generation, solar modules should always be kept perpendicular to the sunrays. This requires tracking structure on which solar photovoltaic modules are to be mounted. To avoid extra cost of tracking infrastructure fixed mounting is preferred. In fixed mounting, photovoltaic modules should be fixed at a fixed angle with optimum tilt, equivalent to the latitude angle of the location.

Solar Photovoltaic ground water pumping system

Solar photovoltaic technologies are having great scope in ground water pumping for irrigation and domestic uses. The advantages of solar photovoltaic technologies over conventional technologies are lying in the fact that they are reliable, convenient, durable and environmental friendly. Its maintenance is low and therefore sustainable even in isolated and remote areas. Compatible in almost in all environments, responds instantaneously to the solar radiation. They are modular in nature and therefore, of desired capacity can be designed by simple integration method. Expected life expectancy of solar modules is more than 20 years. On account of life cycle (>20 years) photovoltaic is economically viable and therefore favourable solution for much small/medium power applications, particularly in ground water pumping. Solar photovoltaic technology is an appropriate and cost effective over longer period of operation.

Under solar powered pumping there shall be control and reliability of water availability. This will encourage the farmers to go for successful IFS models. The use of solar photovoltaic technology will make the farmers independent of grid power and respite from ever increasing price of the diesel and kerosene. To increase water use efficiency farmers may use available pressurized irrigation system viz. drip or micro sprinklers. Drip irrigation saves a considerable amount of water compared to other irrigation techniques. Unlike other irrigating processes, drip irrigation is amenable to a continuous supply of water, so the pump can run incessantly through the entire growing season. Since, the crop water requirement and the output of the pump are functions of the global radiation; the two systems go hand-in-hand up to a certain point. Since different crops have different water requirements, and since those water requirements fluctuate in the course of the growth cycle, the proper choice of crop successions and combinations is of decisive importance to the degree of utilisation of solar pumping systems. Uninterrupted crop rotation patterns or continuous cropping systems with high value added crops (e.g., cash crops such as fruit, vegetables, herbs and spices) are especially suited to irrigation by a solar photovoltaic system. Under various schemes central as well as states government are providing subsidies in promotion and propagation off solar energy, therefore farmers can avail this subsidies in installation of solar powered ground water pumping system.

Mainly, there are two types of solar pumps (dcsubmersible pumps and dc surface pumps) being used for ground water pumping. If water source is a deep well then a submersible pump is required. Submersible dc pumps can be used for water pumping that is up to 200 meter deep. Unlike submersible dc pumps, surface pumps are already at ground level or just above the water surface. Surface dc pumps have the limitation that it can pump water only from few meters of depth. Ac submersible pumps can also be operated by solar photovoltaic system using a variable-frequency drive (VFD) which acts as ac/dc converter and also controls the speed or frequency of the pump (Campbell and Sylvester, 1987).Ac submersible pumps are less efficient than dc submersible pumps because some part of energy is used in the VFD and maximum power point tracker. However, ac submersible pumps are cheaper and robust than the dc submersible pumps. Apart from this repair and maintenance of ac pumps are easy compared to dc pumps and can also be repaired locally. Again, AC submersible pumps are available of any horsepower (hp) capacity and easily accessible in the market. While, the DC submersible pumps in the market are available only of capacities, 0.5 to 2 horsepower. The number of watts, and therefore the number of solar modules needed for a pump depends upon the capacity of the pump, and what for, user is going to use it. For example, when using solar modules with submersible pump the number of modules is required depends greatly upon the depth of the well. Deeper the well, the more power is needed, and therefore, the more solar modules are needed.

In solar photovoltaic water pumping system main components are the solar panels/ array; power conditioning unit, and tracking mechanism.In ground water pumping generally two different system configurations are employed. In first configuration solar photovoltaic generated electricity drives a motor pump to lift ground water from well, which pumps water into an overhead tank. The tank serves as an energy store and supplies the pressure needed for the pressurised irrigation system like drip or mini sprinklers. The stored water can bridge the periods of low insulation and supplies the pressure needed for the irrigation system. In the second configuration, water is directly injected into the irrigation system and no storage system is employed. Experiences show that, the second configuration reduces the initial capital outlay by as much as 30-40%. Uninterrupted crop rotation patterns or continuous cropping systems in IFS with high value added crops (e.g., cash crops such as fruit, vegetables, herbs and spices) are especially suited to irrigation. Another configuration (Fig.3) was thought of in which the solar photovoltaic motor pump to lift ground water from well and pumped it into a ground tank. This tank serves as water reservoir, can be used for aquaculture, fish farming or duck farming in IFS. An additional surface pump may also be used to delivery water to irrigate crop either by surface method or by using pressurized irrigation technologies. The benefit of this configuration is that the water from the reservoir can be delivered to distant fields with higher discharge and pressure head. With this configuration more crop area can be covered, as more water can be pump out under this configuration and delivered to the field, as pumping water into overhead tank substantially increases the suction head which reduces the discharge.

A solar water pumping unit has been established at experimental farm of ICAR Research Complex for Eastern Region, Patna, and (Fig.1). In this configuration a crystalline silicon solar array of 3000Wpis used to operate a three phase 3Hp submersible pump using a VFD. The pump is put at 20m below the ground. The water level of the site fluctuates between 5 to 15m; therefore, pump was put on increased depth to test the efficiency of ground water pumping from a larger depth. The solar array was fixed on manual tracking structures to capture maximum power. On a clear sunny day, on an average 1, 10,000 litters of ground water can be pumped out round the year. A storage tank of dimension 32'x16'x7.5' and equivalent capacity of 110000litters was constructed to store. An additional of 2 HP dc centrifugal pump with solar array of size1400W was also installed to deliver water from storage tank to the nearby fields for crop irrigation either by surface methods of irrigation or using pressured irrigation system of irrigation as discharge was found to be12, 000-15,000 l ph with delivery head of 1.2-1.5 kg cm^{-1} in a 2.5 inch conduit on a clear sunny day round the year.

Fig 1. Solar Pumping unit at ICAR Research Complex for Eastern Region, Patna, Bihar

Conclusion

In India, majority of states receive insulation > 5.5 $kWhm^{-2}day^{-1}$. This provides favourable prospects for the use of solar energy agriculture. The integration of solar powered water pumping system with IFS will provide assured water for crop irrigation and allied purposes. This will increase the role of women as more components could be included in IFS model where the women have to play important roles. Since the solar water pumping system is a stand-alone system, environmentally benign and easy to maintain, therefore even a woman can look after the system's maintenance and operation. As the cost of photovoltaic will become competitive, there will be increasing use in remote areas.

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Women Friendly Agricultural Engineering Technologies for Reducing Drudgery

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Women are the backbone of agricultural workforce and are a vital part of Indian economy. Over the years, there is a gradual realization of the key role of women in agricultural development and their contribution in the field of agriculture, food security, horticulture, dairy, nutrition and other allied sectors. Women comprise the majority of agricultural laborers; women have been putting in labor not only in terms of physical output but also in terms of quality and efficiency. However, they are not active in decision making. While it is often argued that agricultural technologies are gender-neutral, it is important to note that they are not resource-neutral, implying socioeconomic considerations in technology generation and transfer. To be viable, technology has to be ecologically sound and socially acceptable (Satyavathi*et al,* 2010). Most of tools/equipments are designed keeping in view of the male workforce. However, the anthropometric data, muscular strength are different for man and women. Hence the tools/equipments designed for men are not fully suitable for women. Keeping all these parameter in mind some equipments are specifically been designed for women like two wheel hoe, fertilizer spreader etc. But still a lot of work and research is required in this field.

1. Role of women in agricultural sector:

Women have played and continue to play a vital role in every sphere of agricultural activity. Operations that involve less physical labour and more drudgery, such as weeding, are left to women and women under-take these tasks in addition to their primary function as housekeepers and home makers. Women work harder and for longer hours than men. Most importantly, they also work on more tasks than men. Therefore, for an economically viable and ecologically sustainable agriculture, the involvement of women in the process of modernization of farming practices is a must.

In developed countries, agriculture is managed by a small number of men because it is mechanized; except Japan, where mechanized operations are handled by women. In India, about 74 per cent of the entire female workforce is engaged in agricultural operations, but the nature and extent of women's involvement in agricultural operations varies greatly from region to region. Further, male farm workers are relatively free during off-season; however, farm women work during these periods too (Satyavathi*et al,* 2010).

2. Role of improved farm tools and equipments:

Women are still struggling for activity-specific tools and equipments. Whenever agriculture gets mechanized, women are the first ones to be marginalised. However improved tools and equipment serve same purpose for both genders.

- Reduce drudgery
- Increase inputs utilization efficiency
- Ensure timeliness in field operations and reduce turnaround time for next crop
- Increase productivity of man- machine system
- Conserve energy
- Improve quality of work and also quality of produce
- Enhance the quality of life of agricultural workers

3. Ergonomical characteristics of women farm workers

Ergonomics is the scientific study of the relationship between a person & his/her working environment, which includes working environment, ambient conditions, tools & materials, methods of work & organization. The performance of a tool/ equipment not only depends on the constructional features but also on the workers operating it.

Important ergonomical data suitable for design of equipment and work methods are:

a. **Anthropometric data:** It includes data on various body dimensions of workers. Seventy nine body dimensions useful for farm equipment design have been identified and data collected for 4500 women workers. The mean height and weight of Indian female agricultural workers are 151.5 cm and 46.3 kg as against 163.3 cm and 54.7 kg for male workers. The equipment needs to be designed keeping in view the limiting dimensions of women workers in consideration. It will help to make the equipment women friendly and safe for operation.

b. **Muscular strength data:** It is generally considered that a woman has about 2/3 strength as that of a man. The mean values of push strength with both hands in standing posture were 224 N and 143 N for male and female workers respectively.

c. **Maximum aerobic capacity:** The maximum aerobic capacity, also called as maximum oxygen consumption rate sets the limit for maximum physical work capacity of a person. For women, this value is generally 75% of that of men. As per the data available for Indian workers, this value for women workers is about 1.5 litres/min.

d. **Physiological cost of operation:** Physiological cost of any operation is expressed in terms of heart rate and oxygen consumption rate. For an 8 hour work period for women workers a work load requiring oxygen at a rate of 0.6 l/min is considered as the maximum limit for acceptable work load. The heart rate for such a work load will be about 110 to 120 beats/min.

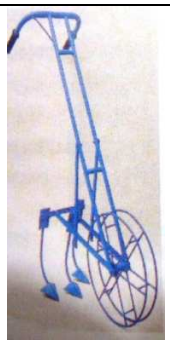
e. **Posture:** A good working posture requires minimum static muscular effort. If a work can be done in a standing posture instead of bending or squatting posture, it should be preferred for long duration jobs. Also for long duration work, a sitting posture may be better than the standing posture.

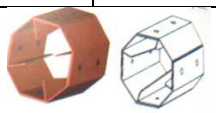
f. **Load carrying capacity:** Load to be carried by a woman worker should not exceed 15.0 kg (about 40% of body weight). The mode of load carrying should be such that the static loading of hands and arms is avoided. For hilly terrains, the limit will be lower depending on slope and the terrain. Women have different ergonomical characteristics and therefore, due attention needs to be given to their capabilities and limitations while designing various equipment (Chandra and Gite, 2012).

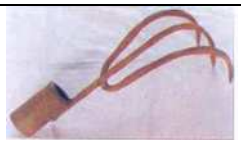
4. Women friendly equipments in agriculture:

A number of small tools and equipments have been designed by ICAR institutes, Universities and other agencies/industries. Some of them which can be easily used by women are depicted below:

Sr No.	Tools/ equipments	Remarks	Photograps
a.	Dibbler	It is single row manually operated equipment for dibbling bold or medium seeds in row or gap filling into well prepared soil. It is suitable for drilling wheat, field pea, and maize in small plot.	
b.	Dibbling Stick	The dibbling stick is a simple manually operated device for creating a conical cavity in the soil for sowing of seeds. To operate the dibbling stick it is held in vertical position and the conical end is pressed into the seedbed to the desired depth. This action creates a conical cavity in the soil in which the seed is placed.	
c.	Rotary Dibbler	The rotary dibbler is a manually operated push type device for dibbling of medium and bold size seeds. For its operation, the hopper is filled with seeds and transport-cum covering wheel is drawn to rear side. The dibbler is then pushed forward in the direction of travel with covering cum transport wheel behind the dibbling head. The jaws penetrate into the soil and automatically drop the seeds.	
b.	Paddy drum seeder	The seeder consists of a seed drum, main shaft, ground wheel, floats and handle. Joining smaller ends of frustum of cones makes the seed drum. Nine metering holes of 10mm diameter are provided along the circumference of the drum at both ends for a row-to-row spacing of 200mm. Two floats are provided on either side to prevent the sinkage and facilitate easy pulling of seeder.	

c.	V blade hand hoe	V blade hoe is used for weeding of the vegetable crop planted in the rows and earthing operation. It is a long handled weeding tool for operation in between crop rows. Consists of v blade, arms, ferrule and wooden handle. The pulling actions cause penetration of the blade into the soil and cut or uproot the weeds. Because of v shape , the blade creates small furrow between crop rows and also earthing of the plants	
d.	Three tined hand hoe (grubber)	It is for weeding, interculture and breaking of the soil crust in vegetable gardens, flower crops and nurseries It is a simple and light weight, manually operated equipment for weeding and interculture in upland row crops in black soil. It consists of long handle, ferrule, three tynes and sweep type blades. The operator uses pull force to break the soil crust and uproot the weeds.	
e.	Single wheel hoe	It is used for weeding and interculture of vegetables and other crops sown in rows. It is a widely accepted weeding tool for weeding and interculture in row crops. It is manually operated equipment for weeding and inter-culture in upland row crops spaced above 240 mm. It consists of wheel frame, V-blade with tyne and handle. Weeds cutting and uprooting are done through push and pull action of the unit.	
f.	Double wheel hoe	It is manually operated equipment for weeding and inter-culture in upland row crops in black soil region. It consists of twin wheels, frame, V-blade with tyne, U clamp, scrapper and handle. Weeds cutting and uprooting are done through push and pull action of the unit.	

g.	Cono weeder	The cono weeder is used to remove weeds between the rows of paddy crop efficiently. It is easy to operate, and does not sink in the puddle. The weeder consists of two rotors, float, frame and handle. The rotors are cone frustum in shape, smooth and serrated strips are welded on the surface along its length. The rotors are mounted in tandem in opposite orientation. The float controls working depth and doesn't allow rotor assembly to sink in the puddle. It is operated by pushing action.	
h.	Groundnut decorticator	It is a manually operated equipment to separate kernels from groundnut pods. The unit consists of frame, handle, oscillating arm sieve with oblong hole. The pods are feed in batches of 2 kg and crushed in between concave and oscillating arm having cast iron/ nylon shoe to achieve shelling.	 
i.	Tubular maize Sheller	It is a hand operated tool to shell maize from dehusked cobs. The unit consists of galvanized mild steel pipe with four tapered fins riveted to its inner periphery. The Sheller is held in left hand, a cob held in right hand is inserted into it with forward and backward twist, to achieve the shelling. Octagonal designs are also available.	 
j.	Fertilizer broadcaster for women	It is hand operated fertilizer broadcaster for women .It weighs only 3.5 kg. its tank capacity is 7.5kg, and Swath width- 5 m. an area of 1.1 hectare can be broadcasted by it in one hour.	

k.	Hanging type Grain Cleaner	It is a simple hanging grain cleaner. Around 225 kg of grain can be cleaned per hour as against the conventional cleaning of 25 kg per hour	
l.	Transplanting Trowels	The trowels are simple hand tools. It is provided with a short wooden handle. These are of various shapes and are also known as transplanting, hand or garden trowels. The working part of the tool is curved to facilitate handling of the soil.	
m.	Khurpi	The khurpi also known as a hand hoe is most commonly used hand tool for weeding. The tool is used in squatting position. For operation the khurpi is held in one hand and pushed into the soil for removal of weeds or unwanted plants. The cutting or uprooting of the weed or undesired plant takes place due to shear and impact action of the blade of the khurpi.	
n.	Hand Fork	It is a multipurpose 3-prong long handled tool. For operation the tool head is drawn towards operator.	
o.	Hand Sprayer	The hand sprayer is a small capacity pneumatic sprayer. For spraying, the tank is usually filled to three-fourths capacity and pressurized by air pump. The compressed air causes the agitation of the spray liquid and forces it out, on operation of the trigger or shut off type valve.	
p.	Sickles	Sickle is one of the most common hand tools used for harvesting of the crops, grass and cutting of other vegetative matters. For cutting, the part of the plant to be cut is held in one hand and sickle operated with other hand. Cutting is achieved by imparting translatory and rotary movement to the blade around the point of cut.	

q.	Dao	It is a curved tip type manual cutting tool used for different agricultural operations and domestic purposes. It is made from mild steel flat or old leaf spring steel by forging operation. For cutting, the cutting edges are struck against the material to be cut by impact.	
r.	Plucker	The tool is ergonomically designed. The plucker consists of two arms hinged together, cutting blades joined to open ends of arms and two rings joined to the arms. Panicles are cut individually using this tool. The operator is spared of drudgery, discomfort and itching to skin of his hands, which are associated with conventional method of manual plucking without any aid. It fits in to the hand properly with the help of two rings, one over thumb and another over index finger.	
s.	Pedal Operated Thresher	It consists of wire-loop type threshing cylinder, power transmission system, mild steel sheet body and foot pedal. On pressing the pedal the threshing cylinder starts rotating. For continuous rotation of the cylinder, the pedal is lowered and raised repeatedly. For operation, paddy bundle is held in hands and ear head portion of the crop is placed on the rotating cylinder. The wire-loops hit the ear heads and grain get detached from the rest of the crop.	
t.	Pedal operated thresher (Developed by VPKAS, Almora)	The machine is developed for hill conditions of North Western Himalayan Region, where the drudgery caused by the weight of the machine is a major concern. To overcome this, polycarbonate sheet was introduced to reduce the weight, vibration and noise level of the paddy thresher. The power requirement for operating the thresher is 1 man or women working continuously for 1 hr, without feeling fatigue.	
u.	Self Propelled Riding Type Reaper	The riding type vertical conveyor reaper is a self propelled unit in which the operator rides on the machine. Drive is by means of two large pneumatic wheels and steering is by rear idlers. The prime mover is a 6 hp diesel engine. Convenient clutch, break, steering, hydraulic system and simple power transmission are provided for ease of	

		operation. It consists of crop row divider star wheel cutter bar (76.2 mm); conveyor belt and wire spring etc. This reaper has two forward and one reverse speed.	

5. Constraints in usage of agricultural tools by women

a. **Training:** This is more relevant when the technology involves tools and equipments where training in operation, repair and maintenance is a must. If urban women can operate machines, there is no reason why rural women should not be encouraged to operate agricultural equipment. It only requires infrastructure and facilities for training them in rural surroundings within their reach. This may be accomplished either by training them in their own environments or by bringing them to the training centres located in their close proximity. Imparting skills to women workers for proper use of the improved agricultural tools/equipment is very important.

b. **Extension Services**: The major constraints in taking the technologies to farm women include Illiteracy among farm women, social customs and taboos, shortage of women extension workers, insufficient funds for extension programmes for women, lack of infrastructural facilities for women extension programmes and lack of coordinated and concentrated efforts.

c. **Availability of Improved Tools in Rural Areas:** The state agricultural departments and State Agro Industrial Development Corporation(s) may have to take lead role because the agricultural machinery is under the control of state governments. The supply of improved tools and equipment need to be ensured at block level so that assured availability is ensured to the farm women as per their requirement.

6. Strategy for Technology Development and Promotion for women

Tools/equipments should be designed using anthropometric and strength data of women workers, rules and regulations for manufacturing women-friendly agriculture machinery must be developed and proposed. Proper trainings to rural women on various improved equipments should be provides so that they can operate them properly and safely. Assisting farm women in getting loans after being duly trained by trainers so as to procure various tools/equipments, building up of linkages with central/ state departments, NGOs, banks, and other stakeholders to promote these improved tools and equipments.

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Adoption of Modern Soil and Water Conservation Techniques For Enhancing Productivity

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Introduction:

Soil is the most fundamental and basic resource. Although erroneously dubbed as "dirt" or perceived as something of insignificant value, humans cannot survive without soil because it is the basis of all terrestrial life. It underpins food security and environmental quality, both essential to human existence. Essentiality of soil to human well-being is often not realized until the production of food drops or is jeopardized when the soil is severely eroded or degraded to the level that it loses its inherent resilience. Productive lands are finite and represent only <11% of earth's land area but supply food to more than six billion people increasing at the rate of 1.3% per year (Eswaran et al., 2001). Thus, widespread degradation of the finite soil resources can severely jeopardize global food security and also threaten quality of the environment. Conserving soil has many agronomic, environmental and economic benefits. . Erosion control is a necessity in almost every country of the world under virtually every type of land use and has the potential to sequester carbon as well as restoring degraded soils and improving water quality. Water conservation is very essential for increasing water use efficiency in agriculture which leads to sustainable agriculture and food security. The productivity of irrigated land is approximately three times greater than that of rain fed land. Beyond that global fact, there are many more reasons for highlighting the role of water control in agriculture. Investing in irrigation development provides insurance against erratic rainfall and stabilizes agricultural output, boosting crop productivity and allowing farmers to diversify. This translates into increased and less volatile farm incomes.

Principles of soil and water conservation

There are always strong links between measures for soil conservation and measures for water conservation. Many measures are directed primarily to one or the other, but most contain an element of both. Reduction of surface run-off by structures or by changes in land management will also help to reduce erosion. Similarly, reducing erosion will usually involve preventing splash erosion, or formation of crusts, or breakdown of structure, all of which will increase infiltration, and so help the water conservation.

The strategies for soil and water conservation must be based on: covering the soil to protect it from raindrop impact; increasing the infiltration capacity of the soil to reduce runoff; improving the aggregate stability of the soil; and increasing surface roughness to reduce the velocity of runoff and wind. The various conservation techniques can be described under the headings of agronomic measures, soil management and mechanical methods. Agronomic measures utilize the role of vegetation to protect the soil against erosion.

Soil management is concerned with ways of preparing the soil to promote plant growth and improve its structure so that it is more resistant to erosion. Mechanical or physical methods, often involving engineering structures, depend on manipulating the surface topography for example, installing terraces or windbreaks to control the flow of water and air. Agronomic measures combined with good soil management can influence both the detachment and transport phases of erosion, whereas mechanical methods are effective in controlling the transport phase but do little to prevent soil detachment

Soil Conservation:

A.* Agronomical measures*:

Agronomical measures or practices are growing vegetation on mild sloppy land to cover them and to control the erosion from there. Agronomical measures include contouring, strip cropping and tillage practices to control the soil erosion. The use of these measures is entirely dependent upon the soil types, land slope and rainfall characteristic. It plays second line of defense after mechanical or engineering measures. It is more economical, long lasting and effective.

1. Contour cultivation:

It refers to all the tillage practices, mechanical treatments like planting, tillage and intercultural, performed nearly on the contour of the area applied across the land slope. In low rainfall regions the primary purpose of contour cultivation is to conserve the rain water into soil as much as possible. In humid regions its basic purpose is to reduce the soil erosion or soil loss by retarding the overland flow. In this system, the furrows between the ridges made on the contours hold the runoff water and stored them into the soil. Thus they reduce the runoff and soil erosion

2. Strip Cropping:

It is also a kind of agronomical practice, in which ordinary crops are planted or grown in form of relatively narrow strips across the land slope. These strips are so arranged, that the strips crops should always be separated by strips of close-growing and erosion resistance crops. Strip cropping check the surface runoff and forces them to infiltrate in to the soil, which facilitates to the concentration of rain water. It is more effective than contouring (about twice effective as contouring) but it does not effect on soil erosion.

Strip cropping controls erosion by

- Reducing the runoff flowing through the close growing sod strips.
- Increasing the infiltration rate of soil under cover condition.

Types of strip cropping:

a) Contour strip cropping.
b) Field strip cropping.
c) Buffer strip cropping.
d) Wind strip cropping.

3. Tillage practices:

It is defined as mechanical manipulation of soil to provide a favorable environment for good germination of seed and crop growth, to control the weeds, to maintain infiltration capacity and soil aeration. Tillage practice protects and maintains a strong soil structure to fight against erosion.

Types of tillage practices

a. Mulch tillage: application of many plant residues or other material to cover top soil surface.

Mulching material: Cut grasses, straw material, wood chips. Saw dusts, paper and sand stones, glass wools, metal foils and stone plastic.

Types of Mulch: Natural, synthetic, petroleum, conventional, Inorganic, organic.

b. Vertical Mulching: Insertion of stuffed plant residue vertically into subsoiler marks to keep the slot open.

c. Minimum Tillage: Preparation of seedbed with minimum disturbance of soil.

d. Conventional tillage: Ploughing, secondary cultivation with harrowing and planting.

e. Listing: Used for controlling soil erosion.

i. Hard ground listing.
ii. Loose ground listing.

4. Soil management practices:

Various soil and land management practices are –

a) Those practice which helps to maintain the water infiltration rate at high level to reduce runoff to a negligible amount.
b) Practices which helps in safe disposal of runoff from field.

The cultural practices which are helpful for creation of high infiltration rate are essential based on farming techniques, tillage or minimum tillage and use of cover crops. Whereas the safe disposal of runoff from the field is carried out by physical manipulation of soil surface including land shaping, leveling, construction of ridges, bunds and water ways.

