ROLE OF WOMEN IN INTEGRATED FARMING SYSTEM

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Introduction

Today in India as well as the world over, the biggest challenge agriculture faces is to increase returns on existing agricultural land with environmentally suitable use of inputs, coping in the same time with the climate change impacts, land competition, water shortage, ecosystem services deterioration and food price volatility. In a country like India, the shrinking average farm size in India due to population growth and land competition as well as financial constraints for higher investment in agriculture are constraints due to the fact that almost 80% farm families belong to small and marginal categories. Added to this is the problem of productivity declining due to environmental degradation for example, deforestation, leading to more unstable water resources and soil erosion especially in India.

Female farmers are the invisible farmers whose contribution is immense but not visible because their contribution is primarily seen as part of their household works which is not considered as a formal sector of work. In our country when technologies were introduced, men were the key recipients of it. This was because of the lack of recognition given to women's contribution. Also the agriculture policies in India till recently were male-centric. Men only were seen as the beneficiaries of agriculture sector- so all programs, policies and schemes were addressed from their perspective alone. Now our governmental and non-governmental policies and programs are awakening to female farmers as a commendable contributor to the sector. Due to land competition and low productivity and profitability many of the households are becoming female headed owing to men migrating to the urban centers for other means to earn a living.

Hence, the need for an array of technological solutions to provide sustainable intensification of agriculture globally, each customized for a specific agro-climatic zone. The much anticipated solution lies in a set of advances in the field of improved genetics and improved agricultural practices. While the biotechnological improvements can be expected in the long term period, there is a large space for short term strategies referred to as sustainable and climate friendly systems and techniques. Also there is need for knowledge and understanding of our traditional agricultural practices which were basically eco-friendly in nature. This knowledge is mainly resting with the women. Highly productive, resilient, low emission agriculture requires sound management of land, water, genetic resources and soil nutrients and higher efficiency of these. Due to geometric increase in population, there is huge need to raise the productivity per unit area per unit of time per unit of capital input as bulk of the farmers are small scale and most of the farm land are cultivated under rain fed conditions. There is a range of such production systems such as conservation agriculture, agroforestry, improved livestock production, urban and peri-urban agriculture, organic farming and integrated farming systems.

The word *integrated* is derived from the Latin word "*integrare"* which means to make whole, to complete by addition of parts or to combine parts into whole. The crop, livestock, fish subsystems may function independently in certain farming systems. However, an output from one subsystem which otherwise may have been wasted becomes input to another subsystem resulting in greater efficiency of output of desired products from the land/water area under a farmer's control.

There is synergism in IFS since the working together of the subsystem has greater total effect than the sum of their individual effects. The other related advantages are that it improves their diet, balances the risks among the various farming subsystems, provides fuller employment and generates surplus produce for sale. It is indeed ironical that the food production potential of the tropics where year round is often possible, have not often been realized. It also improves space utilization and the recycling of by-products. Now, the small and marginal farmers are the group which has limited access to off-farm inputs necessary to exploit modern farming technology. So applying IFS is of high value. A major socio-economic benefit is that the inputs for the various subsystems now become intra-farm inputs with less dependence on inter-farm and off-farm inputs.

In this system, an inter-related set of enterprises are used so that the "waste" from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. In other words, we can say that *IFS works as a system of systems*.

The issues of transfer of technology are also addressed well through this holistic approach. It has evolved as a result of the understanding that basically farmers' production environment is much more heterogeneous than had been thought to be earlier. Its a farming system where the, technologies are used not just for their immediate efficiency but for their flexibility too and thus the need to take into account the farmers' perception of uncertainty and security, their long term perspectives and their farming goals. IFS is an actor oriented approach in order to ensure compatibility with the local socio-economic environment.

Integrated Farming System is a paradigm shift from the earlier agricultural research which is reductionist and command-and-control approach. Korten characterizes it as a people centered process rather than the earlier technological blueprint approach.