5. Supporting Practices:

It involves application of fertilizers to soil either to make more fertile or to recover the fertility loss during different physical action. Application of fertilizer plays sometimes a significant role to develop abundance vegetative growth e.g. grass waterways and terrace outlet are generally established on low fertile sub soil.

6. Vetiver Grass Planting:

It is most effective vegetative material for soil and water conservation, land rehabilitation and embankment stabilization. Vegetative hedge formed with thick growth of vetiver grass, forms a protective barrier across slope which slows down sheet erosion and deposit the slit behind hedges.

B.* Engineering Practices*:

It is used to control the soil erosion in highly sloped areas

1. **Terracing*:***

"A terrace is an embankment or ridge of earth constructed across a slope to control runoff and minimize soil erosion". A terrace reduces sheet and rill erosion and prevents formation of gullies by reducing the length of the hill side slope. Terraces are usually built in a series parallel to one another, with each terrace collecting excess water from the area above. Terraces can be designed to channel excess water into grass waterways or direct it underground to drainage tile and a stable outlet.

Types of Terraces: There are two major types of terrace.

a) **Bench Terrace**: A bench terrace is shelf like embankment of earth with a level or nearly level top and a step or vertical downhill face constructed along the contour of sloping land. Bench terracing is one of the oldest mechanical methods of erosion control having been used for manly centuries in many countries .bench terrace, though not very scientifically designed have been extensively used in India in the mountainous regions of Kerala, Himachal Pradesh and Assam.

Bench terracing consists of transforming relatively steep land into a series of nearly level strips or steps running across the slope. Bench terracing is adopted only on slopes steeper than 15% and where soil conditions are favorable. The use of bench traces retards erosion losses and makes cropping operations on these slopes possible and safe.

Bench terrace may be of four types depending on the slope of the terrace.

1. **Table top bench terrace*:*** Table top bench terrace are suitable for areas receiving medium rainfall which is evenly distributed and which have highly permeable and deep soils. In paddy fields it may be used for slopes as mild as 1% and used where irrigation facilities are available.
2. **Sloping inwards bench terrace*:*** In heavy rainfall areas, bench terraces of sloping inwards type are more effective. It prevents ponding of water and useful for crops susceptible to water logging.
3. **Sloping outwards bench terrace*:*** Bench terraces sloping outwards are effective only in low rainfall areas with a permeable soil of medium depth. At lower ends graded channels are provided for safe disposal of runoff.
4. **Puertorican Type*:*** In this type of terrace, the soil is excavated little during every ploughing and gradually developing bench by pushing the soil downhill against a mechanical of vegetative barrier. Mechanical or vegetative barrier is established across the land at suitable interval and the terrace is developed gradually over the years, by pushing soil downhill and subsequent natural leveling.

b) **Broad Base Terrace:**

Broad based terraces are sometimes referred to as magnum terraces after the inventor, Priestly Magnum, who introduced B.B. terrace by widening narrow ridge. A broad base terrace has a ridge of 25 to 50 cm high and 5 to 9 m wide with gently sloping sides and a channel along the upper side constructed to control erosion by diverting runoff at a non-erosive velocity.
It may be level or have a grade towards one or both ends. Based on grade; it is divided or classified as:

i. **Graded Terrace*:*** A graded terrace has a constant or variable grade along its length and used to convey excess runoff at safe velocity into a vegetated waterway or channel.

ii. **Level Terrace*:*** A level terrace follows the contour line in control to a graded terrace and recommended in areas having permeable soil.

2. **Bunds**

Bunds are the most common soil conservation measures adopted by people in most of the cultivated lands. Bunds are ridges or embankments or long and narrow projections constricted on the surface on the land at selected places and in selected directions. The bunds may be of different sizes and heights and constructed for various purposes. The earthen dam is also a bund; but is constructed to stop and store large amount of water coming down through a river: for example Hirakud darn. Bunds have a top width and a bottom width. Sometimes the top may be made round instead of flat. The top width will always be less or at the most equal to one-third width of the bottom width. For the same height and width (top and bottom) the bund can be of any length in any direction.

Bunds are usually made on lands less than 8 % slope. Between two bunds is the space of land either terraced or left unterraced and used for cultivation.

Types of bunds:
Depending on the purpose the bunds are classified as contour bunds, graded bunds, side bunds, lateral bunds, marginal bunds and shoulder bunds.

a) **Contour bonds**

When bunds are constructed across the slope in a contour line they are called contour bunds. They are constructed to reduce the length of the slope by dividing slope into different sections and to impound the running water at different sections to increase percolation. They are normally constructed on lands with 1-6 per cent slope. But bunds may be constructed up to eight per cent slope.

b) **Graded bunds**

When the contour bunds are made with slight deviation from the contour line towards one direction to drain out the surplus water that may occur during the rain, they are called graded bunds. For a casual observer the graded bunds look like contour bunds. Graded bunds are made on land with slope between 2-8 percent.

c) **Side bunds**

Side bunds are the bunds that are constructed at the extreme ends of the contour bunds along the line of slope. But in the case of graded bunds the side bund is constructed as part of the drainage channel on the side towards which the water is drained. But side bunds are constructed on both sides of the contour and graded bunds.

d) **Lateral bunds**

Bunds constructed along the slope between two side bunds in order to prevent concentration of water along one side and to break the length of the contour bund into convenient bits are called lateral bunds. Usually the lateral bunds are constructed when the contour or graded bunds are more than 300 m long. Like the side bunds the lateral bunds also should be accompanied by drainage channel to drain out the excess of rain water.

Water Conservation

1. **Broad Bed and Furrow System*:***

The Broad Bed and Furrow system has been mainly developed at the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) in India (Krantz 1981, Pathak et al. 1985). The recommended ICRISAT system consists of broad beds about 100 cm wide separated by sunken furrows about 50 cm wide. The preferred slope along the furrow is between 0.4 and 0.8 percent on vertisols. Two, three, or four rows of crop can be grown on the broad bed, and the bed width and crop geometry can be varied to suit the cultivation and planting equipment.

The BBF system is particularly suitable for the vertisols. The technique works best on deep black soils in areas with dependable rainfall averaging 750 mm or more. It has not been as productive in areas of less dependable rainfall, or on alfisols or shallower black soils - although in the latter cases more productivity is achieved than with traditional farming methods.

2. **Ridging and Tied Ridging*:***

This method is also known as furrow blocking, furrow damming, furrow diking, and basin listing. The principle is to increase surface storage by first making ridges and furrows, then damming the furrows with small mounds, or ties. Graded ridges alone will usually lead to an increase of surface run-off compared with flat planting, while tied ridges will decrease the run-off and increase the storage. In

different seasons either of these two effects may be prefer able and so the design question is when to go for drainage and when for storage. An interesting possibility is to use tied ridging in connection with sprinkler irrigation to allow higher application rates at low pressure. Tied ridging is usually associated with mechanized farming. Either ridging alone or tied ridging has occasionally been practiced using hand labour, but the high labour requirement usually makes this unpopular with subsistence farmers. Anyway hand-made ridges are usually less efficient. They are more likely to depart from a true contour and to have variations in the height of the ridge, both of which will increase the risk of overtopping.

3. Conservation Bench Terraces *(CBT):*

Conservation bench terrace is also known as Zingg terrace, and flat channel terrace. This is another type of rainfall multiplier, using part of the land surface as a catchment to provide additional run-off onto level terraces on which crops are grown. The method is particularly appropriate for large- scale mechanized farming.
The features required for CBTs are:

- Gentle slopes of 0.5 - 1.5 percent are most suitable as a steeper slope requires more earth moving.
- A deep soil is required, both to provide sufficient soil moisture storage, and also to lessen the effect of cutting during the construction of the terraces.
- Smooth slopes are an advantage where large mechanized farming can be made more convenient by constructing all the terraces parallel and of equal width.
- Precise leveling off the bench terrace is important to ensure uniform buildup of soil moisture.
- If there is a risk that run-off from the catchment area will be greater than can be absorbed and stored on the terrace, there must be outlets at the ends of the terrace, which can discharge into grass waterways or other safe disposals.
- The ratio of catchment to terrace may be from 0:1 (in which case the whole land surface is converted to level bench terraces) but typical values are 1:1 or 2:1. In general, the lower the mean annual rainfall the larger will be the required catchment area to provide sufficient moisture for the crop.

4. Contour Furrows or Contour Bunds*:*

These are variations on the theme of surface manipulation which require less soil movement than conservation bench terracing, and are more likely to be used by small farmers, or in lower rainfall areas. The cropping is usually intermittent on strips or in rows, with the catchment area left fallow. The principle is the same as Conservation bench terraces *i.e.* to collect run-off from the catchment to improve soil moisture on the cropped area.

On heavier soils, contour bunds may be less effective because of the lower infiltration. Studies on vertisols in India showed that yields were lower near the bunds, both upslope and down, as a result of water logging (ICRISAT 1976). If the contour furrows are not laid out precisely on the contour, or are built with some irregularities, there may be a danger of uneven depths of ponding behind the bank.

A disadvantage of contour bunds at intervals down the slope is that the crop tends to be uneven, reflecting the soil moisture profile, and only a small part of the field is cropped. But the point is that it enables some crop to be grown where otherwise the rainfall would be inadequate for any cropping.

Management of Wind Erosion

The reduction in wind erosion rates in the USA since the "Dust Bowl" shows that refined understanding of soil and wind dynamics, prudent soil management, and use of conservation practices could reverse the severity of wind erosion. In the rest of the world, wind erosion rates have, however, increased or remained the same, which warrants increased research on site-specific conservation practices. Adoption of appropriate farming practices can offset wind erosion. Intensive tillage, summer fallow, and residue burning are practices that increase wind erosion. Vegetative barriers, strip cropping, continuous cropping, crop rotations, no-till, minimum tillage, management of crop residues, cover crops, green manures, animal manure, and forages are recommended practices. Practices that stabilize soil aggregates and roughen the soil surface also control wind erosion. Wind erosion prevails in large and flat fields with smooth, bare, loose, dry and non-aggregated soils.

Some of the strategies to control wind erosion include:

1. Maintain a vegetative cover (e.g., cover crops, residues)
2. Reduce cultivation during fallow
3. Establish windbreaks (trees and shrubs)
4. Reduce intensive grazing
5. Minimize or eliminate tillage
6. Reduce tillage speed and do not bury residues
7. Implement strip cropping and mulch tillage
8. Apply soil stabilizers or conditioners &
9. Roughen the soil surface and reduce field length.

Role of women in Agriculture:

Women comprise an average 43 percent of the agricultural labour force of developing countries. The female share of the agricultural labour force ranges from about 20 percent in the Americas to almost 50 percent in East and Southeast Asia and sub-Saharan Africa. The regional averages hide wide variations within and between countries. In developing countries, most women's work is devoted to agriculture. Women are involved in every stage of food production. Although men usually plough the fields and drive draught animals, women do most of the work involved in sowing, weeding, fertilizing and harvesting the staple crops such as rice, wheat and maize which allows for more than 90 percent of the rural poor's diet.

Women's contribution to secondary crops, such as legumes and vegetables, is even greater. Most of these crops are grown in home gardens, tended almost exclusively by women. These gardens are often remarkably productive and critically important to nutritional and economic well-being. A study in eastern Nigeria, for example, found that home gardens occupying only 2 percent of a household's farmland accounted for half the farm's total production. Similarly, home gardens in Indonesia are estimated to provide more than 20 percent of household income and 40 percent of domestic food supplies.

Women are heavily engaged in the livestock sector. In particular women often have a prominent role in managing poultry and dairy animals. In some countries small-scale pig production is also dominated by women. The role of women in meeting the rising demand for livestock products may diminish as the sector becomes more commercialized because women often find it more difficult to start their own business and tend to lose control over profitable activities.

Available data shows that about 12 percent of fishers and fish farmers in the primary sector are women. In two major producing countries, China and India, women represented a share of 21 percent and 24 percent, respectively, of all fishers and fish farmers. Women play a particularly significant part in all regions in the processing and marketing stages (FAO).

Conclusion:

Soil and water conservation is an essential component for sustainable agriculture and it will play a significant role in future food security. The adoption of different conservation measures in India is very little and limited mostly to hilly region. But for maintaining productivity, soil water conservation is very essential in every piece of land. Monsoon in India is very uncertain and its distribution is erratic. Water conservation by different means and its use in agriculture can reduce the negative effect of erratic monsoon. In many developing countries, agriculture is underperforming, and one of the key reasons is that women do not have equal access to the resources and opportunities they need to be more productive.

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Information and Communication Technologies for women empowerment

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Introduction

Information and communication have always mattered in agriculture. Information and communication technologies (ICTs) play an important role in world's societies. ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. It is the study of the technology used to handle information and aid communication. ICTs allow users to participate in a rapidly changing world and have the potential to help disadvantaged groups, increase their participation in the civic, social, political, and economic processes critical to achieving change. However, women–particularly women in developing countries–don't benefit from these new technologies, a reflection of the existing unequal power relations in societies as a whole. ICTs can be used to either exacerbate or transform unequal power relations. ICTs cannot create gender equality, or end poverty, but they can be tools for social action and positive social change.

Intensification and Drivers of ICT in Agriculture

Now, it is well evident that any attempt to improve the quality of life of people in developing countries would be incomplete without progress towards the empowerment of women. ICTs are emerging as a powerful tool for gender empowerment in a developing country like India. There has been a rapid growth in ICT sector since the late 1980s and the use of ICT has dramatically expanded since the 1990s. According to the World Bank, tele density in India had reached 3.8% of the population by 2001. The number of internet accounts is growing at a rate of 50% per annum. But there is a strong digital divide in society. According to the 2004 report by the Cisco Learning Institute, women comprise only 23% of India's internet users. This gender digital divide in India is characterized by low levels of access to technologies.

Five main trends have been the key drivers of the use of ICT in agriculture, particularly for poor producers:

1) Low-cost and pervasive connectivity,
2) Adaptable and more affordable tools,
3) Advances in data storage and exchange,
4) Innovative business models and partnerships, and
5) The democratization of information, including open access movement and social media.

These drivers are expected to continue shaping the prospects for using ICT effectively in developing country agriculture.

ICT for Women in Indian Perspective

For centuries, women in India have been socially and economically handicapped. They have been deprived of equal participation in the socioeconomic activities of the nation. A large group of working women of India is in the rural and unorganized sectors. Socially, majorities of Indian women are still tradition bound and are in a disadvantageous position. The Constitution of India recognizes equality of the sexes and in fact provides for certain provisions under the Chapter on Fundamental Rights more favourable to women but in actual practice they are observed more in breach than in compliance. In our society the freedom of women to seek employment outside the family is a major issue. This freedom is denied in many cultures and this attitude in itself is a serious violation of women's liberty and gender equality. The absence of this freedom militates against the economic empowerment of women, with many other deleterious consequences.

Since globalization is opening up the Indian economy suddenly at a very high speed, during past decades, advances in information technology have facilitated a global communications network that transcends national boundaries and has an impact on public policy, private attitudes and behaviour, especially of children and young adults. Everywhere the potential exists for the media to make a far greater contribution to the advancement of women. More women are involved in careers in the communications sector, but few have attained positions at the decision-making level or serve on governing boards and bodies that influence media policy.

One of the ignored ICT issues in India is the "gender sensitization" that must be adopted while formulating and implementing the ICT policies in India. It is commonly understood that men and women understand and use computers and Internet differently. Thus, the policy decisions must make sufficient provision for adopting itself with this aspect (Vijayanand and Ananda, 2003). The lack of gender sensitivity in the media is evidenced by the failure to eliminate the gender based stereotyping that can be found in public and private local, national and international media organizations. The continued projection of negative and degrading images of women in media communications electronic, print, visual and audio must be changed. Print and electronic media in most countries do not provide a balanced picture of women's diverse lives and contributions to society in a changing world.

We must understand that the training, use and adoption of ICT must be "gender neutral". For a gender-neutral technology we have to first place the women on an equal platform. They cannot be put on an equal platform till they have equal capacity and opportunity to use ICT. They cannot also effectively use ICT till their "feedbacks and concerns" are incorporated in the National Policies including the Egovernance plans. The position is worst when it comes to women, that also rural woman. In our society, whether they belong to the majority or the minority group, what is apparent is that there exists a great disparity in the matter of economic resourcefulness between a man and a woman (Nath, 2001). Our society is male dominated both economically and socially and women are assigned, invariably, a dependant role, irrespective of the class of society to which she belongs. Thus, the national consensus should concentrate on betterment of women by suitably empowering them. The plight of the women, however, cannot be improved till they are duly represented in the "power structure" of the nation. In a democratic country the voice of women can be heard only to the extent they are sharing the power structure in the supreme governance of the country. Thus, ICT can play a major role in women empowerment if they are provided employment opportunities at the village level after providing them suitable training. We have to open more village kiosks so that greater women participation can be there.

Women Empowerment: Success Case

"Networking Rural Women and Knowledge", a UNESCO project in Nabanna, India, explores innovative uses of databases, intranet portals and web based partnerships in the local language for the benefit of poor women. The purpose of the project is building women's local information networks by providing simple facilities and training at five ICT centers in Baduria, Rudrapur, Taragunia, Arbelia and Punda. Through this project a core group of 60 information agents aged 20-40 years have gained access to and control of information and communication technology through using ICTs. Through the Nabanna Network women share local indigenous information as well as information obtained at the information group meetings or newsletter, e.g. women in Baduria have exchanged information on income generating activities, specific education projects, microfinance and health. Therefore, young educated women have obtained access to and control of ICTs where less educated and older women have obtained access to information through the human network. Women in Baduria have enhanced their agency through ICTs. UNESCO (2004) reports the following changes in women's agency after gaining access to information and communication through Nabanna: Women gained more respect in their local communities as a result of ICT skills acquired at the centres–learning to use a computer and accruing and distributing the information to local people. This resulted in greater respect both at family and community level. Younger women felt they were able to approach the job market with greater confidence than before. ICT skills help them to find jobs and increase their income. Women became more creative after learning a programme like Paintbrush in Window XP. Women have achieved an increase in income as well as enhancement of solidarity among women in the community. While learning to use computers together at the ICT centres women often discuss their problems, creating a sense of unity and developing leadership qualities. ICT increases women's agency in the household, community and the market. In the household, information obtained through ICT enables them to negotiate and bargain with their family members. Thus women have enhanced their sisterhood and experienced collective empowerment through the Nabanna network. This sisterhood in the community empowers women as a group and allows them a greater voice in the community, hence increasing their influence on local government for implementing projects to promote maternal health, girls' education and sanitation. However, although the Nabanna project has tried to include marginalized women in the information network, illiterate and indigenous women still have difficulty accessing ICTs.

Women Empowerment

Knowledge Networking

Empowerment of women in the context of knowledge societies entails building up the abilities and skills of women to gain insight into the issues affecting them and also building up their capacity to voice their concerns. It entails developing the capacities of women to overcome social and institutional barriers and strengthening their participation in the economic and political processes so as to produce an overall improvement in their quality of life. Knowledge networking catalyses the process of women's empowerment by opening up avenues for women to freely articulate and share their experiences, concerns and knowledge, creating the possibility of their further enrichment. By the use of ICT women can broaden the scope of their activities and address issues previously beyond their capacity. There is a growing body of evidence on the use of ICT to empower women all over the world.

The use of ICT helps to bridge the gap between people's opportunities for self employment in the informal economy and the high growth sectors of the world economy. In an informal sector, workers can gain easy access to the Internet through telecenters and obtain information about markets or administrative procedures, and to publicize their services to a wider clientele (Nath, 2000). Since India

has been using ICT for development for more than two decades, there are many good practices for the use of ICTs for women's empowerment. India Shop, an Ecommerce website (2005) in Tamil Nadu, has been designed to sell products made by rural women's cooperatives and NGOs. The Dhan Foundation (2004) and Swayam Krishi Sangam (2004) are using ICTs, such as handheld devices and smart cards, to improve microfinance projects to empower poor women. The Self Employed Women's Association (SEWA) has started using telecommunications as a tool for capacity building among the rural population. It has several ICT projects for women, including community learning centers, a school of Science and Technology for self employed women, and the Theli phone project, which provides mobile phones to women in the informal sector. The term 'informal sector' is used mainly with reference to developing countries. The International Labour Organization (ILO) defines it as an unorganized sector in which economic activities take place outside the framework of public and private sector establishments. Such activities are characterized by small scale of operations, ease of entry, reliance on family labour and local resources, labour intensive technology, low capital endowments a high degree of competition, unregulated market, unskilled work force and acquisition of skills outside the formal education system. In India this sector cuts across well-defined crafts or industry conglomerates like cottage and household industries, khadi and village industries, handlooms, handicrafts, coir, sericulture, etc set up all over the country in rural, semiurban and urban environments. Self help groups of rural women in Andhra Pradesh have been so successful in marketing their products at home and abroad that the major multinational corporations (MNCs) want to use their selling skills. It can be concluded that the women of Tamilnadu is empowered through the help of information and communication technology. It has changed their position from the past. Tamilnadu as a technologically advanced state in India is also doing a lot of projects for the women in general and village and illiterate women in particular. It has also taken several steps and implemented various plans and policies along with government of India to eradicate poverty and bring the women into the Information Technology (IT) related industry. NGOs working in the field, multinational agencies and other private agencies have also extended their help to promote IT among the women. The development of IT has enabled the women section to participate in the daily affairs of the state, which range from the household work to local governance.

In Uganda, with support from the Women of Uganda Network, rural women use a variety of ICTs, for example, they combine a listening club for rural radio with mobile telephony. This has led to better contacts with the outside world and greater opportunities to enhance their agricultural production. In Mali, rural women of the Sikasso region combine video and photos to make digital content, which has greatly improved the marketing of their products. In the rural fishing villages of Benin, women fish processors from the NGO, AquaDeD, are using video, television and mobile phones to learn new conservation techniques and to sell their produce to Togo and Nigeria.

In Ghana, the Kalang Centre found both the time and the space socially suitable to enable more of the shea butter producers, mainly girls and women, to benefit from ICT training. Rural women, novices in the field of ICTs, are now becoming fully aware of the power of these tools to dramatically change socioeconomic relations, open new opportunities and expand their circle of knowledge and opportunities. It will take a combination of advised policy choices, well oriented, private sector investment decisions and convincing media campaigns before the majority of rural women can have access to ICTs.

Access to Information

Access is the central issue necessary for women's empowerment. Women have traditionally been excluded from the external information sphere, both deliberately and because of factors working to their disadvantage such as lack of freedom of movement or low levels of education. ICT opens up a direct window for women to the outside world. Information flows to them without any distortion or

censoring. This leads to broadening of perspectives, greater understanding of their current situation and the causes of poverty and the initiation of interactive processes for information exchange. Access to ICTs is crucial if they are to be a means for women's economic empowerment. We need to work towards universal access. It is important not only to establish physical facilities, such as communication networks or computers, but to ensure that these facilities are utilized by their users to the greatest possible extent. Women's access to and use of ICT is constrained not only by technological infrastructure, but also by socially constructed gender roles and relations. According to a United Nations Educational, Scientific and Cultural Organization (UNESCO) report on "Gender Issues in the Information Society", the capability of women to effectively use information obtained through ICT is clearly dependent on many social factors, including literacy and education, geographic location, mobility and social class. ICT can deliver potentially useful information, such as market prices for women in small and microenterprises. For example, use of cellular telephones illustrates how technology can be used to benefit women's lives, by saving traveling time between the market and suppliers, by allowing women to call for product prices and by facilitating the constant juggling of paid and unpaid family activities. However, use of ICT will be limited in impact wherever women have limited or no access to roads or transport, credit and other development inputs.

ICTs require that users have some skills and one should not assume that providing the facilities means that everyone in the community will immediately embrace the technology. Two important aspects need to be mentioned. First, is that the technologies should be adapted to suit women rather than that women should be asked to adapt to technology. And secondly, ICT training is of utmost importance if women are to use the technology of their choice. Gaining the required skills further empowers women to use ICT in order to increase their employment choices and contribute to community development. Therefore, the provision of ICT facilities should be complemented with additional services and training. In developing countries like India, more than 90% of women work in the informal sector and also in rural areas. These women engage in economic activities such as handicrafts and sewing or rolling cigarettes, weaving of baskets and fabrics, working in cities as vendors–working without any contracts or benefits. These are the women who need and deserve poverty alleviation programmes more than any other. IT will expose these women to telecommunication services, media and broadcast services that will create markets for their products and services. The challenge will be to reach these women and provide them with ICT tools that they feel can make a difference in their income generation potential. For example, the well known Self Employed Women's Association (SEWA) in India has done extensive work to assist women in the informal sector and has established an ICT programme aiming to increase efficiency of rural micro enterprise activities.

Employment Generation

ICT has played an important role in changing the concept of work and workplace. New areas of employment such as teleworking, i.e. working from a distance, are becoming feasible with new technology (Mitter, 2000). The question needs to be asked whether women are getting more opportunities. Undoubtedly, internationally outsourced jobs such as medical transcription and software services have opened up tremendous work opportunities for women in developing countries like India, China and the Philippines. With an expected 500 per cent increase in India's ICT services and back office work, involving jobs for four million people and accounting for seven percent of GDP by 2008, women's employment in this sector is expected to grow. ICT offers women flexibility in time and space and can be of particular value to women who face social isolation in developing countries. As a result of the technologies, a high proportion of jobs outsourced by big firms are going to women. They can, therefore, work from outside the office–often from their own homes and at any time, thereby raising their incomes to become more financially independent and empowered. There is considerable debate

about which women benefit from the new form of work and about the implications of the type of work, women do in this sector. Studies of call centers in Delhi and in the New Okhla Industrial Authority (NOIDA) demonstrate lack of opportunities for development and promotion and a high degree of burnout among women. Very few women are employed at the professional level of business process outsourcing (BPO). Flexitiming is at a great cost to women themselves, given the fact that the division of work at the household level remains the same. Due to the high premium placed on productivity, people invest all their energies, time and emotional needs in their jobs, so that there is little to fall back on when the workplace fails them.

Entrepreneurship Development

Gothoskar (2000), in an interview with women teleworkers in Mumbai, got responses ranging from welcoming the freedom to fulfill family commitments to dislike of the lack of access to public and social spaces and reinforcement of the role at home. Telecenters can solve these problems by combining homework with social spaces and organization. One way to do this is to move to Entrepreneurship on the internet. The Internet can offer great assistance to Entrepreneurship by women. It offers databases, put together by women's groups, from which women can find relevant links, connections, resources and information and develop partnerships, not just for their services, but also for financing, mentoring and business coaching. It can even mitigate the effect of lack of access to capital. One of the most powerful applications of ICT in the domain of knowledge networking is electronic commerce (E-commerce). E-commerce refers not just to selling of products and services online but to the promotion of a new class of ICTsavvy women entrepreneurs in both rural and urban areas. Ecommerce initiatives can link producers and traders directly to markets at national, regional and even global levels, allowing them to restructure their economic activities and bypass middlemen and the male dominated and exploitative market structure. Significantly a number of non-profit organizations have diversified their services to provide support to this class of entrepreneurial women. PEOP Link is one such organization, which has been helping women communities traditionally involved with handicrafts to put their products online in the world market. In Gujarat, women producers use the Dairy Information System Kiosk (DISK), which manages a database of all milk cattle and provides information about veterinary services and other practical information about the dairy sector.

Challenges of ICT Application

Women face enormous challenges to use ICT for their own economic empowerment. Using and benefiting from ICT requires education, training, affordable access to the technology, information relevant to the user and a great amount of support (to create an enabling environment). Access to affordable services and availability of infrastructure is without doubt a major requirement if ICTs are to be used for women's economic empowerment. Availability of electricity, transport and security may also influence the use of ICT. Radio and television, as the widest form of communication, provide one way of solving information dissemination. In addition to being used as effective ICT for development, radio and television should be considered and used as a means of educating the population on the benefits of ICT for development. Radio and Television programmes can be developed to educate women on various development issues, including the various uses of ICT, thus increasing awareness and knowledge of ICT's users. When possible, such programmes should be developed and conducted by women and their content should reflect a gender perspective. Lack of local and community related content in local languages continues to be a major barrier in women's use of ICT for economic empowerment. To make ICT more useful and meaningful, particularly for rural and poor women, relevant information and tools need to be provided to address women's needs and demands. Multimedia can be developed to provide information both in spoken and written language. The challenge is to develop content that is relevant and useful to communities in their own language.

ICT and Strategies for Women's Economic Empowerment

Understanding the challenges allow us to address the problems better and devise strategies that consider the complex dimension of women's lives. One of the strategies adopted to increase access of remote areas and marginalized groups to ICT is the development of public access centers, such as public phones, telecenters, libraries, information centres or cyber cafes. Telecenters can be part of existing institutions such as health centres, schools and community centres. The growth of cyber cafes and kiosks has been rapid in India, especially in the southern states where literacy is high. A survey in eight Indian cities has showed that nonworking women access the net 63% from cybercafes and 32% from home. A knowledge centre project of the M. S. Swaminathan Research Foundation in India has connected four villages in Pondicherry with practical local information in Tamil. This has proved useful in improving agricultural practices and marketing and access to medical facilities. To ensure that women take full advantage of these it is important to make the venue comfortable and safe. In many cases, the location of and arrangements around public access centers are decided without keeping the constraints on women in mind, such as inappropriate opening times [including evenings], security issues and lack of transport. Women's multiple roles and responsibilities may also limit the time available to use such facilities. Experience also shows that women are more comfortable in women only training environments. Training programmes should be offered free of charge or, in fact, be considered a 'job', in that participants are paid a certain salary as an incentive to participate and increase their education and qualification level. Content in local language is extremely important if ICT are to make a difference in women's lives. It is therefore, extremely important to develop content that addresses local/regional/national needs, to provide information relevant to local/regional/national issues and disseminate that information in appropriate language.

It is important to view ICT as a tool to meet women's development needs and accordingly all forms of ICT should be considered to determine which are more appropriate in a particular setting and for a particular programme. For example, women in the informal sector may decide that cellular phones are all that they need to improve their business, but may become more interested in the use of internet for business purposes once their businesses grow and they feel more comfortable with using technology (Banerjee and Mitter, 1998).

Ways forward

Beginning of ICT has changed the global scenario and many unexplored areas are now open for encashment. It is for us to utilize the benefits to the maximum possible extent. The best part about ICT is that it is capable of various adjustments as per the requirements of the segment using the same. The same can also be adjusted as per the needs and requirement of women. Hence it can be operated from every home irrespective of its location. This means that even the traditional and orthodox families can allow the women to participate and use ICT from their respective homes.

India there is an abundance of *"women entrepreneurs"* who are capable of making their mark at the global level. However, the awareness and facilities are missing drastically. The national policies and strategies have not yet considered this unexplored potential pool of intellectual inputs. With simple training and awareness programmes we can make a big difference. Further, we can also encourage the establishment of "Small and Medium Enterprises" (SMEs), Small Scale Industries (SSIs), etc. The need of the hour is to show a positive will to achieve that much needed purpose. Access and costs being some of the greatest barriers for ICT use, it is of the utmost importance to engage women and gender advocates in the policymaking process and dialogue. It is important to engender ICT policy to ensure that women, particularly rural and poor women, benefit from ICT.

Hence the question of where and how they can gain access to ICT becomes important. This is an area where intermediary organizations can help. They can ensure that email accounts, bulletin boards, search engines, mailing lists, and other useful functions serve as communication, networking and collaboration channels among women's groups, and between women and the external sphere. In order to facilitate access for women from other classes and sectors, these intermediary organizations need to be strategically located in local institutions to which women have open and equal accesses, such as health centers, women's NGOs, women's employment centres, libraries, women's studies departments and institutes, community centres etc.

The potential of ICT for women in developing countries is highly dependent upon their levels of technical skill and education and is the principal requirement for accessing knowledge from the global pool. Government and NGOs need to impart technical education on the use of ICT as a part of both formal and informal education system and to initiate distance learning and vocational courses. It needs to be realized that ICT by itself cannot answer all the problems facing women's development, but it does bring new information resources and can open new communication channels for marginalized communities.

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Women Empowerment through Gender Specific Government Schemes

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Gender:

Gender differs from biological sex in important ways. Our biological sex is a given; we are born either male or female. But the way in which we become masculine or feminine is a combination of these basic biological building blocks and the interpretation of our biology by our culture. Every society has different "scripts" for its members to follow as they lean to act out their feminine or masculine role, much as every society has its own language. From the time that we are tiny babies until we reach old age we learn about and practise the particular ways of being male and female that our society prescribes for us. Gender is a set of roles which like costumes or masks in the theatre communicate to other people that we are feminine or masculine. This set of particular behaviours, which embraces our appearance, dress, attitudes, personalities, and work both within and outside the household, sexuality, family commitments and so on--together make up our "gender roles".

We begin to learn our gender roles as soon as we are born. In one laboratory study of gender, mothers were invited to play with other people's babies who were dressed either as girls or boys. Not only did the perceived gender of the baby evoke different responses from the women, but the same behaviour of a baby was treated differently, depending on how it was dressed. When the baby was dressed as a boy, the women responded to the baby's initiatives with physical action and play. But when the same baby appeared as a girl and did the same things, the women soothed and comforted it. In other words, at only six months the children were already being responded to according to gender stereotypes.

Women Empowerment:

India is amongst the fastest growing countries in the world today, with a GDP growth rate of more than 8 % during the XI plan period. This high level of growth can, however, be sustained only when all sections of the society, specially women become equal partners in the development process. It is well recognised that societies which discriminate by gender tend to experience less rapid economic growth and poverty reduction than societies which treat men and women more equally. Gender equality and empowerment would, thus, need to be a core development goal if the growth planned in the XII plan has to be achieved.

Some deliberate policy steps are critical to achieve gender equality. Gender discrimination cannot be automatically corrected in the course of development. The institutions of economics, politics and the law must be considered in terms of how they relate to each other and how they play out across the different arenas where gender discrimination occurs; and gender assessments have to be undertaken continuously to reveal gaps and monitor progress towards gender equality. Empowerment of women is essentially the vehicle of change to achieve gender equality that is meaningful and sustainable.

Empowerment of women is a socio-political ideal, encompassing notions of dignity and equality, envisioned in relation to the wider framework of women's rights. It is a process of gaining control over self, over resources and over existing societal perceptions and attitudes and would be achieved only when an improvement in the 'condition' of women is accompanied by an advancement in their 'position' by enlarging the economic, social and political freedoms and choices available to them. The National Policy for the Empowerment of Women (2001) views empowerment as an enabling process that must lead to their economic as well as social transformation. Government has sought to operationalize this approach through legislative and programmatic interventions as well as by mainstreaming gender into the development planning process. Numerous such initiatives were taken during the Eleventh Plan period. These initiatives need to be consolidated and built on during the Twelfth Five Year Plan to enable women to challenge and change the contexts in which they live. Focussed efforts through development programmes, both multisectoral as well as targeted, along with governance reforms would be a pre-requisite. Women, especially the vulnerable and marginalized, would need to be provided a level playing field to access social, economic and legal entitlements as a right.

Gender Equality and Constitutional Commitments

India has pledged itself to gender equality through several Articles of the Constitution. The Constitution guarantees equality and equal protection in law for men and women (Article 14), prohibits discrimination on the grounds of religion, race, caste and sex or place of birth (Article 15) and discrimination at work place (Article 16). Article 15(3) empowers the State to adopt special measures for women and children; Article 16 (4) empowers the State to make provisions/reservation in employment for any backward class citizens who are not adequately represented in the services. It also provides for special measures to achieve equality. Article 39(a) articulates the duty to provide adequate means of livelihood equally for men and women. Article 39(d) mandates a policy providing equal pay for equal work for both men and women. Article 39(e) mandates that the policy of the State should be geared to protect the health of men, women and child workers. Article 39A directs the State to secure a legal system promoting justice on the basis of equal opportunity and to provide free legal aid for securing justice for its citizens. Article 41 ensures right to work, to education and to public assistance in cases of unemployment, old age and sickness, and in other cases of under -served needs. Article 42 provides for just and humane conditions of work and maternity relief. Article 43 mandates that the state shall secure to all workers a living wage, conditions of work ensuring a decent standard of life and full enjoyment of leisure and social and cultural opportunities. Article 51A (e) casts a duty on the State to renounce practices that are derogatory to the dignity and status of women. Article 51 (A) (k) casts an obligation on the parent/guardian to provide opportunities for education to his child/ward between the age of 6-14.

Over the years and particularly in the XI Plan period, numerous initiatives have been undertaken towards women's agency and empowerment. Significant progress has been made over the last Plan period in various development indicators. For example, Maternal Mortality Rate (MMR) has come down to 212 per 100,000 live births in 2009 from 301 in 2003, Infant Mortality Rates have reduced and are now 47 per 1000 (2011), fertility rates have lowered, there is an increase in school enrolment rates and the gender parity index at the primary level has improved. Institutional delivery has risen from 39 percent in 2006 to 78 percent in 20091, availability of HIV/AIDS treatment has been enhanced, gender gaps in wage rates are narrowing and women's participation in local governance has improved. With respect to strategic shifts in policy, the XI plan recognized women as a heterogeneous category for planned intervention, identifying diversity in castes, classes, communities, economic groups, geographic and development zones. It affirmed that mapping and acknowledging the specific deprivations which

arise from these multiple situations/ locations, can alone determine the success of planned interventions. The groups of women include, but are not restricted to the Dalits, tribal's, minorities, women with disability, migrant, displaced and trafficked women, women in the unorganized workforce, single women, especially widows, women subjected to exploitation, abuse and affected by violence, women infected and affected by HIV/AIDS, women in prisons and women in disturbed areas.

However, despite the achievements in the Eleventh Plan Period, a lot remains to be done in order to break the persisting vicious cycle of multiple deprivations faced by girls and women. Dedicated as well as cross-sectoral policy measures and schemes are necessary to halt gender discrimination and enable women to access their rights. The institutions of society, economics, politics and law have to be analysed in terms of how they relate to each other and how they play out across different arenas where gender discrimination occurs; and gender assessments have to be undertaken continuously to reveal gaps and monitor progress towards gender equality. Gender equality and empowerment should thus be a core development goal in order to achieve the growth planned in the XII plan in a sustainable and inclusive manner.

The National Policy for the Empowerment of Women, 2001 views empowerment as an enabling process that must lead to their economic as well as social transformation. Government has sought to operationalize this approach through legislative and programmatic interventions as well as by mainstreaming gender into the development planning process. Numerous such initiatives were taken during the Eleventh Plan period. These initiatives need to be consolidated and built on during the Twelfth Five Year Plan to enable women to challenge and change the contexts in which they live.

Programmes/ Schemes of the Ministry of Women and Child Development

Schemes for strengthening women's agency and empowerment have evolved over successive plan periods. These broadly aimed at fortifying women's agency and economic empowerment; providing social support to women in difficult circumstances and encouraging their social empowerment and schemes for advocacy and capacity building on gender issues. The existing schemes of the Ministry are proposed to be continued with increased reach and revamp wherever required. Scheme wise details are given below:-

A. Schemes related to Economic Empowerment of Women

Support to Training and Employment Program (STEP):

The Support to Training and Employment Programme for Women (STEP) is implemented as a Central Sector Scheme mostly through NGOs. The scheme has been in existence since 1986-87 and aims at sustainable employment and income generation for marginalized and asset less rural and urban women. The guidelines of the scheme were revised in 2009 and the Programme Implementation Manual has been issued. The key strategies for achieving the goal of livelihood opportunities for women, especially those in SC/ST households and families below poverty line, include training for skill up gradation, facilitating organization of women into viable cooperative groups, strengthening backward and forward linkages and providing access to credit. The ten traditional sectors identified for project funding under STEP include agriculture, animal husbandry, dairying, fisheries, handlooms, handicrafts, Khadi and Village Industries, sericulture, waste land development and social forestry. The scope and coverage of the scheme have been broadened with introduction of locally appropriate sectors identified and incorporated in consultation with State/UT Governments. In the XI

Plan, 1, 60,560 beneficiaries were covered under the STEP scheme.

Based on the evaluation conducted in 2007, the scheme has been revised in 2009 to include training in accordance with market demand, enhancement of beneficiary norms and establishment of credit linkages with the RMK, NABARD, CAPART and other financial institutions. It is proposed to link the STEP Scheme with vocational courses under National Skill Development Programme in order to increase employability of the trained SHG members under STEP. This would be a gradual process and the same would depend upon availability of vocational courses and facilities in the STEP project areas and the sectors covered under STEP.

Working Women Hostels

The Government of India introduced the Central Sector scheme of Working Women's Hostels in 1972-73 where grant-in-aid for construction of new or for expansion of existing buildings to provide hostel facilities to working women in cities, smaller towns and also in rural areas is provided to eligible categories. So far, 891 hostels have been sanctioned under the scheme since its inception with a sanctioned capacity of about 66,299 women and 8532 children in 323 Day Care Centres.

Based on an evaluation of the existing scheme and suggestions received from the Parliamentary Standing Committee on Empowerment of Women, the scheme has been revised. Under the revised scheme, apart from the provision of extending financial assistance for the construction of hostel building on public land, new components of grants-in-aid for maintenance, furnishing of hostel and cost of rent of the hostels running in rented buildings have also been envisaged. Financial assistance can be availed by the State Government agencies including Women Development Corporations, Women Finance Corporation etc., Urban Municipal Bodies, Panchayati Raj Institutions, and Self Help Groups etc.

Priyadarshini

The Ministry is administering the IFAD assisted pilot project since December 2009 as a central sector scheme namely Women's Empowerment and Livelihoods Programme in Mid Gangetic Plains 'Priyadarshini' in 13 Blocks spread over 5 Districts in Uttar Pradesh and 2 Districts in Bihar. The programme aims at holistic empowerment of vulnerable groups of women and adolescent girls in the project area through formation of women's Self Help Groups and promotion of improved livelihood opportunities. Over 1, 00,000 households are to be covered under the project and 7,200 SHGs would be formed during the project period ending 2016-17. The project has been rolled out in the field from April, 2011.

Swayamsidha

The Ministry launched the Swayamsidha scheme in 650 blocks across the country in 2000-2001 as an integrated scheme for women's empowerment through the formation of Self Help Groups (SHGs). The programme was implemented through the State Governments. 69,803 SHGs were formed against a target of 65000 with 10.02 lakh beneficiaries. 56% SHGs have availed of bank loans and 85% are involved in income generating activities. The Swayamsidha programme proved to be very successful in building the capacity of women SHGs and this forms the basis for the evolving approach in the Twelfth Plan.

National Mission for Empowerment of Women (NMEW)

The Ministry launched the **National Mission for Empowerment of Women** on March 8, 2010 **w**ith the specific objective of ensuring convergence and better coordination among the schemes/programmes of various Ministries/Departments. The role of the National Mission for Empowerment of Women is to provide a strong impetus for reform by catalyzing the existing system and ensuring better coordination and convergence of all development programmes that impact women. The mission will work to achieve convergence at all levels of governance and, in close collaboration with grassroots structures, enable participatory approaches and processes. Among the various initiatives that have been planned, a new model of delivery i.e. the 'Convergence Model' has been launched in District Pali, Rajasthan and is proposed to be started in another 31 districts of the country. Recommendations to bridge the gap between demand and supply of services include scientifically estimating demand, bringing greater awareness about women based schemes and programmes, augmenting demand for various services/schemes for women and connecting women with service providers (existing Government departments/ministries). The model will include introduction of convergence cum facilitation centers for women at the district, ward, tehsil/block and village levels. The approved outlay for the convergence model for the mission for 2 years was Rs. 141 cr. On the completion of 2 years, continuation and expansion of the activities of the Mission in the XII Plan would be decided after an evaluation is conducted.

B. Schemes related to Social Security of Women

Ujjawala-A comprehensive scheme for prevention of trafficking and rescue, rehabilitation and re-integration of victims of trafficking for commercial sexual exploitation

MWCD is implementing Ujjawala, a comprehensive scheme to prevent and combat trafficking. The scheme has five components viz. Prevention, Rescue, Rehabilitation, Re-Integration and Repatriation. Implementation of the Scheme started in December 2007. Till now 160 Projects with 79 Protective and Rehabilitation Homes have been sanctioned. The issue of trafficking for commercial sexual exploitation is a continuing concern and further initiatives are required to address the problem. The scheme is, therefore, proposed to be continued.

Swadhar Greh Scheme

Swadhar–A Scheme for Women in Difficult Circumstances was launched by the Department of Women and Child Development in 2001-02. Under the Scheme, temporary accommodation, maintenance and rehabilitative services are provided to women and girls rendered homeless due to family discord, crime, violence, mental stress, social ostracism or those who are forced into sex work. Another scheme with a similar objectives/target group namely Short Stay Home (SSH) is also being implemented by Central Social Welfare Board.

To assess the performance of both the schemes - Swadhar and Short Stay Home, an evaluation study was conducted by Centre for Market Research and Social Development, New Delhi in the year 2007. The evaluation report, while commenting positively on the effectiveness and positive impact of the schemes, observed that the profile of inmates, admission procedure, components of the scheme (counselling, vocational training, rehabilitation) and follow up procedure are almost similar in both schemes. The evaluation study recommended merger of both the schemes for better functioning and reduced administrative burden. The Department Related Parliamentary Standing Committee also

recommended the same. Therefore the two existing schemes i.e. Swadhar and Short Stay Home are proposed to be merged into a new scheme "Swadhar Greh" with revised financial norms. The proposed scheme is expected to cover all districts of the country.

C. Autonomous Bodies under MWCD

Central Social Welfare Board (CSWB)

Central Social Welfare Board (CSWB) was set up in 1953 with the objective of promoting social welfare activities and implementing welfare programmes for women, children and the differently abled through voluntary organizations. It is a fully funded autonomous organisation of the Ministry. The fund requirement for General Grants-in-aid to meet the establishment costs of the CSWB, 33 State Boards and Field Office Establishments is proposed during the XII Plan period.

CSWB implements various schemes providing assistance to the needy, destitute and disadvantaged women and children. CSWB's financial assistance to various voluntary organisations is provided on the recommendations from the State Boards. Following are the schemes of CSWB.

a) **Integrated Scheme for Women's Empowerment for North East Region (CSWB)**

The Integrated Scheme for Women's Empowerment for North East has been designed to address the socio- economic needs of the region for empowerment of women and the development of children.

b) **Condensed Courses of Education for Women (CSWB)**

The scheme was initiated for providing education to adolescent girls/women who are school drop outs, who did not have opportunity of joining a formal system of education (primary/middle/matric level) or those who did not receive skill development training. The scheme of Condensed Courses of Education implemented by the CSWB complements the programmes of Ministry of Human Resource Development in imparting literacy to women and girls. The scheme provides certification for the primary/middle/metric level courses, thereby increasing the employability of beneficiaries. Under the current guidelines the budgetary requirement for the XII Plan would be Rs. 45 crore. However, it is proposed to revise the norms under the scheme to be realistic and effective in the current context.

c) **Awareness Generation Projects for Rural and Poor Women (CSWB)**

The scheme has been formulated for awareness generation and advocacy on issues and concerns of rural and poor women. Under the scheme, camps are organized in the community to generate awareness on issues relating to status, legal rights, problems of women and other social issues; to create an enabling environment for effective participation of women in decision making processes; and for asserting their social, economic and political rights. An evaluation of the scheme is proposed to be undertaken, and based on the recommendations, the scheme would be revised.

d) **Family Counselling Centres (CSWB)**

The scheme of Family Counselling Centres (FCC) was introduced in 1983 with a view to provide counselling, referral and rehabilitative services to women and children who are victims of atrocities, family maladjustment, social ostracism, natural disasters, etc.Family Counselling Centres have been recognised as service providers under the Protection of Women against Domestic Violence Act in several States. Moreover, in some States, Counsellors have been designated as Protection Officers. In

view of its continuing relevance, the scheme is proposed to be continued in the XII Plan. The scheme, which has 787 FCCs at present, is yet to cover all districts. The honorarium of the Counsellors is also proposed to be reviewed.

Rashtriya Mahila Kosh (RMK)

Rashtriya Mahila Kosh an autonomous organization under the Ministry of Women and Child Development was set up as a Society in 1993 as the National Credit Fund for Women to extend micro-credit to poor and marginalized women on easy terms. The initial corpus of Rs 31 crore was increased with additional allocation of Rs.10 crore in 2006-07, Rs.12 crore in 2007-08, Rs.31 crore in 2008-09 and Rs.16 crore in 2009-10, taking the principal corpus to Rs.100 crore. The Governing Board of RMK has taken a decision to restructure and strengthen RMK and convert RMK from the existing society mode to a Government owned, Non-Banking Finance Company (NBFC-ND-SI) u/s 617 of the Companies Act, with a Pan-India office network backed by need based capital. The process for restructuring and expansion of RMK has been initiated, and this should be carried forward in the XII Plan.

National Commission for Women

The National Commission for Women was set up in the year 1992 as a statutory body at the national level to protect and safeguard the rights of women. The mandate of the National Commission for Women, among other things, includes reviewing from time to time, the existing provisions of the Constitution and other laws that affect women and recommend amendments accordingly so as to suggest remedial legislative measures, taking up cases of violations of the provisions of the Constitution and of the other laws relating to women with appropriate authorities, looking into complaints and undertaking *suo moto* notice in matters related to deprivation of rights of women. The Commission also calls for special studies or investigations into specific problems arising out of discrimination and atrocities against women and also undertakes promotional and educational research. One of the important functions of the Commission is to participate and advise on the planning process for socio-economic development of women. The State Women's Commissions are constituted by the States under their respective State legislations.

Concluding observations:

Gender inequality has been an issue since time immemorial and programs/schemes are initiated and implemented time to time for women empowerment. Status of women in our society is changing slowly but on upright mode through these governments sponsored programs and schemes. More concrete and focused efforts are required in this direction till women are empowered and provided desired role and status in the society. However, it is important to understand that it is not the program or the schemes or laws which will do the wonder, but it is the people's mentality and willingness for women empowerment. Finally concluding the chapter with famous quote of Roseanne Barr "*The thing women have yet to learn is nobody gives you power. You just take it*."