Its distinguishing characteristic is its interdisciplinary approach-collaboration between a range of different disciplines. It also involves the farmer herself/himself right from the research process. So instead of only focusing on yield increase of a particular crop, IFS focuses on looking at one specific enterprise (or part of it) and identifying improvements that are compatible with the whole farming system.

Example: The following is another example with regard to greater productivity and greater profit to small and marginal group of farmers.

Toor et al, conducted a study in a cluster of four villages in Phagwara Development Block, Kapurthala district, under the ICAR-funded adhoc project entitled "System Approach towards

Income Enhancement" during 2003-06. A set of 11 different IFS was developed and implemented in the farms of selected farmers with 1.5 ha holdings. The results of the study indicated that all the IFS, involving crops (rice, wheat and Aloe vera) and livestock (dairy animals, pigs, poultry, fish, rabbits and honey bees), proved more profitable than crops alone (rice-wheat system) in terms of net returns. Further, IFS resulted in better utilization of land, water input and human resources compared to arable farming alone and it also increased employment generation.

Integrated Farming combines the best of modern tools and technologies with traditional practices according to a given site and situation. In simple words, it means using many ways of cultivation in a small space or land. It takes into account the knowledge and experiences of farmers themselves. Traditional agriculture as an indigenous form of farming is a result of the co-evolution of local social and environmental systems that exhibits lot of ecological rationale expressed through use of local knowledge and locally available natural resources. So using it is not just cost-effective but also does not disturb the ecological balance. FAO aptly calls this kind of agriculture as *climate smart agriculture.*

In addition to the above, today in India, a substantial change has already taken place in consumer preferences for graded, packaged and processed food items of daily use in urban market, especially among middle and high classes. This trend is on the increase and will certainly filter down to rural areas also. Low cost improved technologies are required to unleash potential and improve market efficiency and remain competitive simultaneously. Moreover, recent trends have clearly shown the accelerated use of by-products for value addition. For example, now sugarcane is not only used for sugar production but every by-product of it is used economically by sugar mills- bagasse forelectricity generation, pressmud for preparation of high value organic manure and molasses for alcohol production. Similarly, in case of paddy, husk is being used as a very efficient source of fuel in boilers and bran is used for edible oil extraction. Many vegetable oils-earlier considered to be non-edible are being extensively used as edible after development of refining technology. All these advantages and the varied value addition technologies can be used by farmers too.

Integrated farming system is a whole farm management system which aims to deliver more sustainable agriculture. It is a dynamic approach which can be applied to any farming system around the world. It involves attention to detail and continuous improvement in all areas of a farming business through informed management processes.

Classification of Integrated Farming System

Some of the combinations of IFS are as follows:

1. Crops subsystem- multiple cropping comprising a mix of cereal, vegetables, cash crops, legumes and fodder crops – any permutation combination
2. Crops + Livestock subsystems
3. Crop + Fish subsystems
4. Crop + Fish+ Livestock subsystems

Role of women in Integrated Farming System

The fact that environmental degradation has affected women's lives in ways different from men is well established by now. Women have been identified as the key casualties of overall global ecological degradation by many environmentalists. This is mainly attributed to the fact that there exists a clear gender demarcation with regard to tasks both at farm level and at household level. It is women primarily who are responsible for producing, processing and gathering food, fetching water and carrying fuelwood.But owing to this women's perspective of task completion is very much holistic and integrated. Traditionally, they look at farm and household as one unit and not as disparate units.

In India too, women play a very important role in household management including agricultural operations. This is especially true for hilly and tribal areas. As such, one can see further on, a gradual feminization of agriculture owing to men especially the small and marginal level farmers migrating to rural non-farm sectors as well as urban centers too.

Research shows that on average, women are better at multi-tasking as compared to men. They are able to organize their time better and switch from one work to another faster with relative ease as compared to their male counterparts. This is due to the fact that there is social and psychological conditioning in the society, nee Indian society for a girl child to adapt herself to multi-tasking and as she grows to be a woman it continues because she does have to look to several tasks contrary to men. This makes it easier for women to adopt IFS. It is definitely easier for them to further hone their multi-tasking skills at home and at the farm taken together.

Micro-credit in India has turned into a big movement to empower women. It has been adopted by various NGOs as well as the government and has served as a huge medium of women empowerment. Women acquire the biggest strength i.e. social capital by being part of a well-knit group which serves as a forum where they can be their own and also develop their management skills. Integrated farming system can greatly benefit from this movement if SHG women take it up as an enterprise as well as replenishing the needs of their families.

Example: *Let's look at women's role in Kumaon Hills. Here the livelihood of the people is dependent on the sound management of its natural resources and their sustainable utilization. Here subsistence farming remains people's main source of livelihood, but it cannot be seen in isolation. Forest, grasslands, farms, livestock and water all were organically linked with each other and everybody respected this link. Farming was done at a subsistence level with forest providing a strong support base. They provided leaf litter for manure to be used by agriculture and fodder for animals. In turn, the livestock manure enriched forests and farms. Good forest especially the broad leaved forest, was essential for preservation of water in springs, which was in turn necessary to irrigate the fields. The linkage between these sectors is well understood by women as they work between sectors and perform multiple tasks. Women's work and knowledge is thus central to bio-diversity conservation and sustainable utilization of resources in hill agriculture.*

There is a vast scope to improve the household profitability by judiciously utilizing family labor using innovative practices and ensuring multiple uses of various household and farm resources. This is possible through women empowerment by way of specific trainings and critical need based support.

Thus women especially need to be given training on the new permutation combinations in IFS. Another rationale for enhancing the skill of women with regard to IFS is due to the fact that they are the key custodians of traditional knowledge. When we talk of managing and preserving traditional knowledge, the pivotal role played by women cannot be ignored. It is true that women have much more pragmatic knowledge of the practices in which they are engaged, leading to a kind of specialization. The close association between women and natural resources exists because of their social and economic roles which have for generations required them to provide food, fuel and fodder from the surroundings.Farm women are closer now than ever before towards increased food production with the increased concern of environment and overuse of pesticides.Recognition of Women work participation will shift agriculture from increased production to increased prosperity through development of various gender friendly IFS required for the sustainability of small and marginal farm families, which are the back bone of agriculture globally.

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GENDER MAINSTREAMING - CONCEPTS AND METHODOLOGIES

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Introduction

Understanding the gender concepts and their uses in agriculture development constitute the basis learning. Each concept has broad definition and operational part according to the field of development. The importance of gender mainstreaming in agriculture is becoming a core subject of policy formulation. This would not only bring significant increase in GDP but also contribute to social development/security.

Hard facts on gender in India

- Inequality between men and women.
- Death rate of children in the group of age 1-5 is 50% higher for girls than boys.
- India is placed at 98th position having Gender Development index 0.586 amongst 140 countries of the world.
- About 40% of the women are subjected to domestic violence.
- Statistics reveals that women perform 75% of the work, earn 10% of the income and own 1% of property (UNESCO).

Given below definitions of concept commonly used in gender studies. A clear understanding of concepts would help the participant to formulate gender development paradigms having constructs and variables derived from the concepts.

1.	Sex	Means the biological differences between women and men, which are universal, obvious and generally permanent.
2.	Gender	Means the socially constructed differences in roles and responsibilities assigned to women and men in a given culture or location and the societal structures that support them. Every society has different 'scripts' for male and female members to follow. Thus members learn to act out their feminine or masculine role, much in the same way as every society has its own language. The term gender was first used by Ann Oakley and others in 1970s as analytical tools to understand the characteristics of men and women which are socially determined in contrasts to biological differences.
3.	Gender roles	The role refers to the activities perform by men and women in different situations and in different times and within the different cultures, classes, castes, ethnic groups etc. The roles of men and women are shaped by various forces such as social, cultural, economic, environmental, religious and political. The gender roles