Integrated Insect Pest Management for Enhancing farm Productivity: A Gender Prospective

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Introduction

Integrated Pest Management (IPM) was initially initiated to manage few invertebrate pests in agricultural environment in fifties. In the present context, the significance of IPM increased manifold not only to produce more and more food to feed ever growing population but also to save the environment from indiscriminate use of hazardous chemicals applied in the agricultural crops to save them. IPM is innovative pest management strategies that can be operated in diversified and complex agricultural environment by amalgamation of as many elements to enhance the efficiency of the control success. It is a technology for improving food production, resource management and sustainability. First of all, IPM was initiated for managing rice pests then other crop like cotton and vegetables. The role of women in IPM is very limited, though they are considered half of the humanity and a shaping force in society. Nowadays, "Gender analysis" is recognised by many institutions as an important aspect for design, implementation and evaluation of development projects. Gender analysis is the way of male and female roles interact with research or project goals and outcomes. The focus of gender analysis is less on equity for women and more on the effectiveness and efficiency of development activities. But recently, it has been noticed that discrimination against women is being eliminated in the society. This consciousness not only eliminates all forms of discriminations by the farmers themselves in the IPM community but will prevent farm women from all forms of social, political, economical as well as cultural dehumanisation.
In this communication, author tried to explore and describe the current role of women in IPM. Since the global problem is to produce safer food, reduction of chemicals in pest management and integration of biological, eco-friendly and need based pest management strategies for sustainable agriculture and safe environment.

Integrated Pest Management (IPM) in brief

What is IPM?

Integrated Pest Management is an ecological approach that suppresses the pest populations without harming biodiversity, environment, natural resource and health of human being by combining several strategies to achieve long term solution.

“IPM emphasizes the growth of healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO, 2002)."

Why IPM:

- Loss of crop at the tune of 18% and above
- Intensive agriculture
- Lack of awareness
- Environment friendly and ecologically viable strategies

Components of IPM:

A. Cultural Methods:

- Clean cultivation
- Deep summer ploughing of solarisation
- Crop rotation
- Intercropping
- Proper spacing
- Balanced fertilizers
- Need based irrigation
- Trap crop

B. Mechanical and Physical Methods:

- Roughing out infectious plants
- Collection and destruction of eggs/pupae/larvae of pests

C. Biological Methods:

A. Bioagents:

- Predators
- Parasites
- Pathogens

B. Botanicals:

- Neem/Karanj cake for soil borne pests e.g. nematodes
- Spray of Neem Seed Kernel Extract(NSKE)?Neem oil as anti-feed ant/pest repellent

C. Chemicals:

Status of women in farmer's community:

Gender based discrimination in the farmer's community is invisible phenomenon that cannot be recognised easily because they have been accepted by farmers men and women and it has already socialized for long time therefore is believed as natural. However, gender relation between male farmers and female farmers basically is socially constructed. These relations are basically determined relations that differentiate male and female farmer's situations and also structuring and influencing the relation between male and female in agriculture such as division of labour and control over agriculture resources. Most of the farm women are getting fewer wages than men in the Bihar. This type disparity is prevalence in many part of the country. Besides gender discrimination, women are also facing social problems like responsibilities at home that restrict their participation in training programmes. Secondly, the dominant ethnic groups also restrict women's movement outside their home, their participation in IPM programmes and other agricultural programmes organised by state departments. To attend such training programmes, women need to get family support to do so. Whereas, men whether join the programmes or not is more an individual decision. Unknowingly, many newer technologies including IPM, favour male farmers and against female farmers as gender in the farmers community. Though, several IPM training programmes and others are being organised to integrate women farmers have not resulted effective change. Secondly, the technical programmes have limited contents may not interest of women participants.

Need of women participation in IPM:

The indigenous knowledge of pest management is often gendered. It has been observed that the women labour and labour share increased during last 25 years in agriculture. Some field work like paddy transplanting, weeding, harvesting etc. are domain of female workers. Women are doing wide range of field tasks on family farms. Nowadays, women are no longer secondary worker in small scale and marginal agriculture particular in Bihar state. Now, women are taking active part in pest management activities and applying management strategies for managing pests in their field crops whereas a decade ago, they did not doing such activities. Even women are handling pesticides very carefully and having great exposure levels than men, even where they do not spray. Women are capable to take decision in purchasing pesticides as per their budget. In present scenario, the organic farming is coming in big way. In this system of farming women are playing major role in implementing the organic methodology. Keeping view, women may be targeted for exposure to IPM.

Requirement for gender participations:

Policy as well attitude against women participation need be changed. Moreover, every farmer man and woman as well as all persons involved in IPM network should agree to eliminate gender equality and discrimination. It requires integration of gender into IPM structure and mechanism. Recently, the FAO has provided sufficient resources to make it possible for gender mainstreaming to take place in the IPM network. Secondly, there has been support and enthusiasm among the farmers themselves to conduct gender training, gender data collection and to build gender information system through participatory approach.

Participatory approach in integration of gender in IPM:

Integration of gender in IPM is basically long-term and process oriented activity. Following points are essential for integrating gender in development programme:

- Integrating gender into development programme cannot induced from out side
- Integrating gender into a programme requires process led by both men and women farmers themselves
- Integrating gender perspective in programme requires political will and leadership of the programme
- Capacity building is essential for integration
- Building of farmers women crisis centre managed by farmers

Conclusion:

Gender has a major role to play in IPM because farm women worker's percentage is increasing day by day. Particularly in Bihar where mostly men go out to earn livelihood and women are looking after farm business. All activities related to farm like sowing, irrigation, weeding, application fertilizers and pesticides etc. are carried out by women. Farm women have a high level of knowledge of pesticides health impacts, perhaps due to their role as health caretakers in the household. But the limited information on the role of women in IPM is available. The interviewed of farm women revealed some constraints like social, cultural and house responsibilities restrict the participation in training programmes whereas for men, it is his individual decision whether join or not. Secondly, ethnic groups dominated society is also restrict the women's movement outside their home. Therefore, women need family support to take part in training programmes.

Another major constraint for women of developing countries like India is educational attainment because generally all the newer agricultural technologies are knowledge intensive that favours educated and skilled farm women. It is therefore imperative to attain education to understand newer technologies like IPM. Whenever, we talk about 'farmer' means 'man' so all the programmes have been impacted to male farmers then female farmers. Therefore, many agriculture programmes have been in favour of male farmers as gender and against women farmers as gender in the farmer's community including with IPM network. There is need a special programme that look after interest of female farmers.

Modern Conservation Techniques for Empowering Women: Problems and Prospects

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Indian Agriculture has transformed from livelihood to commercial farming. Day-by- day the farming scenario is fast changing. The task of keeping pace with population growth is strenuous and challenging. Declining per capita land and water availability, reduced diversion of water for agriculture to meet the food requirement of ever increasing population coupled with degrading water resources are a serious challenge towards improving productivity and sustainability. The pressures on natural resources are immense: soils are less able to sustain crops as a result of continuous and intensive cropping and reduced organic matter levels. Tillage costs are rising, which accentuates the already serious labor shortages during peak periods of land preparation and harvest. For these and other reasons, the sustainability of these systems is in question. Improved tillage and crop establishment practices, especially for rice, show real potential for sustainably improving the productivity and profitability of rice-wheat systems. Efforts are being made to enhance production of rice and wheat up to 8-10 tons per hectare annually through residue management. When burnt during land preparation, the residues instantly generate as much as 13 tons of carbon dioxide per hectare, contaminating the air, depriving soils of organic matter, and constraining supplies of fodder for livestock.

Conservation Agriculture (CA) removes the emphasis on tillage and addresses an enhanced concept of the complete agricultural system; it involves major changes in many aspects of the farm cropping operation. Conservation agriculture includes Resource conservation technologies (RCTs) but is better defined as crop management that minimizes soil disturbance, maintains residue mulch on the soil surface and uses rotations to control various biotic stresses. Appropriate RCTs encompass innovative crop production systems that combine the objectives such as dramatic reductions in tillage with an ultimate goal to achieve zero till or controlled till seeding for all crops in a cropping system if feasible, rational retention of adequate levels of crop residues on the soil surface to arrest run-off and control erosion; improve water infiltration and reduce evaporation; increase soil organic matter and other biological activity to enhance land and water productivity on sustainable basis, identification of suitable crop rotations in cropping system and crop diversification and intensification to boost food security, incomes and overall livelihood security. RCTs are also defined as any technology that uses natural resources more efficiently and saves input for food production. Globally, CA has emerged as a way for sustainable intensive crop production system. About 120 m ha of land is cultivated world-wide based on the concept of CA. However; the area under CA in Eastern region is very limited.

Eastern region of India has been focused for second Green Revolution so as to meet out the ever increasing demand of food in the country. However, it is possible only through improving the soil health, minimizing the impact of biotic stresses, increasing the water productivity, development of suitable varieties and integrated approach of land use. Conservation agriculture, therefore, is need of the hour, particularly in Eastern region.

Activities on Modern Conservation Techniques through Resource Conserving Technologies in Eastern Indo-Gangetic Plains

The resource conservation technologies were assessed, refined, demonstrated, validated and adopted on a large scale at farmers' field in participatory mode in Eastern Indo-Gangetic Plains (EIGP). National Agricultural Research System (NARS) is at the forefront of this work and because it is done with farmers in their fields, adoption is accelerated and up-scaled. Indian Council of Agricultural Research (ICAR), Rice Wheat Consortium, CIMMYT and IRRI encouraged the State Agricultural Universities, State Governments, NGOs, the private sector and extension agencies to test and adapt these approaches and feature them in rural development strategies. The state governments were convinced for subsidy on RCTs machines and service providers were trained.

The resource conserving technologies like zero till direct seeded rice (ZTDSR), direct sowing of rice in puddled field through drum seeder, use of leaf colour chart (LCC) for N management, brown manuring of *Sesbania* in rice, bed planted rice and wheat, double zero tillage in rice – wheat system, surface seeding, residue management, bed planted maize, bed planted potato, ZT lentil/ gram, crop diversification, inclusion of summer pulses after rice – wheat for crop intensification and laser aided land levelling for increasing land and water productivity were, tested, evaluated, authenticated and up-scaled.

Resource Conserving Technologies during Kharif season

Direct seeded zero tillage rice

Zero Till (ZT) drill machine opens a narrow slit in fields and plants 11 rows of crop at 20-cm distance in one pass. Eleven row zero-Till Drill takes forty five minutes for sowing in one acre area. On average HP 35-45 tractors are used. Now seed metering is introduced for seeding of different crops. To control the seed rate and fertilizer, machine is calibrated before sowing.

Direct dry seeding in rice has advantage of faster and easier planting, reduced labor requirement and drudgery with earlier crop maturity by 10-15 days, better efficient water use and high tolerance of water deficit, less methane emission and higher income due to less cost of production (Balasubramanian and Hill, 2002). Various technologies were developed, evaluated and up scaled with different combinations of component technologies like zero till direct seeded rice (ZTDSR) with uses of herbicides, direct sowing of rice in puddled field through drum seeder. Performance of ZTDSR in south and north of Bihar namely, Patna, Vaishali district is presented in Table 1.

Table 1. Performance of ZTDSR in canal command area of Bihar (2005).

District	No. of sites	Grain yield (t/ha)		Remarks
		ZTDSR	Puddled Transplanted	
Patna	29	5.3	5.6	Saving of Rs. 4,000/ha in crop establishment and fertilizer.
Vaishali	08	3.7	2.9	Sodicity affected lands


Direct sown rice crop through ZT Drill till machine

Nitrogen management through organic sources

Farmers participatory trials were conducted to evaluate the nitrogen saving and yield gain in HYV rice by second generation resource conservation technologies (RCTs) through the use of brown manuring of *Sesbania* and leaf color chart (LCC) in continuous growing rice-wheat cropping system of Indo-Gangetic plains. Brown manuring practice was introduced where both rice and Sesbania crops @ 20 kg/ha were seeded together and allowed to grow for 30 days. Sesbania crops were knocked down by herbicide after 30 days when it is tender and succulent so as to get maximum response and makes N available immediately after application. It was dried by spraying 2, 4-D ethyleaster @ 800 g a.i. /ha dissolved in 800-liter water. Weed population was also reduced by nearly half without any adverse effect on rice yield. Farmers found that there was less-incidence of pests due to the brown manuring. Besides organic matter, other recycled nutrients were added to the soil. The soil organic carbon was increased by 0.03–0.05 per cent due to brown manuring (Table-2). More response in sodic land was found.

Nitrogen management through Leaf Colour Chart (LCC)

Excess N use (110 – 150 kg/ha) through urea is a common practice in rice – wheat system against recommended dose of 80 – 100 kg/ha. LCC helped farmers to measure the leaf color intensity, which is directly related to leaf chlorophyll content and leaf nitrogen status. The timings of nitrogen top dressing can be easily determined based on soil N supply and crop demand. This simple tool helped farmers to reduce the excess use of nitrogen fertilizers. The use of LCC and brown manuring through *Sesbania* could save the nitrogen use through chemical fertilizer in rice crop, which ultimately saved the resource of the farmers and there was increase in yield also. There was saving of 42 kg N/ha due to LCC and 36 kg N/ha due to *Sesbania* co-culture (Table 2). More saving up to 60 kg was found in irrigated canal area.

Table 2. Resource Conservation for N management under RW system of south Bihar in alluvial soils (mean of 5 years – 2004-2008)

Treatment	N use by urea (kg/ha)	Yield (t/ha)	N saving by BM/ LCC (kg/ha)	Net gains over control (Rs./ha)	Dry matter added by BM (t/ha)	Status of soil OC (%)	
						Initial	After
LCC based N use	65	6.1	42	3,248	-	0.63	0.63
BM of *Sesbania*	75	6.3	36	3,733	1.75	0.63	0.68
BM of *Sesbania* + LCC based N	55	6.7	51	5,843	1.75	0.63	0.66
Control (110 – 150 kg N/ha) by urea	110	5.5	-	-	-	0.63	0.62

Pre-germinated rice sowing in puddled field through drum seeder

Plastic drum seeder is used to sow the pre-germinated seeds in thoroughly puddled land. Excess water is drained out before sowing, but soil surface must be kept moist. Rice seed should be pre-germinated (24 hours for proper germination). Care should be taken for shorter shoot. The sprouted seeds should be air dried for half an hour to facilitate separation of seeds before sowing. The sprouted seeds are filled in drum boxes (about 2/3 of the boxes). Around 1.5 acres can easily be sown by one person with steady speed walk. Irrigation is avoided for 3 - 4 days after sowing to allow the roots to anchor in the soil. In *kharif* season, immediate rainfall after seeding may wash away the sown seeds. The depth of irrigation water should be gradually increased with the seedling growth and complete submergence is avoided till the full establishment of the plant. Seed rates for coarse, medium and fine seeds are 30, 25 and 20 kg/ha, respectively. The performance was average in Patna and Vaishali districts of Bihar but farmers in Buxar area were enthusiastic due to better performance and resource saving (Table 3).

Table 3. Performance of drum seeder in canal & tube well command area of Bihar 2007

Districts	No. of sites	Yield (t/ha)			
		Drum seeder		Puddled rice	
		Grain yield	Straw yield	Grain yield	Straw yield
Patna	6	3.80	4.70	4.70	5.90
Buxar	15	4.50	5.90	4.20	5.70
Vaishali	11	3.70	5.45	4.42	5.56

Weed Management in direct seeded rice

Weed management

Both grasses and sedges were dominating weeds in rice. It was found that there was 50 % less weed infestation in ZTDSR as compared to Puddled Transplanted Rice (PTR). Probably it was due to effective weed control by pre-emergence herbicides and later on continuous submergence of field by canal water (Table 4).

Table 4. Effects of DSR on weeds in Patna

Rice practice	Dominating weed species	Weed dry weight at 25 DAS (g/m^2)	Remarks
ZTDSR	*Cyperus species*, *Echinochloa species*, Wild rice, *Kena* Species, Amrudi (broad leaf)	73.6	Effective control of weeds by pre-emergence herbicides and later on submergence in ZTDSR.
Puddled transplanted		156.3	

Different experiments were conducted by RWC in Bihar for effective control of weeds in ZTDSR. Use of chemical molecules (herbicides) is primarily used for weed management in direct seeded rice. Light ploughing is also used for removing the weeds. Surface mulch also reduced the weeds if it is retained in the field. The list of herbicides recommended for controlling weeds in direct seeded rice is given in Table 5.

Table 5. Herbicide use schedule in direct seeded rice (DSR)

Situation of plants and field	**Name of the herbicide**	**Time of application**	**Amount of active gradients per hectare**	**Affected weeds**
Before Sowing	Glyphosate	4-8 days before sowing	1.0 kg / 500 litres of water	Perennial weeds like *Cynodon dactylon* & *Cyperus rotundus* etc
	Paraquat	1-2 days before sowing	500 g/500 litres of water	Annual weeds
Immediately after sowing to control germination of weeds	Pendimethalin (Stomp)	Within 1-2 days of sowing in moist field at evening time	1.0 kg / 600 – 750 litres of water	For all germinating weeds
	Pretilachlor with Safner (Sofit/ Erase – N)	Within 1-2 days after sowing (*with wet soil moisture regimes for few days*)	500 g/600 litres of water	For all germinating weeds
Weed emergence after 20-25 days of sowing	Almix (Chlorimuron + Metsulfuron)	20- 30 days after sowing	4.0 g/600 litres of water	For broad leaves, sedges & for some time for *Cyperus spp.*
	Azim sulphuron	20- 30 days after sowing	30 g/600 litres of water	weeds including *Cyperus spp.* except grasses
For *Sesbania*	2,4 – D easter/ sodium salt	25 -30 days after sowing	500 – 750 g/ 600 litres of water	Broad leave weeds including *Sesbania*
Control of weed emergence after 20-25 days of sowing	Pendimethalin (Stomp)	Moist fields	500 – 600 g/ 600 - 7000 litres of water	All germinating weeds

Source: S.S. Singh and A. R. Khan (2008)

Economics of ZTDSR

There was a net saving of Rs. 6,800/ha in crop establishment due to zero till direct seeded rice (ZTDSR) as against the conventional puddled transplanted (PT). A saving of Rs. 320/ha per irrigation was also observed. Saving of 5-6 irrigations in drought year has saved around Rs. 6,240/ha (Table 6).

Table 6. Economics of DSR and puddled transplanted rice in south Bihar (2004)

S.N.	Practice	**Cost (Rs/ha)**	
		DSR/ZT	**PT**

1.	Four irrigations for nursery raising (500m^2)	00	800
2.	Nursery uprooting	00	600
3.	Field preparation (DSR & Puddled transplanted)	1600	3200
4.	Irrigation cost in puddling (40 hrs)	00	1600
5.	Puddling	00	1600
6.	Transplanting (40 labour)	00	1200
7.	Herbicide use	1400	00
8.	Weeding @ Rs. 30/labor for half day	1200	2000
	Total costs	4,200	11,000

Resource Conserving Technologies during Rabi season

Wheat cultivation by different RCTs methods: Different practices of RCTs sowing (equal row, paired row and control traffic), double zero till wheat and different zero till machines like double disc planter, rotary disc drill and eleven tynes zero till machines etc were used and crop was monitored throughout the season till harvesting. Double zero till wheat in the same field without ploughing after the harvest of zero till direct seeded rice (ZTDSR) were taken. Wheat crop was also sown in the presence of the residue of rice crop harvested in the month of November. The residue of rice was around 4.0 – 4.5 t/ha in manually harvested fields, added biomass in the soil and improve the soil properties (Khan and Singh, 2008).

Furrow irrigated raised beds (FIRBs) for planting wheat

Direct dry sowing using zero-till seed drill, and use of permanent Furrow Irrigated Raised Beds (FIRBs) for planting wheat can reduce the cost and saves time in land preparation. It also saves irrigation water for the crop growth. Field trials were conducted in participatory mode using the RCTs like permanent FIRBs planting with two/three rows and zero tilled along with conventional sowing in clay loam soil and loamy soils to study the irrigation efficiency and economics of wheat production. Two/three irrigations were given in entire cropping period of wheat in this region. Furrow Irrigated Raised Beds (FIRBs) planting has resulted 10 –11q/ha higher wheat grain yield in north Bihar and 8.4 q/ha in south Bihar. Wheat with 02 rows on FIRBs was better yielder than 03 rows. Maximum gain of Rs. 8, 415/ha was found with 02 rows on FIRBs in north Bihar. Gain in south Bihar was comparatively less (Rs. 6,660/ha) due to low yield owing to the increased terminal heat (hot wind) at milking stage during March (Table 7).

Table 7. Effect of FIRB planting on yield and economics of wheat (average of 10 farmers fields)

Treatment	Yield (q/ha)		Yield gain over conventional (q/ha)		Total gain through saving in tillage, irrigation and additional yield (Rs. /ha)	
	North Bihar	South Bihar	North Bihar	South Bihar	North Bihar	South Bihar
FIRB planting with 02 row	38.5	26.4	11.0	8.4	8, 415	6,660
FIRB planting with 03 row	37.1	-	9.6	-	7,470	-
Conventional	27.5	18.0	-	-	-	-

Source: Singh, S.S *et al*. (2006)

Weed populations in wheat at varying ZT technologies

The weeds were reduced due to adoption of zero tillage or surface seeding over conventional practices. Minimum weed production was found in rotary disk drill sowing followed by paired row at 30 DAS. Weed in equal row was more than paired row. Maximum weed production was in conventional at all the stages of crop. (Fig. 1).

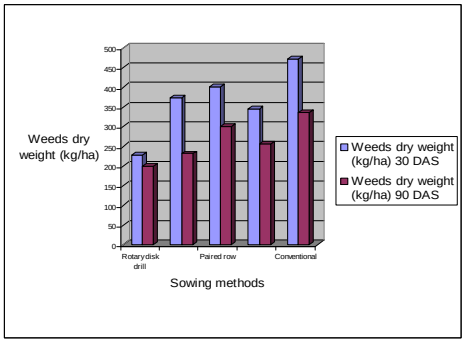

Fig 1. Weed population under varying zero tillage practices

Enhancing land and water productivity

Declining per capita fresh water availability is causing serious concern. Judicious use and management of water is imperative in ZT/RCTs to improve productivity of land and water for rational use of water. Adoption of RCTs/ZT (and now RCTs plus) has assured greater accelerated growth in EIGP. The productivity of water is enhanced by increasing the productivity per unit of process depletion (crop transpiration in agriculture) or other beneficial depletion, and by reallocation of water to higher-value uses.

Laser aided land leveling

Land leveling is one of the important issues for crop production in eastern IGP because most of the traditional leveled lands have 8-15 cm deviation in level which leads to poor water, nutrient and other input use efficiency resulting into reduction in crop productivity. In eastern IGP, irrigation to the crops is become very costly due to ever increasing energy prices and poor electricity supply. In Bihar 97 % irrigation pumps are operated through diesel. In a study conducted on effect of laser land leveling in different districts of Bihar revealed that average savings in cost of irrigation ranged from Rs 550 to Rs 1600 ha^{-1} in rice and Rs 700 to 2200 ha^{-1} in wheat due to laser assisted precision land leveling (Singh *et al.* 2010).

Dr. B.P. Bhatt, Director, ICAR-RCER and Scientists are discussing about Laser Level equipment with QRT members

As per studies, a significant (20-25%) amount of irrigation water is lost during its application at the farm due to poor farm designing and unevenness of the fields. Fields that are not level, have uneven crop stands, increased weed burden and uneven maturing of crops, poor input use efficiency. All these factors lead to reduced yield and poor grain quality. Under such situations laser land leveling proved beneficial in reducing cost and improving farm productivity, therefore laser land leveling is often quoted as precursor technology for resource conserving technologies or gateway of RCTs. The major benefits from Laser land leveling are;

(i) Reduces weed problems and improves weed control efficiency, (ii) improved efficiency of applied fertilizer and herbicides, (iii) approximately 35-45 % saving in irrigation water, (iv) reduction in salinity problems, (v) uniformed of crop maturity, (vi) improved crop establishment, (vii) approximately 4-5 % increase in cultivable area, (viii) easy farm operation due uniform tilth, (viii) increase crop yields by 10%.

The limitations of Laser Leveling are: High cost of the equipment/ laser instrument, need for skilled operator to set/ adjust laser settings and operate the tractor and more efficient for regularly sized and shaped field

Laser leveling reduces the unevenness of the field to about ±2 cm with a slope of 0 to 0.2 %, resulting in better water application and distribution efficiency, improved water productivity, increased fertilizer efficiency and reduced weed pressure. Savings of up to 50 percent in wheat and 68 percent in rice have been reported (Jat *et al.,* 2006). The use of laser leveler would help farmers to make better use of furrow irrigated bed planting system based intercropping.

Crop residue management

Crop residues can be recycled in soil by different methods, such as (i) in situ incorporation, (ii) in situ burning, (iii) application as surface mulch, (iv) through compositing and (v) use for biogas production.

In situ incorporation of crop residues:

Organic materials of different crops left after their harvest can be directly incorporated into the soil before sowing of the following crop. The period allowed for decomposition of the crop residues is important so as to ensure mineralization of nutrients. Decomposition of crop residues in soil, which depends upon carbon to nitrogen (C/N) ratio, also varies with soil properties, temperature and soil moisture regimes. Leguminous plant materials with narrow C/N ratio (< 30) decompose faster. About 40 % of carbon added though green manure has been found (Beri *et al.,* 1989) to get decomposed within 7-15 days. Cereal crop residues having wider C/N ratio (> 100) decompose rather slowly.

In situ burning of crop residues:

Large quantities of crop residues remain in the fields after mechanical harvesting of crops. Removal of mechanically harvested left over residues from the field is rather difficult. They can either be incorporated into the soil or burnt in situ.