		may change depending on the socio-cultural dynamics of the society.
4.	Triple roles	Are roles (tasks and responsibilities) men and women may have related to: production (producing money value), reproduction (the child bearing and rearing responsibilities required to guarantee the maintenance and reproduction of labour force), community management/community polities (producing community goods and well beings).
5.	Gender analysis	Gender analysis is a tool to better understand the realities of the women and men, whose lives are impacted by planned development. These include gender issues with respect to social relations; activities; access and control over resources, services, institutions of decision-making and networks of power and authority and needs, the distinct needs of men and women, both practical and strategic.
6	Access to productive resource	Refers to right and opportunity of men and women to use the resources as per one's need to carry out his/her activities.
7	Control over productive resources	Refers to the rights and power of men and women to decide on the use and destination of the resources.
8	Practical gender needs	Practical gender needs are the needs women identify in their socially accepted roles. Practical gender needs do not challenge the gender divisions of labour or women's sub-ordination position in society, although rising out of them. PGN are a response to immediate perceived, identified necessity, within a specific context. They are practical in nature and often are concerned with inadequacies in living conditions such as water provisions, health care and employment.
9	Strategic gender interests	Strategic gender needs are the needs women identify because of their subordinate position to men in their society. These vary according to particular context. They relate to gender divisions of labour, power control and may include such issues as legal rights, domestic violence, equal wages etc. meeting strategic needs helps women to achieve greater equality. It also changes existing role and therefore challenges women's sub-ordinate position.
10	Gender equality	Gender equality means that women and men enjoy the same status. Gender equality means that women and men have equal conditions for realizing their full human rights and potential to contribute to national, political, economic, social and cultural development and to benefit from the results. Gender equality is therefore the equal valuing by society of both the similarities and differences between women and men, and the varying roles that they play.
11	Gender equity	Gender equity is the process of being fair to women and men. To

		ensure fairness, measures must often be available to compensate for historical and social disadvantages that prevent women and men from otherwise operating on a level playing field. Equity leads to equality.
12	Gender blind	Gender blind is a person who does not recognize that gender is an essential determinant of life choices available to people in society
13	Gender bias	Perception that both sex are not equal and do not have similar rights to resources.
14	Gender discrimination	Unfavourable treatment of individuals on the basis of their gender.
15	Gender mainstreaming	Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies and programmes, in all areas and at all levels. It is a strategy for making women's, as well as men's concerns and experiences, an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. The ultimate goal is to achieve gender equality.
16	Women in development(WID)	WID subscribes to the assumptions of modernization theory. Its programmes generally stress western values and target individuals as the catalysts for social change. Modernization theory identifies traditional societies as male-dominated and authoritarian compared to modern societies which are democratic and egalitarian. It usually seeks to integrate women into development by making more resources available to women. However, these efforts led to increase in women's work load, reinforced inequalities, and widened the gap between men and women.
17	Women and development(WAD)	It emerged from a critique of the modernization theory. The theoretical base of WAD is dependency theory and focuses on relationship between women and development process and examines the nature of integration. It is concerned with women's productive role and assumes that once organizational structures become more equitable, women's position would also improve.
18	Gender and development(GAD)	The gender and development seeks to base interventions on the analysis of men's and women's roles. This approach developed in the 1980s. It questions the basis of assigning specific gender roles. Recognizes that patriarchy operates within and across classes both inside and outside the home and oppresses women. A workshop on "Gender analysis in Agriculture" jointly organized by KAU, Thrissur and MS Swaminathan Research Foundation, Chennai from 6-8 November, 2000 given below the gender relations in agriculture • Unequal rights to private and common land and other assets • Unequal rights to lease land

		• Unequal access to non-traditional tasks • Unequal total workload • Unequal access to extension inputs and credit • Unequal access to family labour • Unequal access to cooperative membership and leadership • Unequal wages for work of equal value • Unequal assess to markets and control over income • Unequal access to food and nutrition
19	Gender planning	An important underlying rationale of gender planning concerns the fact that men and women not only play different roles in society, with distinct levels of control over resources, but that they therefore often have different needs. As gender planning is done only on basis of gender needs, gender needs assessment is an important aspect of the whole process. Gender planning is undertaken with the objectives of achieving gender equity, equality and empowerment through practical and strategic gender needs.