Effects of Straw Burning & residue management

Burning of rice residues is a major source of air pollution in the region. Burning crop residues destroys organic matter and results in large nutrient losses. On average, all of the C, 90% of the N, 60% of the S, and 20–25% of the P and K in the rice straw are lost through burning.

On the other hand addition of crop residue on a long-term basis helps in improving physico-chemical and biological properties of the soil and can be expected to prove beneficial in improving soil productivity. It is only the wider C: N ratio of the material added that results in immobilization of nutrients and in lower crop yields under incorporation treatments

Impact of RCTs on Environment

1. Reducing the need for applying herbicides
2. Reducing the amount of N that "leaks" into the environment
3. Providing environmentally friendly options for managing crop residues
4. Reducing soil compaction
5. Bettering soil physical structure over time
6. Reduction in the production of CO_2, CO, SO_2.
7. Carbon sequestration helps in reducing CO_2 emissions significantly
8. Saving of 20-30% of water would also help to save 80 kWh of electricity & 160 kg of CO_2
9. It has been estimated that CO_2 equivalent emissions from a high input conventionally tilled cropping system with residue burning and organic amendments would equate 29 Mg $C0_{2\ per}$ year from one million hectare which will be reduced to emissions of 14 M g $CO_{2\ from}$ no-till residue retention system with low input from an equal area.
10. Under resource conserving agricultural practices, soil erosion is less than builds up resulting in soil growth of one mm/year due to accumulation of soil organic matter.
11. Adoption of zero tillage systems on one hectare of land would save up to 100 litres of diesel and approximately 1 million litres of irrigation water. Using a conversion factor of 2.6 kg of carbon dioxide per litre of diesel burned, this represents a quarter ton less emission per hectare of carbon dioxide, a principal contributor to global warming (Gupta *et. al.*, 2003).
12. Zero-tillage even on one million hectares of rice-wheat system area would save one billion cubic meters of water each year. About 100 million litres of saving in diesel every year will help reduce carbon dioxide emissions by 0.26 million tons every year. It also improves water productivity.

Livelihood Improvement

Evaluation and acceleration of RCTs and alternate livelihoods support systems through new institutional arrangement was found to improve various livelihoods indicators as described below:

Livelihood indicators / capitals	**Small farmers/ land owners/share croppers**
Financial	Resource saving in operation cost, irrigation and plant protection. More income due to resource saving
Human	Capacity building around new knowledge on seed treatment and RCTs. Better understanding of working around new crop management practices.
Natural	Water saving, improved physical and chemical properties of soil, reduced pest incidence, organic matter build up, use of residue for cultivation
Physical	Better institutional arrangement through new service delivery system on new practices.
Social	Reduced conflict in water management and increased social interaction

Problem faced by farmers

There are few problems in adopting RCTS (Table 8). Farmers are discouraged for bed planting because of higher cost of the machines and availability of *Sesbania* seed was the problem. In the use of LCC, they have to visit frequently to the field for taking observation and they are reluctant to adopt this practice.

Table 8. Farmers' opinion about problems of RCTs.

ZT Wheat	Bed planting wheat	Surface seeded wheat	Direct seeded rice (ZT)	Leaf colour chart (LCC based N management)	Green/brown manuring (*Sesbania* co-culture)	Potato maize inter crop
Presence of moisture	More time taking in land preparation	More pest problem	More weed infestation	Frequent visits to field	Seed availability	Suitable to uplands only
Timely non-availability of machine	High Cost of the machine	Less yield	Dependent on weather	-	-	Non-availability of bed planter
-	-	-	Not suitable to uplands	-	-	-

Service Providers

Different service providers were selected and trained at ICAR-RCER, Patna and were sent to different organizations through traveling workshop for their exposure of resource conserving technologies. Their activities have been continuously monitored and few third generation RCT machines were also provided. For diffusion of project impact and up-scaling of technologies, activities were taken with the help of service providers, SHG members, unemployed landless rural youths, marginal & progressive farmers, share croppers and interest groups on different aspects of RCTs and maintaining machines with component technology helped in up-scaling and diffusions of the technologies in the project area and in adjoining neighbor hoods. The service providers are the best ambassador for up-scaling resource conserving technologies in Eastern IGB.

Constraints and challenges in adopting RCTs

Proven benefits are achieved by the farmers through conservation agriculture based resource conserving technologies. In spite of the benefits these practices are not adopted by a wide range of farmers. However, the cost of equipments and herbicide often diminishes the attractiveness of CA adoption. In general, factors limits the adoption of RCTs are: availability of quality machines and spare parts , most of the third generation resource conserving machines needs more than 50 hp tractors, custom hiring is not very common, bullock ploughing is still in practice, though use of bullocks in farming is reduced drastically, small resource poor farmer face constraints in adopting CA due to financial constraints, service providers are lacking entrepreneurship, hardship in getting the Govt. subsidy by resource poor farmers due to mindsets of officials, use of herbicides for weed control is costly, and spurious materials are available in the market, weed control in direct seeded rice is a deterrent for wider adoption of this technology, attitude of the farmers in favour of puddled transplanted rice, time availability for ZTDSR is limited whereas puddled transplanted rice can be taken till the middle of August, due to rain, sowing through ZT direct seeded rice in time is difficult, pressing needs for feeding crop residue to livestock is a deterrent for conservation agriculture, farmers are using straw for their animal feed and for other uses, combined harvested field leaves the straw in the field

and farmers are compelled to burn it due to non-availability of turbo seeder for sowing with residue, mind set of farmers for intensive tillage and small and fragmented land holdings.

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Integrated livestock management for sustainable production system

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Feed and fodder production for livestock feeding is an important aspect for the sustainability of the system because agriculture and animal husbandry are complementary and not competitive to each other. The performance of livestock in the eastern region is not to the level of satisfaction due to faulty feeding practices. The feed resources are by and large the crop residues, fodder, agro by-products and some indigenous feeds. The farmers feed their livestock with available feed resources, which are not balanced in terms of protein and energy to meet the nutrient requirement leading to poor performance. Therefore, it is felt as need of the hour to explore the possibility of improved fodder production for feeding to livestock in better way. Livestock population, feed scenario, nutrition and some of the encouraging fodder production system and their feeding practices are discussed below for proper management and sustainability of the production system.

Scenario of Livestock and Feed

Eastern region of India has comprises from 176 districts of seven states (eastern UP, Bihar,, Jharkhand, Chhattisgarh, Odisha, West Bengal and Plane of Assam) of the country that belongs to eastern Himalayan, lower and middle Gangetic plains, eastern plateau and hills and east coast plans and hills region. The region having large numbers of total bovine population comprises of cattle 78.70, buffalo 20.00 and sheep/goat 55.96 million (Anon, 2007). The majority of livestock is indigenous type. However, the crossbred cattle are unevenly distributed with highest density in some pockets along the Ganges in the states of Bihar, West Bengal and Eastern UP and indigenous cattle are mostly concentrated in hilly and plateau region of Bihar, Jharkhand, Chhattisgarh and Odisha. Similarly, buffalo is mostly concentrated in the districts of Bihar and Eastern UP. The highest concentration of goat population is in the lower Gangetic plains of West Bengal and followed by Bihar and Odisha (Dey *et al. 2010)*. This large numbers of low productive animals, shortage of concentrate feed (84%) and green fodder (88%), low land holding, negligible area under fodder cultivation and poor husbandry practices with imbalance feeding in terms of total dry matter and nutrients intake are considered to be the main reasons for less production in the region.

Livestock Nutrition

Feeding animals as per the requirement and avoiding wastage is the key in exploiting the production potential of livestock for economic viability and sustainability since feed costs are the major part of production that accounts for 60-80 percent. Mostly livestock is to fed *in situ* the various available crop residues and forages with supplementation of concentrate feed as per production status. The large dairy animals are required dry matter @ 2.5kg/100kg body weight in which 60-80 percent should be supplied by green fodder and straw and remaining 20-40 percent should be supplied through concentrate feed. Hence, effective use of total feed resources by livestock is a definite means of increasing performance of animal per unit area of land. In many situations dietary protein and minerals are main limiting factor for most of the livestock and its requirement not meet from available roughages fed to them (Table 1). An growing calve (6-24 months age) will require to fed with concentrate feed having digestible crude protein (DCP) 16% and total digestible nutrients (TDN) 70% @ 1.5-2.0 percent of

body weight to maintain growth rate of 500g/day or above along with green fodder 15-20kg/day. The DCP & TDN requirement of dairy cow is given in Table 2. Similarly, goat will allow grazing for 6-8 hours daily or providing fodder @ 1.5-2.5 kg green fodder daily during stall feeding system in cut and carries method to ensure daily intake of DM and DCP @ 2.5-3.5kg and 120-130g per 100kg body weight, respectively. Otherwise, little supplementation of concentrate feed (CP 16% & TDN 65%) @ 100-200g/day/head will require depending upon production status (Ray, 1978).

Table 1: Nutritive values of forage based ration and intake in large ruminants

Particulars	Vol. Intake % of body weight	App. Nutritive value (%)		Remarks
		DCP	TDN	
Green cereal+legume forages	2.5	10-15	55-65	Maintenance + 5-6kg milk
Green cereal forages	2.0	3-6	50-55	Maintenance + 5-2kg milk
Cereal hay	1.5	1-3	40-50	Sub-maintenance
Straw	>1.5	0.5-1.0	>40	Sub-maintenance

Table 2: Nutrient requirement of dairy cow

Nutrients	ent requirement for maintenance of 450 kg body weight cow	tional nutrient requirement per kg milk with 4% fat
DCP	275g/day	45g
TDN	3.33kg/day	315g

Fodder Production & Feeding Management

The locally available native pasture are poor in nutritive value and majority of the cattle and goat of this region meet their nutrient requirement by grazing, but milch crossbred cattle get the fodder by cut and carry system. Hence, some promising and suitable fodder crops are identified on the basis of sustained yield of fodders (Table 3), fast coverage, adaptability in soil condition and more importantly palatability amongst different species of livestock for production in large scale to mitigate the gap. Similarly, incorporation of leguminous forages (15-20% in cereal fodder) that enrich the forages and make it balance in terms of nutrients would be right direction to achieve optimum production from ruminants (Gupta and Singh, 2010; Gupta *et al*. 2010). On the basis of above facts, a model has been developed for production of forages to meet the requirement of dairy cattle (Table 4). To maintain 10 crossbred lactating cow having 2800 – 3000 liter lactation yield, total 140 tonne green fodder of good quality will be require and for this 1.5ha area needed (Annon, 2011-12).

Table 3: Round the year fodder and nutrient yield

Particulars	Summer/rainy season (April-October)				Winter season (November-March)	
	Soybean (at 65 d)	Cow pea (at 65 d)	Rice bean (at 65 d)	Sudan (In 3 cuts at 70, 125 & 165 d)	Oat (In 2 cuts at 55 & 95 d)	Berseem (In 4 cuts at 45, 75, 100 & 125d)
Fodder yield (t/ha)	15.67	37.33	33.00	84.48	29.96	77.54
Fodder DM yield (t/ha)	3.99	6.52	5.51	13.44	3.55	8.99
Fodder protein yield (t/ha)	0.76	0.98	0.87	1.22	0.28	1.48
Grain yield (t/ha)	1.69	--	--	--	--	--
Grain protein yield (t/ha)	0.64	--	--	--	--	--
Total protein yield (t/ha)	1.40	0.98	0.87	1.22	0.28	1.48

Table 4: Feeds and fodder requirement per annum for 10 crossbred cow

Requirement		Production	
i. Green fodder for 240days @ 35kg/d/h	84 tone	i. 1ha area under Sudan & oat in relay system	105 tone
ii. Green fodder for lean season (125d) in form of silage or fresh	56 tone	ii. ½ha area under annual legume fodder for rice bean , soybean and/or cow pea in rainy season and berseem during winter	35 tone
or	Total = 140 tone		Total = 140 tone
Out-side support:			
Dry roughages (straw) @ 6kg/d/h & Concentrate feed @ 6kg/d/h	7.5 tone 22 tone		

Future strategies

It is evident from the above discussion that, the eastern agro eco-system is mostly constrained by non-availability of quality fodder resources to feed the livestock. But, it is also a fact that enormous potential are available in these eco-system to produce quality fodder, which can be utilized for feeding the livestock to decrease dependence on external inputs. Pasture based ruminant production in cut and carry method of feeding can be encouraged for the sustainability of the system and better on farm feed resource management. Potential legume forage can be produced for incorporation in the ration to reduce burden of concentrate feed input from outside the source up to some extent.

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Integrated farming system for livelihood security of women in water logged areas

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Agriculture in India supports several million poor people. India has a predominantly agrarian economy. 70% of its population is rural; of those households, 60% engage in agriculture as their main source of income. It has always been India's most important economic sector. Eastern states of India occupies about 22.5% geographical area and supports to 35% human and 28% livestock population, respectively. The region has about 2.73 million ha total water area constituting reservoirs, ponds, tanks, oxbow lakes and brackish water etc. besides rivers and canals. The production levels of agriculture, livestock and fisheries has remained low due mainly to lack of location specific production technologies, dissemination of scientific methods of cultivation, natural calamities like floods, water logging, droughts and social constraints. Although, average annual rainfall in India is slightly higher (~1200 mm) than the World average (~1000 mm), its distribution is temporally and spatially uneven. Entire rainfall in India occurs with fewer rainy days within a time span of few days, in fact within about 300 hours. The average rainfall in eastern region varies from 1091 to 2477 mm with a regional average of 1526 mm, which is sufficient and substantial for growing variety of crops. However, it has erratic annual and spatial distribution with considerable year-to-year variation.

Landforms, non- uniform and heavy rainfall during rainy season and congestion in drainage system cause the problem of water logging. In India the problem of water logging has been assessed from time to time. Water logging leads to salinity. When the water table rises up or if the plant roots happen to come within the capillary fringe, water is evaporated through capillarity. Thus, with the upward flow of water from the water table to the land surface during evaporation, the dissolved salts present in the water are carried to the surface resulting in deposition of salts in the root zone of crops, which eventually reduces the osmotic activity of the plants leaving the plants to fade away. Thus water logging and salinity may be treated as twin problem, which deserve special treatments based on the local conditions and soil texture, structure and topography. Livelihoods consist of the capabilities, assets – both material and social resources – and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, and provide net benefits to other livelihoods locally and more widely, both now and in the future, while not undermining the natural resource base. Livelihoods approach consists of livelihood assets and activities, vulnerability and coping strategies, policies, institutions and processes, and livelihood outcomes in relation to the full food supply system (production, processing, storage, transport and marketing).

Woman plays a vital role in livelihood security as women are the backbone of agricultural workforce. Women involved in animal husbandry, horticulture and poultry, post-harvesting operations, agro/social forestry, fishing etc. which are their main source of income and it is noticed that they always involved in labour and tolerance intensive works like transplantations and weeding operations. She does the most tedious and back-breaking tasks in agriculture, Women in India are major producers of food in terms of value, volume and number of hours worked. Nearly 63 percent of all economically active men are engaged in agriculture as compared to 78 per cent of women. Almost 50 percent of rural female workers are classified as agricultural labourers and 37% as cultivators. About 70 percent of farm work is

performed by women. National Research Centre on Women in Agriculture, under project on development and testing of extension methods for farmwomen in eastern India, studied the extent of participation of farm women in different farming systems and farm enterprises and the role of change agents in that context. Contrary to the situation at coastal tract the male extension agents maintained higher contacts with farmwomen than the lady extension agent. The studies under 'Identification and improvement of farming systems suited to farmwomen in Eastern India' project revealed that there is intense involvement of farm women in vegetable cultivation. Under the project Standardization of women specific field practices in rice in Orissa data were collected from women heads of 50 farm families on participation of women in relation to varying operations in rice cultivation. Women of family contributed highest hours per season (61.66) in harvesting and post harvesting operations and participated lowest in land preparation. Same pattern was observed from the paid women and total women (family + paid labour). Results of a study in Bangladesh showed that members of small farm households were engaged in all field based activities, while female members actively participated in home based income generating activities (IGA). Female persons play vital role especially in home based activities (Sobhan and Khondaker, 2001). Table shows that with enterprises combination of alternate FS, farmers themselves and their household women were involved in rearing poultry and livestock, kitchen gardening and sewing cloths for household use and nursery reforestation (Sadika et al.,2012).

Gender participation	Views of gender participation of selected farm households (%)							
	Poultry rearing	Cattle rearing	Milch cow rearing	Goat/ sheep rearing	Sewing	Vegetable production	Vegetable selling	Nursery Reforestation
Male	2	55	50	30	-	15	85	40
Female	98	45	50	70	100	85	15	60

Food security is a dynamic condition, which results from the interplay of multiple factors (Erickson 2007). It is a state when all people have access to sufficient and nutritious food to meet their dietary needs for life. Food and nutrition security is broadly characterized by three pillars: availability, accessibility, and absorption (nutritional outcomes).Green revolution of the seventies have made us self sufficient in food grain production today, but per capita availability of food grains is stagnant or slightly declining. Growth alone may not be able to ensure food security for the poor and vulnerable. Social safety net programs and employment-generating programs will play an important role in improving accessibility of food to the poor and vulnerable. Economic access to food by about a fourth of the population living below the poverty line is problematic, despite impressive economic growth in the recent years. The level of food absorption is also low. About 44% of children under the age of 5 are underweight, around half of pregnant women are anaemic, and the majority of women do not have access to toilet facilities and safe drinking water.

Taj Uddin and Takey (2006) reported that conventional farming could not generate needed employment opportunities for small farm households. By practicing integrated farming, unemployment decreased with the increases in farm size and the farmers had very few labour surplus compared to conventional farmers. An understanding of how integrated farming contributes to increase household income of the small farmers by improving their livelihood security might encourage policy makers to improve the socioeconomic condition of small farmers through implementing integrated farming. Again, farmers would have idea about how integrated farming contributes to improve livelihood security of the

household members under respective farming system. In order to empower and improve the women farmers' productivity, they need to have proper farm training and capacity building programs to compete various challenges in their rural livelihood. Women land ownership plays a major role in their credit worthiness, if they have right on the agriculture land they will have access to financial resources and savings. The farm labor wages should be the same without gender differences and the equal employment benefits have to be given in all rural schemes like NREG.

Integrated Farming Systems for livelihood security

Integrated farming system (IFS) is the viable option in order to achieve food and nutritional security at household level and even at individual level in flood prone areas. Such land use system could provide round the year employment to the farming family. IFS models have been developed for marginal farmers (area of 0.80 ha), inhabiting in lowland and midland irrigated ecosystems. Crop-livestock-fishery was integrated with allied enterprises like duck/ vermi composting/bee keeping. Cereal crops (*kharif* rice, followed by rabi wheat/maize/ lentil/mustard), fruits and vegetables were cultivated besides fish, duck and milch animal. The net monetary gain from such system was estimated to be Rs. 1, 80,500/- yr. Likewise, the model has been developed for small land holders (size- 0.40 ha) of midland situation. The major components were agri-horti crops, goat, poultry with allied enterprises like mushroom, vermicomposting and poultry. The monetary gain from such model was accounted for Rs. 99,591/-

Other successful IFS model is cultivation of makhana (*Euryale ferox*) with fish and water chestnut. It include cleaning of pond before emergence of makhana seedlings, removal of carnivorous fishes by application of mahua oil cake @ 2.5 t/ha, transplanting and gap filling of Makhana, making refuge area of 10 % of total water body area and integration of different carp fingerlings. Water chest nut is cultivated as a tertiary crop. The technology has a potential for adoption in 1.10 million ha of non-arable waterlogged areas in the country. Net income from integrated makhana based farming system ranges from `44, 686.0 to 51,216.0 per ha/yr whereas income from cultivation of makhana alone is worked out to be Rs.24, 367.0 to Rs. 29,153.0 per ha/yr.

Makhana rice cropping system in seasonally water logged areas

Makhana could be cultivated in a cropping system mode in water logged areas (> 0.60 m water depth). While 4-5 months are sufficient for Makhana cultivation, other crops could be cultivated successfully from the same piece of land. Makhana could be transplanted in the second week of April and harvested by the second week of August. Short duration varieties of rice could be cultivated thereafter.

Multiple water use system with Integrated Agriculture and Fishery

Medium deep waterlogged lands (0.5 – 1.0 m) can be modified in the form of a reservoir that can be used as a tool for multiple uses with high water and land productivity and profit. About 20 percent of farm area may be converted into a secondary reservoir upto 2 meter depth. The excavated soil is spread around the periphery to form a bund of 3-4 m width with crest level at least 50 cm above the peak water level to ensure water do not overtop the bunds. High value horticultural/ vegetable production on bunds utilizing seepage water with little supplemented water can produce good profit for the land, which was poorly utilized. In conjunction, good fish production can be achieved with water quality management through water routing for irrigation purposes The routed water containing good amount of nutrients as well as provide opportunity for applying water in the fields in correct amount and at appropriate time, which enhances yields and quality of agricultural produce. Ducks, poultry,

piggery, etc. are other components that can be added to have complementary benefits and increase water productivity.

Trenches-cum-raised bed system

Waterlogged areas with more than 1 m stagnant water can be use for this technology. Trenches in such areas can be excavated in such a way that excavated soil is filled in alternate strips to make bunds and raising a portion above highest flood level using excavated soil to cultivate vegetable or horticultural crops. Two types of models like meandering type simulating river condition and Island type simulating pond were developed. First model simulates the river flow conditions, in which trenches are made in meandering style, and water may be allowed to enter from one side with enough provision for protecting culturing fishes. The second simulates pond type conditions in which continuous trenches are excavated with island type of raised bed, which may provide enough security to any high value production on the beds, and fishes have access to continuous movement around the island. Banana with vegetables has been grown on the raised beds and composite fish culture in fish trenches. Net income from Trenches–cum raised bed system is about Rs.81000 per hectare per year. Fruit crops contributed 54 percent to the net income followed by fish (24%) and vegetables (22 %).

Pond based farming system

This technique has been devised to stabilize and enhance the productivity of coastal deep waterlogged areas where water logging is around 1.5 m to 2.0 m deep. This includes deep water rice in kharif + salt tolerant vegetables like watermelon, ladies finger, spinach, chilly in winter + on dyke vegetables, fruit + fish inside pond. The technology has been successfully implemented in representative deep waterlogged areas of Puri district, Orissa.

Summary

In the eastern states, out of 31.40 million ha of net sown area, about 10.0 million ha area is drought prone and 4.0 million ha area is flood prone, where sustainable agriculture is the major issue of concern. Lowest per capita income, large population of land less population, and about 116 million population surviving Below Poverty Line (BPL) also limits agricultural development in the eastern region to a great extent. Integrated farming system models in water logged areas besides location specific climate resilient agriculture systems should also needs to be propagated in order to achieve food and nutritional security besides livelihood improvement. Women in India are major producers of food in terms of value, volume and number of hours worked. An understanding of how integrated farming contributes to increase household income of the small farmers by improving their livelihood security might encourage policy makers to improve the socioeconomic condition of small farmers through implementing integrated farming. In order to empower and improve the women farmers' productivity, they need to have proper farm training and capacity building programs to compete various challenges in their rural livelihood. Promoting gender equality needs to become a key component in the fight against poverty and hunger. Giving women the same access as men to agricultural inputs, for example, could increase production on women's farms by 20 to 30 percent or between 2.5 and 4 percent at national level. Such production increase could reduce the number of undernourished people in the world by 12 to 17 percent, or 100 to 150 million people. By putting more income in the hands of women, increasing gender equality in agriculture would also improve health, nutrition and education outcomes for children. Such social benefits are particularly important as they help build human capital, which will contribute to long-term economic growth and effective climate change adaptation.

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Role of Agro-Advisory in Crop Production System

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Every living thing favours certain inter-related conditions of temperature, moisture and light. There are also extremes, beyond which, a given organism will not grow and within the range of these there is a climatic optimum. Amount and rate of growth in plants depend on difference between net and gross photosynthesis. Photosynthesis is the process in which complex compounds (carbohydrates) are formed. These compounds provide energy for growth and development. When water and nutrients are not limited, the temperature and light determine the rate and amount of crop growth. On the basis of this, the crop has been classified as those belonging to the tropical, subtropical, temperate and cool temperate regions of the world. Plants have different growth phases and each phase require a temperature range within which growth and development can take place. These are termed as the cardinal temperatures i.e. maximum, minimum and optimum. Cardinal temperatures for cool season cereals are 5 to 14 °C, 25 to 31 °C and 31 to 37 °C and for warm season cereals are 15 to 18 °C, 31 to 37 °C and 44 to 50 °C. Most of the plants show response to thermo-period and require alteration of low night temperature and high day temperature for successful growth and development. The plants require a certain degree of winter chilling before flowering and seed setting can take place within the growing period.

Temperature: Temperature provides working conditions for nearly all the plant functions and energy for some processes. Low Temperature and consequent snow and ice do not allow crop production in polar and tundra lands of the world. Shortness of frost-free season restricts crops in the sub-arctic area to quick-maturing vegetables and hardy-grains. Moving towards the equator temperature rises and frost-free season becomes longer and there is a greater diversity of crops. Some examples to show how the low temperature has restricted the crop produce in world are given below: - The mean summer temperature of 19^{o}C marks the approximate pole ward limit of the commercial production of corn. Sugar beets demanding moderate temperature are grown mainly where the mean summer temperature remains between 19 & 27^{o}C. The pole ward limit of cotton is marked by the line, representing the mean summer temperature of 25^{o}C and approximate frost-free season of 200 days. Crops, such as Bananas or Cacao, requiring uniformly high temperature are not grown outside the tropical zone. The warm Limits are generally less clearly defined, but are quite significant. Coffee requires year-around growing season of the tropics, but yields best, where the average month temperature is between 16 ^{o} and 27 ^{o}C. Many kinds of plants require a lowering of temperature to promote maturing or seed production. For example many deciduous fruit trees need a long frost-free period for growth but also require a period of dormancy brought in by the frost.