Goals of Gender Mainstreaming

- Recognition and visibility
- Participation
- Decision making
- Development/ extension programmes
- Participation in research
- Access to productive resources
- Control over resources and outputs.
- Organizational participation
- Access to food and health care services.
- Benefit sharing

Methodologies

- International collaboration
- National Gender Policy
- Gender planning
- Gender sensitization for all stakeholders including general public
- Strengthening gender in the institutions

Participatory approaches

- Appointment of women as grass root worker in different sectors would promote participation of women (Gender Sensitive Extension Approach).
- Training programmes and field activities must take into account the problems and needs of the women.

- Activity calendars of various departments should understand the women's role before deciding the date and time for various programme.
- Agricultural programmes having horticulture, livestock, honey bee, value addition, post harvest enterprises can promote participation of women.
- While addressing the practical gender needs, participatory approach should be employed to find a best solution.
- Research projects in agriculture on problems and needs of women should be plan and executed through participatory on-farm trials (Gender Sensitive Technologies).
- Drudgery reduction of farm women through various farm implements can be demonstrated by involving women.
- Programme on bio-diversity, seed production, homestead farming and organic farming may provide better opportunities for women in terms of employment and income.

Conclusion

The concept and methodology give the learners wide ranging thoughts for promoting growth, harmony and peace in the society. The operational parts would be more useful to the participants in initiating and directing the refers to achieve gender mainstreaming.

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GENDER PERSPECTIVE IN AGRICULTURAL RESEARCH AND DEVELOPMENT

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Introduction

Gender has, now-a-days, become an area of immense interest in agriculture and rural development. The term 'gender' describes the characteristics of men and women which are socially determined in contrast to biological differences. Gender means the socially constructed differences in roles and responsibilities assigned to women and men in a given culture or location.
The distinction between sex and gender is made to emphasize that everything women and men do, and everything expected of them, with the exception of their sexually distinct functions(childbearing and breast feeding; impregnation) can change, and does change, over time and according to changing and varied social and cultural factors. As culture is dynamic and socio-economic conditions change over time, so also gender patterns. Thus gender is a dynamic concept (Williams, 1999).

Women Vs Gender

Many often wonder- why 'gender'? Why not 'women'? In fact shifting of focus from women to gender reflects the changed approach of world community for addressing problems of women. The term 'women in development' (WID) was coined in the early 1970s by the Women's Committee of the Washington DC, Chapter of the society for International development, a network of female development professionals. The term was adopted by the United States Agency for International Development (USAID), and gave rise to what is known as 'Women in Development (WID)' approach. The underlying rationale of WID approach is that women are an untapped resource who could contribute to economic development. Therefore, development outcomes would be better realized if women were fully incorporated into the development process. It focuses mainly on women in isolation, and advocates measures such as access to credit and employment for integrating women into development process. But WID approach by focusing on women in isolation ignored the real problem, i.e. subordination of women to men, which is manifested in unequal gender relations.

There emerged another school of thought, which, after recognizing such limitations of WID approach, drew attention to the concept of gender and propounded 'Gender and Development' (GAD) approach. This approach focuses on gender rather than women. In other words, it look not only at women as a category, but also at women in relation to men, and the way relations between men and women are socially constructed (Moser, 1999).

To explain the term 'gender' further, it is a neutral term meaning either men or women or both in a particular context. For example, in men dominated society, gender issues would mean mostly the issues concerning women as it can be fairly assumed that men in general are better off socially as compared to the women. Similarly, in women dominated system, gender issues should focus on problems faced by men. Our goal is to improve the status of disadvantaged class and get rid of socially created and approved discriminations. Therefore, while discussing gender issues in particular context focus could either be on men or women or both. Obviously, reference has to be made to the relative gender position in the society or system or domain in question in order to assess and appreciate the situation from gender perspective.