Moisture: Moisture also sets limits to agriculture. Every plant has a dry limit. This fact is indicated in the driest deserts, where without irrigation vegetation may be entirely absent. Requirement for moisture however differs greatly. Many grass species will grow under semi-arid conditions, whereas most of the growth requires humid conditions. There are also wet limits. For example cotton is not grown commercially in Tropical and sub-tropical areas, which have excessive rainfall during the maturing period.

Wind: Wind is an important weather element and both its direction and velocity are significant. The influences of wind are both local and regional. It influences the configuration and the distribution of plants in a region. It influences the plant life, both mechanically and physiologically. It influences on the higher slopes of the mountains wind effects the plant directly by increasing transpiration and the intake

of carbon dioxide and by causing several types of mechanical damages. Less significant effects are numerous, including the transporting of cold and heat waves, the moving of clouds and fogs and the changing of water, light and temperature conditions. Under natural conditions, wind increases transpiration. However, this increase is only up to a certain point, beyond which either it becomes constant or begins to fall. With the increasing velocity there is a greater increase in the transpiration than in stomatal transpiration. Wind increases the turbulence in the atmosphere, thus in greater photosynthesis rates. However, the increase in photosynthesis is again up to a certain wind speed, beyond which its rates become constant.

When the wind is hot, it accelerates the desiccation of the plants by replacing the humid air by dry air in the intercellular spaces. When the hot and dry winds blow at the time the cells are expanding and maturing it results in the dwarfing of plants. This is because the cells cannot attain full turgidity in the absence of optimal hydration and become fixed at subnormal sizes. When the developing shoots come under the influence of a strong wind pressure from a fixed direction, the normal form and position of the shoots is permanently deformed. Another severe injury to the plants caused by strong winds is lodging. This injury is commonest in crop plants, such as maize, wheat and sugarcane. Strong winds break the twigs and shed the fruits of many plants. Further, two crops and trees with shallow roots are often uprooted. Many trees, which bear comparatively big fruits, have preference for light winds. Crops grown on sandy soils in areas where strong winds prevail are damaged because of abrasion. When the plant cover is not thick, strong winds remove the dry soil so as to expose the root of the plants and kill them. The eroded material from one place becomes a hazard to the existence of small plants in places where it is deposited. This is because the deposited material sharply reduces the aeration around the roots of the plants. Winds which blow from closed seas and lakes do a lot of salt spraying on the wind ward coastal areas, making it impossible to grow crops which are sensitive to excessive salts.

Light: Light is essential to plant growth; without it, there will be no development of chlorophyll and no absorption of carbon dioxide. The duration and intensity of light, in addition influence the plant development, vegetative shapes and the production of leaves and flowers. Wheat provides an excellent example. It grows under many different combinations of climatic conditions, provided a frost-free period of 90 days exists and humidity is not too high during the maturing period.

Effects of climate on sowing, germination, growth, maturity, harvesting and storage.

The most important climatic elements, which are significant in crop production, are air and soil temperature, precipitation, wind and light. The significance of these, however, varies from stage to stage in the complete life cycle of the crops.

Sowing: Optimum temperature is required at the time sowing farm crops. Similarly if the soil is not in the proper moisture condition the sowing is affected. Light and wind have very little effect on sowing operation.

Germination: Temperature provides the working conditions for all plant functions and necessary energy for various metabolic processes. The germination of seeds requires specific range of temperature conditions. If the temperature is within this range, the germination will be maximum. The optimum ranges of temperature for most of the crop plants is 16-27 oC and below 4 oC seed of very few crops germinate. Excess or deficiency of moisture leads to defective germination. Germination is quick and maximum when the moisture is adequate. If it is excessive, anaerobic conditions will be created which are harmful for germination. If the moisture is less, physiological functions of the plant do not become active and seeds do not germinate for want of water. Wind and light have not direct effect on germination.

Growth: The limit of survival of living organisms on the earth is reported between -35^{o} to 75^{o}. However, the range of growth for most of agricultural plants is 5 to 45^{o}C. At temperature much below or above these limits, growth decreases rapidly.

Maturity: Below normal temperature and humidity, maturity is delayed and at high temperature desiccation of plants occurs and thus maturity will be hastened. Excessive rainfall, hailstorms may shatter the grains and may also affect the quality of the produce. Strong winds at the time of maturity may cause lodging shattering and shrivelling of the grains. Light has got little effect at the time of maturity.

Harvesting: Temperature has got a great bearing on the type and speed of harvesting by affecting the efficiency of manual labour as well as machinery. At high temperature and higher humidity, the plants are cut with a greater difficulty than when they are cut in drier weather. Light has indirect effect on harvesting. Strong winds hinder harvesting operation and also cause inconvenience in transporting the harvested produce.

Storage: Proper temperature and moisture affects the storage quality. The produce can be stored for a longer time if the storage has got low temperature and low humidity. High temperature and high humidity affects the produce and pest population inside the storage facility.

Weather Forecasting

Weather is one of the factors, which has great influence over the success and failure of agricultural crops. This natural force is beyond the control of man. Every year huge losses occur due to abnormal weather conditions. Although crop losses due to un favourable weather cannot be avoided completely, yet these can be minimised to a great extent by making adjustments appropriate to the expected weather conditions. Farmers need to be made aware about the abnormalities in weather parameters so that they can utilise the weather forecast more scientifically to reduce the magnitude of losses due to adverse weather conditions experienced during different growth phases of the crops. So there is a need to acquire the elementary knowledge of weather forecasting.

The weather forecast can be divided into three categories

1. Short Range Forecast
2. Medium Range Forecast
3. Long Range Forecast

Type of Forecast	Period of validity
Short Range Forecast	Up to 72 hours (3 days).
Medium Range Forecast	Beyond 3 days and up to 10 days
Long Range Forecast	Beyond 10 days i.e. (month or a season)

Observations to be required for weather forecasting:

Observations of atmospheric variables are fundamental to the study and understanding of the atmosphere.

- Surface observations of temperature, humidity, pressure, wind, visibility, clouds etc. are obtained by installing properly exposed instruments.
- Observations at various levels in the atmosphere are made by Radio/Radar tracking of hydrogen filled balloons carrying appropriate sensors. Radio sounding (Radiosonde) observations provide measurements of pressure, temperature, humidity and wind at various levels in the atmosphere.

- Satellite pictures can be received at any Meteorological Satellite Ground Receiving Stations. These pictures are used to determine the earth's surface temperature, surface humidity, cloud cover, cloud temperature and cloud height. The cloud pictures received at short intervals provide accurate information on the development and the movement of the clouds, their types, height, and temperature as well as wind speed.

Techniques of Weather Forecasting

There are different techniques utilised to forecast the future state of atmosphere. The basic techniques of weather forecasting are broadly classified as

1. Synoptic Techniques
2. Statistical Techniques
3. Numerical Weather Predictions (NWP)

1. **Synoptic Techniques:** In synoptic approach, a forecaster attempts to predict the future changes in the state of the atmosphere from the initial state using his theoretical knowledge and experience. The forecaster analyses the current data available at various heights of the atmosphere and tries to match it with the past similar situations. The success of the forecast depends upon the skill and experience of the forecaster. Hence the method is subjective and very useful in short-range prediction.

2. **Statistical Techniques**: In statistical approach a forecaster tries to correlate one weather element with another. By studying the past weather records, useful relationships can be established relating the occurrence of one weather event with another or a number of other weather elements. This method is very useful in the Long Range Weather Forecasting. Long Range Forecast of monsoon is made through statistical techniques.

3. **Numerical Weather Prediction**: In recent years with the advent of super computers and very efficient numerical schemes, NWP **(**Numeric Weather Prediction**)** has become more promising method of weather forecasting especially in short and medium range weather forecasting. In this method, the hydro-dynamical equations that govern the atmospheric motions are solved by numerical methods using high-speed computers.

   Out of these different methods of weather forecasts, statistical method is often misleading. NWP is popular in mid-latitudes but weather forecasts through numerical methods have not been successful in the tropical regions due to weak gradients of meteorological parameters. Synoptic meteorology is popular all over the world because complex atmospheric equations can be understood through synoptic charts.

Applications of weather forecasting:

Weather elements which influence agricultural operations and crop production can be forecast up to different spans of time, however with increase in time span, the accuracy decreases.

Weather phenomena	Advance time of forecast
Hail	< 12 hrs in advance
Tornado	-do-
Flash flood	-do-
Heavy rainfall	24 hrs in advance
Thunderstorm	-do-
Wind velocity	36 hrs in advance
Rainfall amount	-do-
Occurrence of rainfall	5 days in advance
Temperature intensity	-do-
Temperature departure	3 months in advance
Precipitation departure	-do-

***Short range weather forecasting** (Accuracy is 70-80 per cent). Its applications are

- Irrigation scheduling
- Timing of field operations
- Protection of plants from frost
- Efficiency of chemicals
- Spray applications
- Labour efficiency (workable hours)
- Insect-disease effects
- Soil workability
- Livestock protection from cold and heat
- Drying rate of soil

Medium range weather forecasting (Accuracy is 60-70 per cent). Its applications are

- To determine depth of the seed to be sown
- To determine whether or not to sow a crop
- To take account of expected rainfall to plan irrigation
- To decide whether or not to harvest
- To ensure maximum efficiency of spray programme
- To prepare in time for protection of crops against frost
- To the management of labour and equipment
- To animal feed requirements

Long range weather forecasting (Accuracy is 60 per cent). Its applications are

- In soil moisture management
- In pasture management
- To determine irrigation frequency
- To decide whether or not to grow marginal crops
- To aid in the management of limited water resource
- To plan timely measures against diseases and pests likely
- To be favoured by the expected weather

Agro-advisory Based on Weather Forecast

The synopsis is discussed with the subject matter specialists in various agricultural disciplines eg. Agronomy, Plant Pathology, Entomology, Vegetable/ Horticulture, Soil Science and Animal Science etc.

Various agencies and the specifications are contributing to the weather and crop outlook. Based on the weather synopsis for next 2-3 days, the recommendations of the concerned specialists are compiled and final summary of the weather and crop outlook is prepared for dissemination to various agencies.

A sample of weather agro-advisory is given below:

Partly cloudy weather is likely to prevail over Bihar and there are chances of isolated thunderstorms during next two days. The daily maximum and minimum temperature are expected to range between 32-36°C and 24-29°C, respectively. These temperatures are almost normal for these days. The daily loss of water through evaporation is expected to remain between 4-6 mm for most of the days of this week. The mean relative humidity is likely to remain around 75 per cent during these days.

Rain water has accumulated in the fields. Farmers are advised to drain out excess water from the field crops which are highly sensitive to water stagnation. Kill the weeds on water channels and field bunds by spraying Gramoxone/ Glyphosate. Keep the weeds under check in the field crops. Prop up the sugarcane crop. Remove off type plants from paddy crop. Do not flood the paddy fields for longer period, to avoid damage to the crop plants. Vegetable growers are advised to continue the harvesting and marketing of leafy vegetables of okra, chilli and brinjal. Transplanting of brinjal may be done. Sow nursery of cauliflower of November maturity. Start preparation of transplanting of *kharif* onion bulbs in the field. Start sowing early varieties of radish. If rainfall occurs, then excess rainwater from orchards should be drained out. Apply 10g Bavistin + 5 g Vitavax in 10 liters of water as the drip of plants to avoid root and sapwood in pear, peach, plum and grapes. Grape crop is likely to be affected by anthracnose resulting in die back of twigs.

Dissemination of Agro advisories:

Once the agro advisories are finalized, it is crucial that information should reach the users in the shortest possible time, so that the farmers can plan their agricultural operations.

The various agencies for dissemination of the agro-advisories include:

- Television
- Radio
- Newspaper

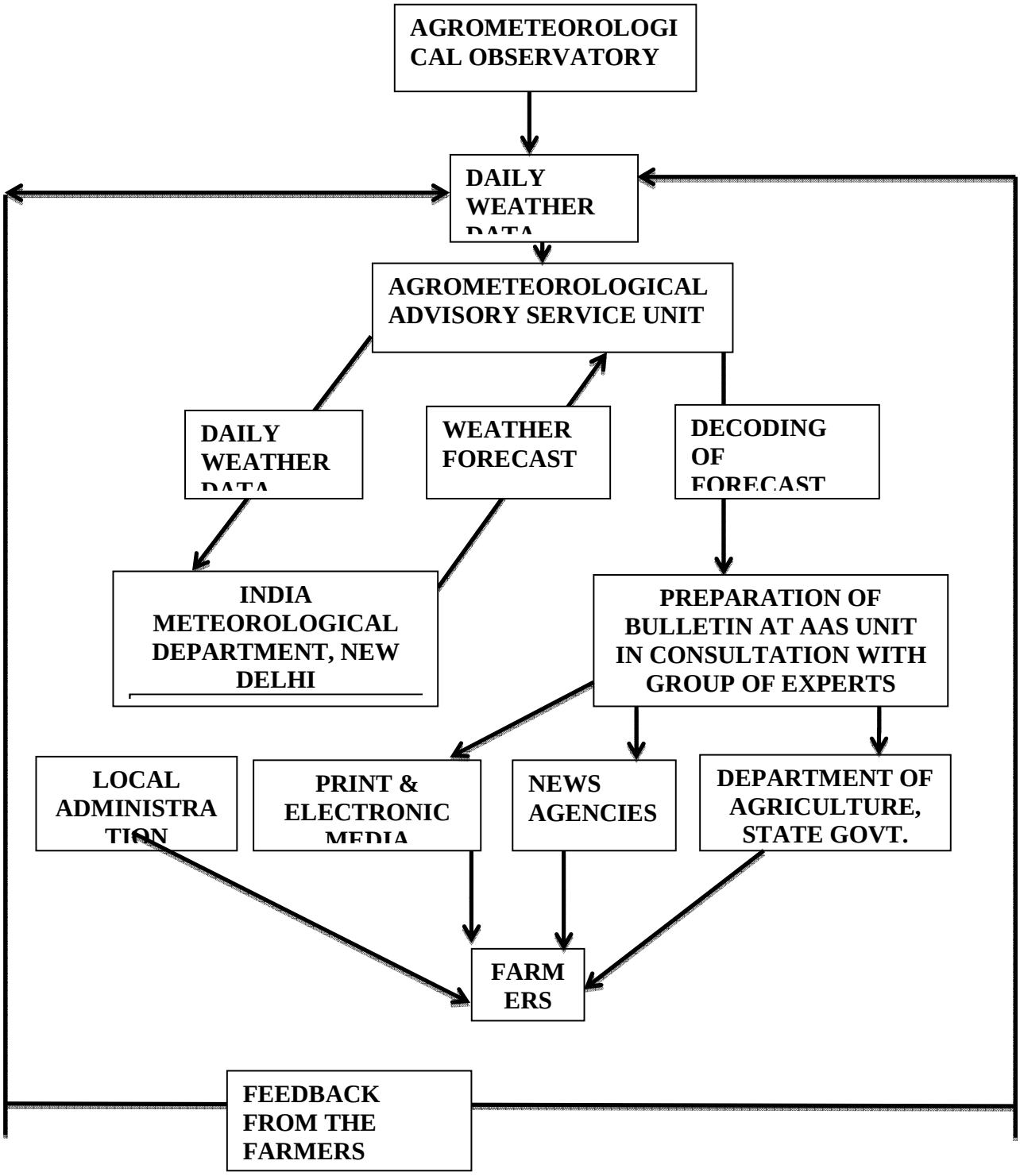
Special Agro advisories:

When abnormal weather conditions are expected, special weather agro advisories need to be issued for timely information to the farmers to make contingency plans to avoid/ minimize the losses from adverse weather conditions. Such weather abnormalities may include the development of cyclones/ tornadoes, heavy rains, floods or prolonged severe droughts, dust storms, strong surface winds, heat waves and cold waves. These special advisories need also to be communicated to the farmers in the shortest possible time as special bulletins through the various communication media.

Feedback Analysis of Agro advisories:

To assess the impact of weather agro advisories, there is a dire need to have feedback from the users. Such feedback analysis can provide valuable information for further improvements in the preparation and dissemination of weather agro advisories and also provide data on the utility of the agro advisories.

Figure-1. Schematic diagram of Agro advisory



Women Participation in Integrated Farming System

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Women's Involvement in Indian Agriculture

Out of total women workers in India, 32.51 per cent women work as cultivators who works in the own farm and 39.43 percent work as agricultural laborers (Table1).Women make a substantial contribution towards rural economy of India. About 70 per cent of the total working population of women is extensively involved in agricultural activities. Mainly rural women are engaged in agricultural activities as paid laborers or as cultivator doing labor on their own farm or engage in supervision of certain activities of agriculture and animal husbandry and also participation in post harvest operations. In agriculture, women are involved in sowing, transplanting, weeding, irrigation, fertilizer application, plant protection, harvesting, winnowing, grading, cleaning and storing of farm produce Nature and extent of their involvement differ with the variations in agro-production systems. Further, their mode of participation in agricultural activities varies with the ownership of land of farm households. Their role ranges from managers/decision makers to landless laborers. In the highly diversified Indian context, no simple gender division of labor exists with regard to crop production. In certain areas in India, women play key roles as seed selectors and in seedling production. Their knowledge on seeds and seed storage contribute to viability of agricultural diversity and production. Women prepare and apply green and farmyard manure. As integrated pest management practices are introduced, it could be expected that women's work would increase due to more labor-intensive activities. In farming system perspectives, besides their role in crop production, women are intensively involved in agri-based allied activities like dairying, animal husbandry, poultry, goatery, mushroom cultivation, vermicomposting, apiary, floriculture, horticulture, fruit preservation etc. In case of livestock more than 90 per cent of the work related to animal care is done by women. In Livestock management their role vary widely ranging from care of animals, grazing, fodder collection, cleaning of animal sheds, processing milk and livestock products. In livestock sector, indoor jobs like milking, feeding, cleaning etc. are done by women in 90 per cent of families while management of animals and fodder production are done by men. One can easily find women with the sickle in hand harvesting green fodder for their own animals or for the sale which also contributes to family income and savings. Mostly, this operation is done in the non owning farms which sometimes happen to be cause of conflicts. Though women play a significant role in livestock management and production, women's control over livestock and its products is negligible.

About 60 per cent of agricultural operations like sowing of seeds, transportation of sapling, winnowing, storage of grain etc are handled exclusively by women, while in other jobs they share the work with men. Apart from participation in actual cultivation, women participate in various forms of processing and marketing of agricultural produce. Study conducted at Villages of Rajasthan and Delhi revealed that transplanting, drying, cleaning produce and processing were completely done by farm women. Table 2 depicts that in operations like sowing, intercultural activities, harvesting, winnowing, drying, cleaning and storage involvement of women is more than 80 per cent.

Nature of participation of farm women in livestock activities

Women's participation in livestock management was studied in some villages of Karnataka. It was observed that majority of women were involved in almost all the livestock activities (table3) *viz.* feeding animals (96 per cent), fodder collection (96 per cent), maintenance of cattle shed (94 per cent), cow dung making for fuel (94 per cent) milking (88 per cent), marketing of milk and milk products(84 per cent) , cleaning and health care of animals (80 per cent).Percentage of farm women under "doing" were found to be fairly high in the activities like cow dung making (88 per cent), fodder collection (84 per cent), maintenance of cattle shed (80 per cent) and feeding of animals (78 per cent). The Time Use Survey of 2000 shows that on the average, women spend more time than men on activities related to animal husbandry in states in which animal husbandry contributes substantially to the agricultural GDP, as in Gujarat and Haryana. In activities such as collection of fodder, fuel, wild food, water etc., women spend more time than men do in all the states (Table 4 & 5). Various findings reported that majority of the farm women actively participate in almost all the housekeeping activities, farm operations and livestock production activities. Participation of rural women is more in terms of "doing" than that of supervision in case of agricultural and livestock production activities.

Nature of participation of farm women in fishery activities

In the states of Assam, Andhra Pradesh and Maharashtra, women are also involved in fishery activities. Highest number of participation has been reported in Maharashtra followed by Assam and Andhra Pradesh. Fisheries related activities includes pond cleaning and management, selection of fish seed, size, feeding, harvesting, management of produce, marketing, processing, packaging, management of labor and cash flow. In Assam and Andhra Pradesh involvement of women was higher than men and in Maharashtra it was equal. In Andhra Pradesh, only a small number performed drying, product preparation independently with complete responsibility. Women involved in fisheries had complete responsibility of drying, salting, processing, marketing and management of cash in coastal villages of Maharashtra (DRWA, 2011).

Gender gap

Women cannot migrate as easily as men and hence they are forced to accept agricultural works in their own village or nearby areas. Women workers are preferred to men by the owners because they are docile, require lower wages and are less lazy than men. The work of women within family-based agriculture is preferred because it is cheaper than hiring labor. Although women agricultural workers represent a big proportion of all women workers but it continue to receive lower wages than men. In most of the cases women received 15 - 50 per cent lesser earnings than the earnings of men. Table 6 reveals wage difference between male and female workers. The difference is minimum in Assam (15 per cent) and is maximum in Arunachal Pradesh (52 per cent). While earnings from agricultural work have not improved for women, modernization and mechanization of agriculture has in some cases brought new kinds of problems and demand. Mechanization has occurred for activities mainly carried out by men and women continue to strive in labor intensive activities.

A woman being a key human asset for agricultural and rural development, more emphasis is required exclusively to the women to build leadership skills for managing agriculture and community based development activities by empowering them. Access to input, technology, information and credit for the women has to be ensured through women field functionaries. Moreover, demonstration is very essential to convince rural women to adopt improved agricultural technologies. Hence, demonstration on specify enterprises should be given for better output and technology dissemination.

Gender Based Institutions

As per the National Agriculture Policy 2000, National Gender Resource Centre in Agriculture (NGRCA) was set up under department of Agriculture and Cooperation (DAC), Ministry of Agriculture, during 2004-05 to serve as a focal point for convergence of all gender-related issues in agriculture and mainstreaming gender concerns in agriculture. Department of Agriculture & Cooperation, adds gender dimension to agriculture policies and programmes, renders advocacy and advisory services to the States and UTs to internalize gender specific interventions for bringing farm women into mainstream of agriculture development. In order to bring gender concerns on to the centre stage in all aspects of public expenditure and policy, a Gender Budgeting Cell (GBC) has been constituted in Department of Agriculture & Cooperation, to look into budgetary Commitments of various schemes of DAC and ensure proportionate flow of public expenditure to women farmers. It has been mandated that a minimum of 30% funds would be utilized for women farmers under all the beneficiary oriented programmes / schemes.

The Working group on Agricultural Research and Education constituted by The Planning Commission for the formulation of Eighth Five Year plan recommended for establishment of a Research Centre for Women in Agriculture to conduct basic, strategic and applied research on gender issues in agriculture and allied fields and to test appropriateness of available farm-technologies/ programmes/ policies with women perspective. Accordingly, the ICAR established National Research Centre for Women in Agriculture (NRCWA) in 1996 at Bhubaneswar which was upgraded to Directorate of Research on Women in Agriculture (DRWA).

There is no argument about the importance of women for rural economic growth and livelihood improvement. They play many important roles, as farmers, wage earners and small-scale entrepreneurs, as well as caretakers of children and home. Rural women equally have the ability to lift their household's economy as par to their male counterpart. Integrated farming system provides additional employment opportunities by engaging more number of manpower, especially family and female labourers to make production system more remunerative and sustainable. By adoptioning gender based approach in IFS one can think about the upliftment of rural women who are still deprived and lag behind men in access to social capital (organization) land, credit, a broad range of technologies, information, advisory services and training.

Gender –based approaches in IFS

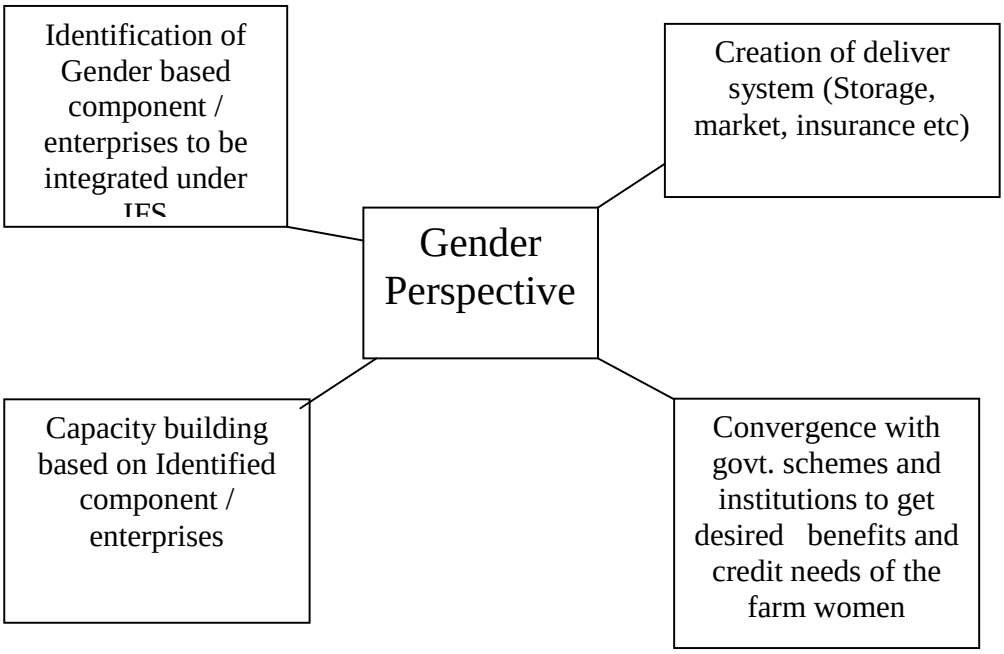

Table 1. Distribution of women workers in India (2001)

Sl. No.	Category of women workers	Population (Millions)	Percentage
1	Total women owner cultivators	41.30	32.51
2	Total women agricultural wage workers	50.09	39.43
3	Total women household industry workers	8.08	6.36
4	Total women other workers	27.57	21.70
5	Total women workers	127.05	100.00

Source: Census 2001

Table-2. Share of Farm Women in Agricultural Operations

Activity	Involvement (Percentage)
Land preparation	32
Seed cleaning and sowing	80
Inter cultivation activities	86
Harvesting-reaping, winnowing, drying, cleaning and storage	84

Source: Impact of WTO on Women in Agriculture, 2005

Table 3. Nature of participation of farm women in fodder and livestock activities

Sl. No.	Activities	Women's Participation (percentage)		
		Doing	Supervision	No participation
1	Milking	70	18	12
2	Marketing of milk and milk products	76	08	16
3	Feeding animals	78	18	04
4	Maintenance of cattle shed	80	14	06
5	Fodder collection	84	12	14
6	Cleaning of cattle	56	24	20
7	Cow dung making for fuel	88	06	06
8	Health care	64	36	20

(Source: Nataraju, M. S et al, *2009)*

Table 4.Average weekly time spent on activities related to collection of food, fodder, fuel, water etc., (Hrs/week)

Sl. No.	States	Women	Men
1	Haryana	7.78	1.57
2	Madhya Pradesh	1.52	0.91
3	Gujarat	3.0	1.4
4	Orissa	5.95	1.92
5	Tamil Nadu	2.78	0.55
6	Meghalaya	5.29	2.95

Source: Report of the Time Use survey 2000

Table 5. Average weekly time spent on activities related to Animal husbandry (Hrs/week)

S.No.	States	Women	Men
1	Haryana	9.8	4.78
2	Madhya Pradesh	3.75	7.72
3	Gujarat	5.93	4.31
4	Orissa	3.15	3.35
5	Tamil Nadu	2.42	3.69
6	Meghalya	1.22	3.92

Source: Report of the Time Use survey 2000

Table 6. Average daily wage difference between male and female rural casual workers

S.No.	States	Male wage (₹)	Female wage (`)	Percentage difference
1	Andhra Pradesh	50.30	30.88	39
2	Arunachal Pradesh	104.38	50.60	52
2	Assam	62.59	53.29	15
3	Bihar	45.41	37.42	18
4	Chhattisgarh	37.60	28.55	24
5	Gujarat	52.80	43.17	18
6	Haryana	75.26	59.34	21
7	Himachal Pradesh	88.88	62.00	30
8	Jharkhand	51.11	37.93	26
9	Karnataka	48.33	30.74	36
10	Kerala	134.86	65.75	51
11	Madhya Pradesh	38.58	30.53	21
12	Maharashtra	47.37	28.16	41
13	Orissa	42.29	29.65	30
14	Punjab	75.14	53.10	29
15	Rajasthan	64.33	52.03	19
16	Tamil Nadu	70.45	36.53	48
17	Uttarakhand	69.66	56.20	19
18	Uttar Pradesh	53.37	39.54	26
19	West Bengal	79.88	30.88	20
20	All India	55.03	34.94	27

Source: NSS Report No. 515 (2004-05)

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Gender Based Fisheries and Aquaculture Practices

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Background:

Historians believe that it was women who first domesticated crop plants and thereby initiated the art and science of farming. Indian rural women have always been an important and prominent partner in sustainability of agriculture sector. Since ages, women continued to be the important stakeholder in farming activities in India. Involvement of Indian women in farming enterprise has been on rise in recent years. Other than crops they are involved in allied sectors like Fisheries, animal husbandry, dairying, piggery, poultry, sericulture and apiculture. The extent of women contribution is aptly highlighted in a study conducted in Andhra Pradesh where it has been revealed that work day of women agricultural labour during season lasts for 15 hours and her male counterpart works for 7 to 8 hours (Mies, 1986, (Swaminathan, 1985). Fishery is the oldest and most important livelihood option for the inhabitants of the country since times immemorial. Approximate of about 1 % of the total population depends upon fishery sector in India as a primary source of livelihood – direct employment to about 6 million fishermen and to another six million people who are employed in fishery related activities. India is endowed with 2.02 million sq. km of EEZ (Exclusive economic Zone) along with a coastline of 8129 km and 0.5 million sq. km continental shelf with a catchable annual fishery potential of 3.93 million tonnes occupying a very important strategic position in the Indian Ocean. The aquaculture resources in the country comprise 2.25 million ha. of ponds and tanks, 1.3 million ha. of bheels and derelict waters, 2.09 million ha. of lakes and reservoirs and also 0.12 million kilometres of irrigation canals. Among the Asian countries India ranks second in the culture and third in capture fish production and one of the top leading exporters of sea foods (FAO, 2009, Ayyappan and Diwan, 2007). Fisheries and aquaculture are the sources of livelihood for over 14 million Indian people and also contribute to foreign exchange earnings considerably, constituting about 1% of the total gross domestic product (GDP) and 5.3% of the GDP from the agriculture sector of the country (DAHDF, 2011). Aquaculture is always consumer driven and the extension services need to focus their efforts beyond technology dissemination to adoption of food safety practices, value addition, environment safety and social responsibility issues, such as Fisher women empowerment. Aquaculture extension services are expected to facilitate the Fisher women farming community to access backward and forward inputs and services, educate the farmers on better farm management practices, food safety guidelines and enforce regulatory guidelines for the planned aquaculture growth. However, insufficient extension service orientation, inadequate manpower and lack of budgetary provisions for extension work have hampered the public extension agency in providing the expected service.

Introduction:

A key message from the Food and Agriculture Organization of the United Nations' report *The State of Food and Agriculture 2010–11. Women in Agriculture – Closing the Gender Gap for Development* (FAO, 2011) was that women's relative lack of access to education and extension services contributed to the "gender gap" in agriculture (including aquaculture) productivity. Gender concerns in the fishery business have a different dimension altogether in terms of physical as well as financial exploitation of the women even though they play an important role in the fish supply chain at the local level. The centre of power in terms of decision making, trade, financial access over product and market had been traditionally the domain of the male counter parts and women have little say in it. Fish drying and selling is the major

activity in which the women are involved. The financial exploitation of women is severest in the market place because of the unregulated market. Also the choice in terms of purchases is very limited at the landing centre where they have say only for the products of low value and category. Men and women engage in distinct and often complementary activities that are strongly influenced by the social, cultural and economic contexts in which they live. Male–female relations in the fisheries sector vary greatly and are based on economic status, power relations and access to resources. More commonly, in coastal artisanal fishing communities, women manage the smaller boats and canoes that go out fishing. Women are also involved in gathering shells, sea cucumbers and aquatic plants in the intertidal zone. They also contribute as entrepreneurs and provide labour before, during and after the catch in both artisanal and commercial fisheries. In addition, they are often responsible for skilled and time-consuming onshore tasks, such as net making and mending, processing and marketing catches, and providing auxiliary services to the boats. However, gender issues in the fisheries and aquaculture sector have seldom been examined, and the important role women that play has often been overlooked and, thus, not taken into account in decision-making processes and outcomes, thereby hindering development. When fish business activities are being up-scaled in response to increasing globalization, local women risk being forced out of the business and, therefore, not benefiting from development and market opportunities in the sector in which they were previously extensively involved.


Picture showing Fisher women selling the farm produce in fish market in Purnea District of Bihar

Picture showing Fisher women selling their farm produce in fish market in Katihar district of Bihar.

Gender based fisheries activities:

In India fish is often a secondary source of food. Under such circumstances, fishing communities are a marginalized group occupying a lower priority in state policies relating to food. The priority given to fisheries in state policy is further attenuated when it comes to women. The fisheries sector has seen significant change over the last couple of decades in the region. Women in coastal states play a significant role in the small-scale fisheries sector. About 30% of women in rural and coastal areas are directly or indirectly engaged in small-scale fisheries. The major areas of women's involvement are aquaculture, shrimp culture, fish processing, net, gear and craft making. Though women in India are not involved in active fishing from the sea, they participate in certain forms of fishery as a family along with the men. This is usually seen in the estuarine areas where set bag nets are employed for fishing. However, a study of the set bag net fishing communities also revealed that though women work as a family in the set bag net fishery, their work remains largely unrecorded. In any case, set bag net fishery as an occupation is very low paying and most fishers involved supplement it with other occupations. Capture fishery in rivers, lakes and reservoirs, paddy fields and marginal lands and swamps are widely scattered throughout the country and is not organized. Most of the fishers involved in capture fishery are widely dispersed along rivers and other water bodies. They use mostly their traditional boats and fishing gears and thus generate only marginal economic benefits. Traditionally, rural women are involved either in fishing or fishing-related activities. To enhance fish production, a number of inland water bodies, e.g. lakes, reservoirs and swamps have been stocked with selected species of indigenous as well as exotic carps in collaboration with local fisher communities. In these inland water bodies, women are actively involved in mending nets, laying out the fishing gears, harvesting and marketing of the catch. Women farmers participate in various fields of inland fisheries. In aquaculture, rural women are deeply involved in manuring fish ponds, feeding fish, harvesting and marketing farm products.

Women in the fish marketing sector: While fish processing is a female-dominated activity in the South Asian region, marketing of the processed product as well as selling of fresh fish is often seen as undesirable activities, usually a last resort for a poor family. Retail fish marketing is often best achieved through individual small-scale enterprise. In India, owing to the lack of an established marketing infrastructure and the demand for cheap fish, women have created a niche for processing and marketing fish at very low costs in the supply chain of fishes. The supply chain is defined as “the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers and final disposal after use.” The important supply channels which cater to the various usages are – marketed fresh (70% of fish catch), fish drying and curing industry (14% of fish catch), frozen fish production (6.5% of fish catch), reduction to fish meal (8.4% of fish catch), offal reduction (0.8% of fish catch), and miscellaneous purposes (1.6% of fish catch). The most important supply chain is for the fish marketed fresh owing both to the size of market as well as the nature of the product i.e. perishability. A study undertaken by the Department for International Development (DFID) Post-Harvest Fisheries Project along the east coast of India, documents the heterogeneity among women who are involved in fresh and processed fish marketing (Post-Harvest Fisheries Project, Department. The three categories identified are:

a.Head loaders: These are women who deal in small quantities of low value species, which are sold in inland villages. b. Petty fish traders: These are women who deal with medium value species and have considerably higher investment capacities and are therefore considered credit worthy by non-institutional credit sources. c. Dry fish traders: These are older women who are primarily involved in fish salting and drying in a large scale. Fish for processing is procured during "glut" landings of a particular species and they usually employ family labor (including their own) for processing activities. These women access weekly markets and are usually wholesalers. However, with the increasing use of ice and

consequent movement of fish in its fresh form, this group is affected. While women in the post-harvest fisheries sector in India are more visible in fresh fish trade, it is important to recognize that credit plays a crucial role in fish marketing activities. To enable the participation of women in this sector, credit should be made easily available at affordable interest rates to better address the needs of women in fish marketing.

The role of transportation: Studies done by the DFID Post-Harvest Fisheries Project in the state of Tamilnadu along the East coast of India, document the problems faced by women in accessing public transport. One of the problems that have emerged with centralization of fishing has been the increasing distances to landing sites, as village landings have decreased. Women involved in fish marketing today have to travel long distances to buy fish and again to sell it. Considering that most fishing villages are often poorly linked by roads, access to public transport becomes a question of primary importance.

Women and the organized processing sector: The organized processing sector such as the shrimp processing units, usually employ women as peeling labourers. In India, these are found along the coasts of Veraval, Mangalore, Goa, Mumbai, Calcutta and Bhubaneswar. Studies done in India showed that it is usually migrant young women who are preferred as labourers in these units, which are mostly export-oriented and exploitative. Fishing, including aquaculture, and their associated downstream activities, like fish processing, are among the most depressed economic activities. Women from poor fisher households are involved in fish processing, aquaculture, small-scale artisanal fishing and fish mongering, but less often in commercial fishing using bigger vessels.

Outlook for Women empowerment in Fisheries:

Gendered value-chain approaches can be used to recognize and value women's roles and contributions to agriculture and fisheries. To mainstream gender equality in development cooperation programmes and related activities, a number of steps are essential. Information provided by FAO indicates that, in 2008, 5.4 million women worked as fishers and fish farmers in the primary sector and represented 12 percent of the total. In two major producing countries, China and India, women represented 21 percent and 24 percent, respectively, of all fishers and fish farmers. Women make up at least 50 percent of the workforce in inland fisheries, while as much as 60 percent of seafood is marketed by women in Asia and West Africa. Moreover, although comprehensive data are not available on a sex-disaggregated basis, case studies suggest that women may comprise up to 30 percent of all those employed in fisheries, including primary and secondary activities. No single blueprint exists for closing the gender gap as yet, but some basic principles are universal. i.e.

- eliminate discrimination under the law, improving women's endowments, opportunities and agency to help shape more positive outcomes for the next generation;
- promote equal access to resources and opportunities, reducing barriers to more efficient allocation of women's skills and talents and helping to generate large productivity gains;
- ensure that policies and programmes are gender-aware, increasing women's individual and collective agency to produce better outcomes, institutions and policy choices;
- make women's voices heard as equal partners for sustainable development.

Empowering Fisher women, mainstreaming gender is an essential component of alleviating poverty, achieving greater food and nutrition security, and enabling sustainable development of fisheries and aquaculture resources. Gender considerations should be firmly placed on all fisheries and aquaculture policy agendas at all geographical and institutional scales.

Gender Mainstreaming:

"Gender mainstreaming is not only a question of social justice but is necessary for ensuring equitable and sustainable human development. The long-term outcome of gender mainstreaming will be the achievement of greater and more sustainable human development for all."(The United Nations Economic and Social Council (ECOSOC) 1997,). The issue at hand is how to ensure genuine and active mainstreaming of gender and the many facets of gender considerations in the fisheries and aquaculture sector. Indeed, until recently, gender analysis in fishing communities focused mainly on the different occupational roles of men and women, i.e. that men usually do the actual fishing and women are to a large extent involved in post-harvest and marketing activities. While the role of women in the management and utilization of natural resources is generally acknowledged, their role does not carry the same weight as that of men. Given that production goals have tended to be the focus of research and policy, the predominantly male catching sector has remained the centre of attention. However, with the shift to a multidimensional and more holistic definition of poverty and the increased focus on reducing vulnerability, gender has become more central to fisheries policy and development practice. Fisheries resource management is increasingly being linked to all levels of the so-called "deck to dish" fish value chain in which both men and women have important roles to play. Gender- disaggregated data, which are needed for in-depth gender analysis are largely lacking in most of these countries. It is imperative that such data is collected, and gender research is conducted, so that appropriate interventions and policies changes are implemented, to ensure that women are not left out of mainstream development, and are accorded the basic rights, which all humans are entitled.

Conclusion:

There is an immense potential in fishery as a trade and livelihood option. The need of the hour is to develop sync between the two so that they reciprocate each other rather than come in conflict. The issues and concern of various players of the value chain need to be addressed so that they come in supportive mode rather than the exploitative mode. Here it is imperative to mention that environment will play a crucial role for success or failure of any intervention. Economic empowerment should be the end goal of a road map on gender in fisheries and aquaculture. The suggested approach could facilitate strong research and extension linkage and build partnerships with service-oriented private people like the farm opinion leaders, farmers' groups and fisheries professionals in the field, to streamline the fisheries and aquaculture in India. In view of the findings, it becomes imperative to scientifically educate and train women in specialized skill so that they too can improve and sharpen their skills and abilities for performance of tasks which need some technical knowledge and skill In view of the critical role of women in the agriculture as producers, concentrated efforts need to be made to ensure that benefits of training, extension and various programs reach them in proportion to their participation pattern. Strategies should be designed to enhance the capacity of women and empower them to meet the future participatory needs in farm operations. Special training programmes for women will enhance their skills and strengthen faith in them for effective and independent performance of farm operations and help them to make a shift from physically enduring operations to specialized tasks.

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Integrated Disease Management under Livestock Farming System

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Introduction:

Integration of various interventions required for treatment, control and prevention of diseases in livestock is referred to as integrated disease management. Various interventions required for animal disease management varies with type of disease and species involved. However major interventions required for animal disease management include prophylaxis, metaphylaxis, nutritional interventions, management interventions, treatment instituted using chemotherapeutics agent, herbal medicine, physiotherapy, nutraceuticals, etc. Traditional livestock systems based on local resources and animal breeds are the major source of livelihood for 200 million rural families, and provide food and income for some 70% of the world's rural poor. Livestock Farming system in Eastern region of India is based on low input backyard farming and very few high input large commercial livestock farm exists in the region. Low input backyard farming of livestock is generally undertaken along with agriculture farming system in integrated mode by majority of farmers baring urban and peri-urban areas where in livestock farming exists as separate module meant only for commercial milk production. Interestingly, low input backyard farming system of livestock is dependent on inputs form women gender. Majority of livestock related works are carried out by women including cleaning, dung disposal, feeding, forage chaffing, grass cutting, etc. Major sources for zoonotic disease transmission from livestock rearing include dung, urine, after births, etc. and are often handled by women and thus are most potential gender for disease acquiring. Animal wealth in India has increased manifold and presently the Animal Husbandry practices have also been changed to a great extent due to newer interventions and technologies available. However, liberalization of trade after the advent of the WTO's SPS agreement, the chances of access of exotic diseases into the country have increased. Climate change has resulted in emergence and reemergence of animal diseases. Cross breeding programmes in the country resulted in the improvement in the quality of livestock however the susceptibility of these livestock to various diseases including exotic diseases has increased. The eastern region of the country has high density of livestock as it supports 31.14% of the livestock population of India and occupies only 22.5 % of country geographical areas. Major animal infectious diseases of this region include Foot and Mouth disease (FMD), Hemorrhagic septicemia (HS), Brucellosis, Black Quarter (BQ), Anthrax, Rabies, Johne's disease, leptospirosis, ringworm, mastitis, etc. In addition to these infectious disease there are many non-infectious disease including metabolic and nutritional deficiency diseases like milk fever, ketosis, Downer's cow syndrome, mineral deficiency diseases, etc. The present chapter elaborates about few of the important infectious and non-infectious diseases of livestock with respect to its integrated management.

Hemorrhagic Septicemia (HS): It is a highly fatal acute bacterial septicemia affecting mainly buffalo (most susceptible), cattle, sheep, goat and pig populations in our country. The causal agent of the disease is *Pasteurella multocida* B 2 strain. The disease occurs more commonly in low laying humid areas and is often seen during the periods of highest humidity and stress induced by adverse climate like monsoon season. HS is characterized by high fever, increased respiration, marked salivation,

inflammatory swelling in the head and neck region and protrude on tongue in per acute form, the death occurs usually within few hours, in acute form, the cases may linger up to 3-4 days. Cases in buffalo are always fatal. The mortality rate may go up to 100%.

Animals are infected by direct or indirect contact. The source of infective bacteria is thought to be the nasopharynx of bovine or buffalo carriers. Upto 5% of cattle and water buffaloes may be carriers in endemic regions.

The disease can be treated effectively by oxytetracycline, fluroquinalones and sulphonamides, however due to acute onset and rapid mortality, often treatment cannot be initiated. Therefore, one of the most important strategies to control the outbreak of HS is to immediately remove and isolated the diseased and in-contact animals from the herd or farm. The affected animals and suspected to be infected animals should be immediately be treated with sulfa drug or potentiated sulfa along with other supportive therapy. However, proper strategic vaccination using HS oil adjuvant vaccine is important to achieve maximum economic benefits. During outbreak, the healthy animals should be segregated from the diseased ones and vaccinated. The dead animals should be either burnt or buried under ground, 6 fit deep putting sufficient lime or bleaching powder under and above the carcass. This will prevent disease spread.

Prophylactic vaccination is carried out annually before the onset of monsoon preferably in the month of May-June. Oil adjuvant vaccine is preferable, as it protects the animals for one year. Primary vaccination is done at 6 months of age or above followed by annual revaccination. Treatment recommended for HS is immediate administration of sulfonamides.

Black Quarter (BQ): It is an acute infectious myositis of skeletal muscles, but a non-contagious disease characterized by severe toxemia and high mortality rate in cattle and sheep. The causative agent is soil borne pathogen *Clostridium* (feseri) *chauvoei*. The disease is common in cattle and remains confined to young calves between the age of 6 months and 2 years. Buffaloes usually encounter the mild form of disease. The cattle acquire infection from ingestion of organism and the ingested bacteria remain as dormant spores in tissues until predisposing factors stimulate the development of negative forms and rapid multiplication and formation of toxins. Initially there is acute lameness and fever. Characteristic oedematous and crepitating swellings develop in the hip, shoulder chest, back and neck. Death usually occurs within 12-48 hrs.

Prophylactic measures include vaccination and proper hygiene. Proper hygiene requires the destruction of carcases by burning, and cleaning and treatment of all wounds. Penicillin and tetracycline's if given promptly and inoculated into the site of lesion are of value and should be given in normal therapeutic dose. Sulphathiozole and antitoxic sera are also effective. A formalin inactivated aluminium hydroxide gel adjuvant vaccine is recommended. During outbreaks, all unaffected cattle should be vaccinated and given penicillin at dose of 10,000 IU/ kg BW. Animal having disease and in-contact and suspected to be infected should be isolated from the apparently assumed uninfected animals in the herd/farm/locality. Primary vaccination is done at the age of 6 months followed by annual booster. Wounds should be treated immediately. Combined HS+BQ vaccine are also available commercially.

Brucellosis: Brucellosis is a contagious disease of domestic animals characterized by inflammatory response of reticulo-endothelial system and infection of placenta during pregnancy resulting in retained placenta, abortion and expulsion of the foetus and to a lesser extent, orchitis and infection of the accessory sex glands in males. It is also of zoonotic importance. It is caused by different

species of Brucella organism such as *B. abortus* (cattle and buffalo), *B. mellitensis* (goat), *B. ovis* (sheep), *B. suis* (pig) and *B. canis* (dog).

Natural transmission occurs by ingestion of organisms present in large numbers in aborted fetuses, fetal membranes and uterine discharges. Animal may ingest contaminated feed and water, or lick contaminated genitals of other animals. Venereal transmission by infected male to susceptible female seems rare. However, transmission may occur by artificial insemination with infected semen deposited in the uterus but, reportedly, not when deposited in the mid-cervix. The organism may enter the body through mucous membranes, conjunctivae, wounds, or intact skin.

No definite schedule of treatment using various antibiotics alone or combination can cure brucellosis in domestic animals. The organism remains intracellular, capacity to persist in carrier state and therefore most of the antibiotics are ineffective. Most effective approach is prevention of disease by vaccination. Hygienic disposal of uterine discharge, fetus, fetal membrane and infected carcasses are to be observed strictly. Strain 19 *Brucella abortus* attenuated live vaccine can be used in female calves or adult cattle. The recommended dose is 2 ml given by SC route to female calves of 4-8 months age. This consists of viable culture of *B. abortus* strain19, which has practically no virulence for guinea pigs and cattle. Sometimes adult pregnant vaccinated cows with strain 19 may show severe reaction and may abort. So it is advised not to vaccinate the pregnant animals and male calves. *B. abortus* killed 45/20 vaccine has been considered useful in tropical countries. The main advantage of this vaccine is that agglutination test reactors rarely occur following vaccination because this vaccine is of rough strain. The only disadvantage lies with the fact that repeated vaccinations are to be done at specific intervals which is costly. It is not recommended for calves under 6 months of age.

Anthrax: It is a fatal infection characterized by septicemia and sudden death with exudation of tarry blood from the body orifices of the dead animal. This disease is important from zoonotic point of view as it is communicable from animals to humans and the causative organism *Bacillus anthracis*, has been identified as a possible agent for bioterrorism. Spores are formed when the materials containing the organisms are exposed to the air and these are capable of in fleeting both animals and humans. The spores may survive in soil for long period ranging from10 years or more, or up to 60 years. The disease commonly occurs in cattle, sheep and goats, but buffaloes, horses, pigs, camels and elephants may also suffer. In per acute form of anthrax, affected animals die within 1-2 hours without any premonitory signs. Momentarily there may be fever, staggering gait, muscle tremors, dyspnoea and collapse. Discharge of blood from nostrils, mouth, anus and vulva is commonly noticed in carcasses died of anthrax. In acute form, there is fever; the animal becomes excited and then depressed. Difficulties in respiration, staggering, convulsions and stupor are observed. Pregnant cows may abort. The oedematous lesions in the region of throat, sternum perineum and flanks are also observed the duration of the disease in this form is 24-48 hrs. The confirmation of diagnosis is made by examination of blood smears and also smears prepared from oedematous fluid. In acute cases, the treatment can be initiated soon after appearance of clinical symptoms using antibiotics, such as strep to-penicillin, oxytetracycline, amoxicillin, ciprofloxacin and enrofloxacin. Anthrax spore vaccine is used before onset of rain or should there is likelihood of flood. Like HS and B vaccine is given to animals 6 months of age and repeated annually. The animal died of anthrax should not be opened and carcass should be burnt or buried as indicated in case of HS.