Gender- some connotations

The word 'gender' carries different connotations. First, it is a concept that describes the socially constructed roles played by men and women. This concept has given rise to several other concepts and terminologies that are of socio-economic relevance. Importantly, these concepts are having significance for planning research, development and policy interventions.

Second, gender is an important subject of Research & Development. During past years, there has been a spurt in gender related activities in areas like research, development and documentation. This has contributed to a wealth of literature, including volumes of gender disaggregated data, tools for analysis and framework for planning and implementation of research and development activities with gender perspective. After all, as a subject it has not only found space within many other disciplines, but also has given rise to new universe of study encompassing different disciplines. For example, within disciplines like agriculture, horticulture, fishery, livestock production and management, the subject of gender is gradually taking shape and gaining importance. Similarly gender as a subject can also encompass other disciplines into its fold for a comprehensive understanding of the situation. However, till today the subject has remained largely unexplored and is still evolving.

As a subject it has the blend of sweetness and sourness. Sweetness; because it is an interesting as well as exciting subject for many, particularly those in the field of social science. But it may be somewhat sour and confusing for many particularly those are from commodity research background. At the same time, it is a challenging area especially when we are looking at gender in the context of technology generation and refinement for creating gender friendly technologies. Notwithstanding the challenges in applying the idea, it has become one of most sought-after subjects in research and development.

Third, gender is a factor in R &D process. It is a factor because men and women are primary stakeholders in development process. It is the quantity and quality of their labour and human resource that determine the outcome of development process. It is precisely in this context that researchers have tried to investigate if 'gender' (man or woman) as a factor has any influence on output or outcome. In this case we treat gender as a variable in nominal scale that takes values either 0 (say for man) or 1 (for woman) for doing the analysis. Lessons from such exercises may imply how the presence of men or women affects the outcome of interventions and what are the specific attributes that might have resulted in differential output or outcomes.

Gender and Agricultural R &D

In past many of the developments in gender related knowledge were sociological in nature. Of late, gender concepts have found increasing attention and application in applied areas such as agriculture, livestock, fishery, rural development and livelihood security etc. There are two ways that we can look at gender in the context of agriculture R & D. First, effects of R & D process on gender and second, gender role in R & D process.

A. How R & D process affects men and women?

This is an important approach to study relationship between gender and R&D processes. A very common area of research in this context is gender impact analysis of agricultural research and development. For example, how the structural, technological and institutional changes have affected men and women from different background in different situations in matters like sharing of benefits, work burden, changes in gender role, access to resources etc. and reasons thereof. How the much talked triple role of women i.e. reproductive, productive and community roles have been affected by the developments. Such studies are quite useful as the findings can be used in revision of the programmes and policies to create wider and equitable gender impact.

B. How gender affects agricultural R & D process?

The focus here is on gender as a factor in R&D process. This approach to study the relationship between gender and R & D considers both similarities and differences between men and women. Similarities, because both men and women are important stakeholders in R&D process, and differences, because men and women have different roles to play and needs to address. At the same time they have attributes that can differentially influence R&D process. The objective is to see how men and women do participate in R & D process and influence the outcomes. How they differ in their perception about R & D processes and in managing the situation. In other words, we have to characterize the situations to explain the level and diversity of gender participation. What should we do to make men and women more effective?

In this approach we can focus on case studies, evaluation studies like performance of men and women managed systems and enterprises. Some useful theme areas could also be gender role, participation and contribution in agriculture and allied sectors, and their dynamics under varying situations to understand gender implications in research and development. Outputs from such studies would be useful to design interventions for strengthening gender role in agricultural development and develop gender based R&D models.

Gender perspective in development

In development context, there are two critical issues that a development manager should worry about; smooth implementation of programme as per plan, and attainment of envisaged objectives leading to desired outcomes. Adding gender perspective to an intervention would, therefore, mean looking at these two different aspects through gender lens. First, what is

gender role in implementation of interventions? Is there any scope for strengthening gender role in carrying out the intervention? Secondly, how would the development intervention affect men and women? Would there be gender equity in sharing of benefits of intervention, or would there be differential incidence of adverse consequences on gender?