Leptospirosis: It is important water borne zoonotic disease characterized by septicemia interstitial nephritis, haemolytic anemia and abortion in most species. Different serovars of *Leptospira interrogans* are responsible for causing infection in cattle, buffaloes, sheep, goats and pigs suffer from

this disease. Rodents play pivotal role in disease cycle and spread. Source of infection is infected urine, though it can directly penetrate skin, route of infection is mostly by ingestion. The disease occurs more commonly during rainy season and flood. Infected animals excrete numerous Leptospira organisms particularly in their urine which remain viable in river, ponds, canals and mud for longer period and contaminate the water. The important symptoms consist of fever, jaundice, abortion haemoglobinuria and nephritis. Treatment with antibiotics viz dihydrostreptomycin, oxytetracycline, ciprofloxacin, and enrofloxacin is effective. There is no vaccine available so far for immunization in cattle. The animals should be prohibited from drinking of contaminated water.

Johne`s Disease (JD): It is chronic contagious enteritis of cattle, sheep, goat, buffaloes and occasionally of pigs caused by *Mycobacterium paratuberculosis* avium. The disease is characterized by chronic diarrhoea and thickening of the intestine in cattle and buffaloes and progressive emaciation and immune suppression. It spreads by ingestion of feed and water contaminated by the faces of infected animals. The infection is acquired in early age of life. The animal aged 3 to 6 years mostly suffer from the disease since the incubation period extends from 12 months to several years. The infected animals which are apparently healthy often show clinical signs after parturition.

The organisms are more resistant to chemotherapeutic agents in vitro than Mycobacterium tuberculosis. Therefore treatment is not attempted. So again, the role of hygiene and prophylaxis comes into play. The affected animal should be segregated and their faces properly disposed off.

Foot and Mouth Disease (FMD): It is an economically important viral disease of cattle, pigs, sheep, goats, buffaloes caused by 7 distinct serotypes of Picorna virus. In susceptible population morbidity reaches up to 100%. It is characterized by rise in temperature and vesicles in the mouth, muzzle, teats, and feet, resulting in anorexia, retarded growth, sudden drop in milk production in lactating animals, poor reproductive performance. It also affects endocrine dysfunction resulting in panting, abnormal hair coat and lack of heat tolerance capacity. The virus also affects the immune system of the body. The mortality rate is low except in young animals. Normally the occurrence of FMD is more during March to May. But now, it has no definite epidemiological pattern. It can occur in any season. The occurrence of this disease has also been observed during the periods of flood.

Disease transmission generally occurs by contact with infected animals, However aerosol transmission is also very important, depending on climatic condition (moist humid condition with wind). All excretion and secretion of the affected animal contain virus including milk, semen, even before clinical signs are visible. Even dogs, birds, farm workers in the farm can be source of transmission.

One the biggest problem in implementing strategies for management of animals post outbreak is to check the morbidity and bring back the physical health of animal in terms of lesions in mouth, foot and teats which often due to secondary complication develop into lameness and mastitis. Therefore following measures are required post outbreak of FMD:

a) Restrict disease morbidity: Though it is very difficult to restrict the disease spread due to its transmission mode discussed above, following measures should be immediately be instituted.

i. Movement restriction: The movement restriction of all susceptible and infected animals, farm workers, veterinarians, etc should be instituted immediately at farm level, locality, village level, district level and at different levels depending on the severity of outbreak. Decontamination can be done by using mild acid or alkali (NaOH, most commonly used) or by fumigation. All entry to the farm should be made after foot wash and changing cloths.

ii. Rapid culling: This policy cannot be taken up for dairy cattle herd in our country because of social issues. The process not only decreases the population of susceptible animals but also prevents rapid transmission.

iii. Emergency strategic vaccination: Quick response vaccination against FMD is also recommended with effective vaccine chosen having the strain which has caused the outbreak. It takes around 3 days after vaccination for the animal to produce antibodies to combat the virus. Because of this delay, a larger number of animals need to be vaccinated. If vaccination is used it is important that the consumer must be aware that vaccinate animals products are safe to consume and doesn't pose a hazard to human health.

iv. Separation of animals (Isolation): Isolation is another important aspect which has to be implemented to restrict morbidity. Once disease outbreak has been notices in any herd or area, immediately all animals in contact or sharing common feed, water and shelter should be isolated for the remaining animals of the farm or locality. Isolation should be done in corner confined area of the farm, if separate isolation facility away from farm area is not available, possible having separate entry and exit point. If separate space is not available, efforts should be made to distance the calf and newborn herd from the affected herd. Susceptible increases in animals already immuno-compromised or stressed either due to chronic diseases or due to lactation or gestational stress. Pregnant animals due to gestational stress are more prone to disease manifestation and often results in abortion or stillbirths. Calves borne from affected animals should not be mixed in health calves. Dead fetus borne should be either burnt or burrowed deep into ground away from the farm.

b) Therapeutic approach for health recovery: The objective is to prevent secondary bacterial complication and bring back health of animal to near normalcy. Major complication which needs to be addressed post FMD outbreaks are combating problem of anorexia, mouth and teat ulcers, mastitis, resulting lameness and growth retardation. Lesions in mouth and feet should be addressed as priority while handling FMD affected cases. Mouth should be first washed with Potassium permagnent (PP) solution followed by application of borogycerine on the mouth lesions. Foot lesion should be thoroughly but gently washed with PP solution, followed by povidone iodine solution and then apply antiseptic and fly repellent ointment. Antimicrobials generally in veterinary practice are not effective against FMD virus, but antimicrobials are recommended for combating secondary bacterial invaders through the ulcers and resulting immunocompromised state. It is recommended to give for at least 7 days post development of lesions. Nutraceuticals such as multivitamins, liver extracts and mineral supplements are also recommended. These aids in healing as well as helps in revitalizing animal body.

For control, regular vaccination programme must be undertaken. FMD Oil Adjuvant Vaccine is effective. The dose is 2ml for cattle, buffaloes and calves; 1 ml for sheep and goat. It should be given by deep IM route. Primary vaccination is done at 4 months of age, followed by booster after 9 months of primary vaccination and then subsequent revaccination is done annually. But high risk areas as well as for having solid immunity, it is preferable to repeat the vaccination at 6 monthly intervals. Under field conditions the mass vaccination is generally undertaken in Jan.-Feb. months to avoid the overlapping with other vaccination schedules.

Rabies: Rabies is one of the oldest known fatal viral zoonosis. The rabies virus (Rhabdoviridae, Lyssa virus) affects all warm blooded animals, but it is more prevalent in dogs, cats and in wild carnivores including jackals, foxes, wolves and mongoose. In fact, these wild animals are said to be carriers of rabies virus. Rabies in cattle occurs due to dog bite. Rabies is untreatable and prophylactic or post-exposure vaccination is the only way for protection. After the bite of rabid dogs, the wound should be thoroughly washed with soap and tepid water for 15-20 minutes. After washing, Tr. Iodine or Betadine should be applied on the wound. Post-bite Rabies vaccination is available for man and animals. Almost all vaccines used for animals are inactivated tissue culture vaccines. Current vaccination protocol

suggests immediate vaccination and strict quarantine for 90 days. Booster is recommended in 3rd and 8th week of isolation period and just prior to release. The cell culture vaccine is also used both for prophylaxis and post-exposure therapy in cattle. The dose of the vaccine for all types of animals irrespective of age is one ml given by s/c or i/m route. The recommended post exposure vaccination regimen for animals in India is similar to the recommendation of WHO for human beings. The first dose is given at 0 day, followed by 3rd, 7th, 14th, 28th and 90th day post bite.

Ringworm: Ringworm is a transmissible infectious skin disease caused by a fungi *Trichophyton verrucosum*. The spores can remain alive for years in a dry environment. It occurs in all species of mammals including cattle and man. Direct contact with infected animals is the most common method of spreading the infection. It infects the shafts of the hair and the skin. Exudates ooze from the damaged skin. It mixes with debris from skin and hair and forms a crusty scab. The grayish-white scab is raised than the surrounding skin, located mostly on neck and head. Infection spreads centrifugally. When scabs fall, it leaves a ring with a hairless area in the center. Ringworm will usually cure itself without treatment. Common treatments include topical application of povidone iodine, thiabendazole paste or any fungicide.

Milk fever or Parturient Paresis

Milk fever is a disease of high yielding dairy cows due to depression of levels of ionized calcium in tissue fluids around peri-parturient period. It is an acute to per-acute, afebrile, flaccid paralysis of mature dairy cow and manifest by changes in mentation, generalized paresis and circulatory collapse. It is the disease of high producing cows for which increasing age, dry period nutrition, and housing acts as major risk factors. Supplementation of Ca in higher quantities during advanced pregnancy is often redisposing. It will impair the mechanism of intestinal absorption as well as bone resorption to maintain homeostasis. Excess loss of Ca in colostrums, along with insufficient mobilization of Ca from bones and decreased intestinal absorption has been reported as causal factors in milk fever.

Prevention of milk fever in dairy cows can be achieved by supplementation of 30 gm of Ca per day during pregnancy while supplementation should be reduced to 20 gm/day during last two weeks of pregnancy in order to activate hormonally regulated bone Ca resorption and intestinal Ca absorption mechanisms. Milk fever could also be practically eliminated through dietary manipulations. Application of concept of dietary cation-anion difference (DCAD) in mineral supplements to prevent milk fever in cattle was a successful preventive strategy. Dietary anions (sulfur, chloride) are considered as acidogenic, whose excess during Ca stress will increase the concentration of Ca in blood by either increased intestinal absorption or bone mobilization.

Osteodystropies *(*Osteomalacia and Rickets*)*

The skeleton and teeth of mammals contain over 98% of the body's calcium (Ca) and about 80% of the body's phosphorus (P). Because of the relative mass and density of bones and teeth, Ca and P are required in large amounts, relative to other macro-minerals. In addition to their critical structural role, these are essential for normal cellular communication and modulation. Calcium is involved in blood clotting, muscle contraction, transmission of nerve impulses, regulation of the heart, and secretion of hormones, enzyme activation and stabilization. Fortunately, calcium is available in adequate amounts in high quality forages, although calcium can be deficient in weathered or mature forage. Ca deficiency may be primary or secondary, but both conditions results in osteodystrophy. However, the specific disease will depend on the species and age of animal affected. Phosphorus is often discussed together with calcium because these minerals interact in many bodily functions and they are both stored in bone tissue. Phosphorus has many other important physiological roles including cell growth and differentiation, energy utilization and transfer, cell membrane structure, primarily as phospholipids and

acid-base and osmotic balances. Phosphorus is also required by ruminal microorganisms for growth and cellular metabolism. Adequate Ca and P nutrition depends on three factors: a sufficient supply of each nutrient, a suitable ratio between them and the presence of vitamin D. These factors are interrelated. The desirable Ca: P ratio is often between 2:1 and 1:1. For dairy cattle, the Ca:P ratio should be at least 2.4:1 for cows when lactating, but should be less than 1.6:1 for dry cows to minimize Ca intake during that period.

Rickets is one such nutritionally-related metabolic bone disease characterized by a failure of mineralization of bone osteoid and cartilage matrix resulting in visibly swollen joints and lameness. It results in weak, soft bones in young cattle. Retarded bone growth and performance of growing animals. Abnormal bone growth is a common problem in young growing animals of all domestic species. If left untreated, long bones become deformed, leading to angular limb defects, and prone to fractures. Absolute or induced deficiencies of calcium, phosphorus, vitamin D or some combination have been identified as causes of rickets. Absolute minimal daily amounts of all three nutrients are required within appropriate relative ratios to allow for normal mineral deposition in growing bone.

Osteomalacia is defective mineralization of osteoid on the trabecular and cortical surfaces of bone resulting in weak brittle bones caused by demineralization of bones in adult animals. Clinical signs initiated are similar to those of phosphorus deficiency, however specific signs of osteomalacia are painful condition of bone and joints, stiff gait, moderate lameness, arched back. Hindlegs are most severely affected and hock may be rotated inwards.

Grass Tetany or Grass staggers

Grass tetany is caused by a deficiency of Mg in the blood; however, not all animals with hypomagnesaemia will develop grass tetany. Normal levels of Mg in the blood are about 2 mg/100 ml of plasma. In a hypomagnesaemic animal, the level of Mg in the blood is reduced to 1 mg/100 ml. In an animal with grass tetany, a level of blood Mg will likely be below 1 mg/100 ml. Cows in transition and up to 2 months post-calving are the most susceptible to grass tetany. This is due to their need for excess minerals because of those that are lost through milk production. Absence of feedback mechanism in the Mg homeostasis, decrease in the rate of Mg mobilization from bone reserves with age, increased requirements of Mg during pregnancy and lactation, in presence of dietary deficiency predisposes dairy cattle to hypomagnesemic tetany. It is also called as lactation tetany, grass staggers or wheat pasture poisoning. Salivary Na: K ratio affects the absorption kinetics of Mg in the rumen. Peak absorption being recorded at ratio of 5:1. As young grasses are rich in K content while deficient in Na, the feeding of dairy animals on such grasses makes animals more prone to hypomagnesemic tetany.

In acute cases, the animals are generally found dead. If the animal is discovered alive, clinical signs may include excitability, twitching, ear flicking, aggressiveness, abnormal gait, vocalization, convulsions, and frothing at the mouth. Their body temperature begins to rise and their heart beats louder and faster. Death generally occurs within 1 h of the onset of symptoms. In sub acute cases, animals remain standing and signs develop over a period of a few days and include abnormal gait, excessive blinking, decreased feed intake, weight loss, and decreased milk production. The sub acute form, if not treated, can also result in death. Lastly, in the chronic form animals may not show signs but there may be sudden death. Chronic deficiency is characterized by dullness, unthriftiness, indifferent appetite which may end in one of above two syndromes. In simultaneous tetany and hypocalcaemia causes paresis and circulatory collapse in adult recently calved cows. Deficiency of Mg in blood affects the impulse transmission at neuromuscular junction, release of neurotransmitter Acetyl choline (ACh), muscle membrane threshold, as well as activation of cholinesterase. This signifies the importance of the assessment of cerebrospinal Mg concentration in the diagnosis of lactation tetany over plasma or serum Mg.

The prevention of grass tetany depends largely on avoiding conditions that predisposing and precipitating it. Application of fertilizers containing Mg (dolomite or high Mg limestone, MgO) to pasture fields may enhance the pasture Mg content. Pasture dusting with MgO as well as provision of salt containing MgO in *ad lib* to dairy cattle are some of the effective preventive strategies. Ideal management practices with routine forage testing for its mineral composition (Mg) and accordingly supplementation in the diet might be helpful in prevention of lactation tetany in dairy cows. Adequate amounts of magnesium must be consumed on a daily basis.

Postpartuirent haemoglobinuria

Parturient hemoglobinemia or hemoglobinuria, red water and nutritional hemoglobinuria have been used synonymously with postparturient hemoglobinuria (PPH). The disease is usually seen in adult dairy cattle during their third to sixth lactation. Post parturient hemoglobin uria tends to occur during the winter months, especially when preceded by a dry growing season. The pathogenesis of erythrocyte destruction leading to anemia and hemoglobin uria in PPH is unknown. In part, this is probably due to the number and diversity of etiological factors associated with the disease. However, the most likely predisposing factors are phosphorus deficiency, which increases osmotic fragility of erythrocytes, and copper deficiency which increases susceptibility of erythrocytes to oxidative injury. The diagnosis of PPH can be made on the basis of the history, clinical and laboratory findings and after eliminating other causes of intravascular hemolysis. Transfusion of large quantities of whole blood is required for severely affected cows. Crystalloid fluids may be beneficial if blood is unavailable and may protect kidney damage. Treatment with sodium acid phosphate or copper glycinate may prevent hemolysis. Correction of mineral deficiencies and elimination of plant toxins from the diet may help prevent recurrence.

Pica

It is a disturbance related to the appetite and food intake of animal in which animal used to ingest materials other than normal food. Nutritional deficiency of one or several dietary components has been incriminated in the development of Pica. Generally dietary deficiency of bulk, in some cases specific deficiency of dietary fibers or deficiency of specific nutrient like salt, cobalt or phosphorus in the diet. Pica is a deficiency syndrome in livestock animals while it is normal physiological behavior in rabbits and foals where it is thought to be method of dietary supplementation or refection of intestinal bacterial flora. Diseases related to chronic abdominal pain (peritonitis/ gastritis), disturbances of central nervous system like rabies, nervous acetonemia have also been incriminated in the genesis of pica in farm animals. Animals affected with pica may chew bones (osteophagia), eat infants (infantophagia), feces (coprophagia), or soil (geophagia). They also eat woods, bark, carrions, and may show cannibalism. Salt hunger is characterized by coat-licking, leather chewing, earth eating and drinking of urine. Erratic behavior of eating abnormal constituents may lead to serious consequences like deaths of young ones in cannibalism, poisoning (lead, botulism), lodgment of foreign bodies in alimentary tract or obstruction of esophagus/stomach, reduction in grazing time etc. It is a challenging task to point out the actual cause of pica in animals. So therapy is generally done on hit and trial basis or balancing of ration by inclusion of all the nutritional components. Pica can be prevented by inclusion of adequate dietary fiber, provision of salt-licks in ad lib or regular supplementation of balanced mineral mix to meet the deficiencies and to prevent geophagia.

Nutritional deficiencies Anemia

Deficiency of micro-nutrients needed for RBC formation results in anemia which is initially regenerative but ultimately becomes non-regenerative. These micro-nutrients include iron, copper, cobalt (mediated through deficiency of cobalamine).

Iron deficiency is usually of primary type commonly occurring in newborn animals whose sole food source milk is poor in iron content. Iron is major component of hemoglobin which is oxygen carrying protein. Newborn piglets are more prone to iron deficiency anemia (**Piglet anemia**) due to their rapid growth rate with high iron requirement, milk with poor iron concentration as sole feed, and no access to soil a main source of iron. Clinically deficiency of iron in piglets is characterized by reduced growth rate and feed intake, mild diarrhea, dyspnea, lethargy, pallor of mucosae, edema of head and forequarters. Increased incidence of stillbirths has been reported in the litter of sow suffering from iron deficiency anemia. Piglet anemia can be prevented by allowing piglet's access to pasture or dirt yards as a source of iron. For indoor impervious housing system iron should be supplemented at the rate of 15 mg/day until weaning either by oral dosing or by injectable preparations. Oral preparations include ferrous sulfate, iron pyrophosphate, iron-dextran, and iron-galactan while injectables include iron-dextran, iron fumarate, and glutamate.

Copper deficiency anemia is mostly manifested in primary copper deficiency. Copper is required for metabolism and reutilization of iron released from breakdown of haemoglobin. The presence of hemosiderin deposits in tissues of Cu deficient animals supports the above role of Cu. Preventions aims at supplementation of copper as oral (copper sulphate 1-5 g at weekly interval) or injectable (Cu methionate, Cu glycinate) preparations.

Cobalt deficiency results in deficiency of vitamin B 12 in animal body. Resulting anemia is normocytic, normochromic and non-regenerative. However the hemoglobin and erythrocyte levels are often within normal range. Cobalt deficient diets should be supplemented with Co to meet recommended dietary concentration of 0.11mg /kg DM of diet for both sheep and cattle.

Goiter*:*

Goiter is non-neoplastic and non-inflammatory enlargements of the thyroid gland. Major cause of goiter may be due iodine deficiency and is most common in newborn pigs, lambs, calves and foals in iodine-deficient areas. Iodine is an essential trace mineral required in synthesis of thyroid hormones. Deficiency of iron in the animals may be primary or secondary. Secondary deficiency occurs due to conditioning factors in diet like high calcium, gross bacterial pollution of feedstuffs or water, diets containing plants of Brassica species like cabbage, brussels sprouts etc. Subclinical iodine deficiency has been reported as a cause of neonatal mortality. Deficiency of iodine decreased production of thyroxine, hyperplasia of tissue in thyroid gland. The primary deficiency of thyroxine causes weakness and hypoplasia of hairs. Economically important outcomes of iodine deficiency includes loss of libido in bull, failure to express estrus in cow, high incidence of aborted, stillborn or weak calves in cattle, prolonged gestation in mares, ewes, and sows. Major factor responsible for iodine deficiency in farm animals is the failure to provide iodine in the diet. Iodine can be supplemented as salt or as a mineral mixture to meet recommended dietary intake of 0.8-1.0mg/kg DM for lactating and pregnant cows while 0.1-0.3 mg/kg DM for non-pregnant cows and calves. Addition of 200 mg of potassium iodate per kg of salt fulfils the iodine requirement.

Selenium-responsive-disease

Several diseases of farm animals are caused by or associated with the deficiency of selenium and vitamin E alone or in combination. The enzootic nutritional muscular dystrophy (NMD) or white muscle disease occurs in all farm animal species, but common in young rapidly growing calves, lambs, kids and foals from dams fed for long periods on diets low in selenium and vitamin E (NRC, 1983). Disease is characterized clinically by leg weakness, stiffness, flexion of the hock joints, and muscle tremors. Both cardiac and skeletal muscles have been affected. Acute enzootic NMD has been reported to cause around 100 % case fatality in affected animals. In pigs, Se deficiency results in liver necrosis, hepatosis dietetica, resulting in high mortality. Mulberry heart disease in swine has been attributed to

Se deficiency and is complicated by other factors other than Se deficiency. The disease can be prevented by supplementing selenium and vitamin E to deficient animals. Se deficiency diseases can be prevented by administration of Se to the dam during pregnancy in order to build up Se stores in fetus or direct supplementation to young growing animals. The recommended dietary Se requirement in farm animals is 0.1 mg/kg DM content of the diet. Se can be supplemented to animals either by dietary inclusion in feed or water, individual parenteral injections, oral administration or by top-dressing of pastures.

Gender and livestock Health:

Males and females of all ages participate in small-scale backyard animal production predominant in Eastern region of the country. Men usually own and manage large animals, such as cattle and buffalo, while women are almost always responsible for poultry and small ruminants, such as goats and neonates of large ruminants. In fact, their livestock is often one of the few sources of income over which women have complete control.

But gender roles change especially during peak agriculture work or as a result of migration of male in the family for earning in lean seasons. Male livestock keepers also have far better access to training and technology and awareness about animal health and related zoonosis. Extension programmes are usually oriented towards men's livestock, and extensionists lack the incentive and communication skills needed to work with often illiterate women. Interventions to control animal diseases should also take account of gender roles. Men's income may be more at risk from outbreaks of contagious disease like FMD. But as the primary managers of many activities like stall cleaning, disposal of excreta, after-birth, feeding animals, forage collection etc. make women and children face greater health and economic risks from zoonotic diseases like Brucellosis, Leptospirosis, Tuberculosis, Q fever, etc.

The involvement of women in livestock production is a long-standing tradition all over the world. In eastern region of the country, the majority of livestock raisers are agro-pastoralists, deriving their incomes from both livestock and crop production. Gender roles are considered as the social definition of women and men in a society. It is difficult to generalize about the typical role of women within a livestock production system, as it differs even on a regional basis.

Interventions for restricting Gender disposed Zoonosis:

Female Gender is more susceptible to contract various animal diseases owing to work share they perform as discussed above. Various intervention required to restrict zoonosis in female gender are:

1. Educating farm women about various zoonotic diseases which can be transmitted, if carelessly done.
2. Training farm women with good animal farm management practices.
3. On-field practical demonstration of benefits of hand washing with antiseptic soaps.
4. Disposal methods of cow waste including after birth, cow dung, etc.
5. Demonstrating benefits of using various economical sanitary measures in animal houses.
6. Free regular health check up of farm women at 6 month interval at Government hospitals.

Conclusion:

Animal wealth in India has increased manifold and presently the Animal Husbandry practices have also been changed to a great extent due to newer interventions and technologies available. The Eastern region of the country has high density of livestock as it supports 31.14% of the livestock population of India and occupies only 22.5 % of country geographical areas. Livestock Farming system in Eastern region of India is based on low input backyard farming and very few high input large commercial livestock farm exists in the region. Major important infectious diseases of livestock in eastern region are

Foot and mouth disease, Haemorrahgic septicemia, leptospirosis, mastitis, Black quarter, etc and many are important diseases capable of being transmitted from animal to human (zoonotic) and also cause huge economic loss to farmers. Proper integrated disease management is very vital to reduce economic losses due these diseases and also prevent zoonosis. Gender role and disease transmission to animal handler is dependent on type of work performed by Gender. Males and females of all ages participate in small-scale backyard animal production predominant in Eastern region of the country. Male livestock keepers also have far better access to training and technology and awareness about animal health and related zoonosis. Many activities which are related to handling animal waste and its disposal result in zoonosis. Female genders are more susceptible due to more participation in work activity resulting in disease transmission and lack of knowledge, training and public awareness.

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