Even though the two aspects appear completely different, at certain level, one reinforces the other. For example, adding gender perspective in management of intervention may lead to better outcomes in terms of gender equity in sharing of benefits. Similarly, equitable gender impact may motivate men and women to participate in development process.

In recent years there has been a greater emphasis on people's participation in planning and implementation of development interventions. Since the impact of these interventions ultimately reflects upon the living conditions of people, following the same traditional approach of project planning and implementation without understanding gender implications thereof may exclude women from benefit sharing process. In situations, it may even make women worse off in normal course of development. Therefore, a development manager should be careful not to lose sight of gender perspective before implementation of the intervention in order to reap additional dividends in terms of enhanced output, and gender equity.

Government policies are important instruments to influence the development process. In fact policies are aimed at creating a favorable environment for accelerated development. For creating wider and equitable impact, policies should contain adequate provisions to encourage women's participation. In other words, policies should be gender sensitive.

Incorporating gender perspective in development necessitates two simultaneous activities; (a) making development institutions gender sensitive, (b) enabling development managers and planners understand and apply gender perspective in respective areas.

To make the organizations gender sensitive, there is a need for re-orientation on following lines.

- Adding gender dimension in development approach
- Making an explicit mention of gender in mandates, objectives and policy documents of departments
- Recognizing women as a stakeholder in organization's programmes
- Providing for opportunities to encourage women's participation

Besides the above, there is also an urgency to introduce reforms both in structure and functioning of the organizations to impart gender sensitivity. No doubt, we have, in India, a host of central sponsored women specific programmes being implemented by agriculture departments of state government. However, review of policy documents, thrust areas and mandates of agriculture departments of state governments suggests that very few states have made explicit mention of gender.

The second part, i.e. enabling development managers understand gender perspective, involves orientation and capacity building on gender. In other words, they should not only be gender sensitized, but also fairy educated on the subject.

Gender in the context of research

There are two points that are worth mentioning in the context of research.1) Is there any need to incorporate gender perspective in research; If so, how? 2) Does gender as a factor influence the research output?"

Technology development

It is generally argued that the process of technological development in agriculture has largely bypassed the needs of women. As a result, many of the technologies developed so far are said to have failed the test of gender suitability as evidenced from very low level of adoption by women and gender inequity in sharing of benefits of such technologies. This suggests that technologies, in order to create desirable impact on agriculture and rural households, must also be accepted and adopted by women, who constitute a significant part of workforce in agriculture. The level of acceptability and adoption of a technology would be high if natural demand of that technology is high. When we talk of natural demand of a technology, it means the technology must have the characteristics to meet different gender needs in the said context. This is only possible if a researcher adds gender perspective into the technology development process considering relevant gender needs. Therefore, incorporating gender perspective in technology development process is an essential condition, if not a sufficient condition, to develop gender friendly technologies for meeting gender needs and preferences that would ultimately push up the adoption level.

With increasing complexities of socio-economic environment, social science research has now-a-days assumed greater significance. Moreover, poor adoption of agro-technologies among clientele and not-so-encouraging performance of technologies in the field have led us to realize the importance of socio-economic inputs not only in technology development and refinement process but also in planning and implementation of technology transfer programmes. Policy research is another area that have gained significance at a time when there is need for gender sensitive polices for mainstreaming gender concerns in agriculture and creating equitable gender impact.

Why Gender for a researcher?

There seems to be an initial reluctance on part of researchers in general to accept the concept of gender. Also, they do not find the concept comfortable to work with. It is but natural for them to ask, 'why to add gender perspective in research'?

As we know, all researchers invariably look for certain output from their research. But all may not be fully convinced as to how the output would be useful. Except in case of basic researches, outputs from all other types of researches have implications for development, and could be

used for designing, planning and implementation of programmes. Outputs could be new information and knowledge, technology, methodology and even policy recommendations. Therefore, every scientist should see that the outputs from her/his research should be relevant, acceptable to, and used by the stakeholders.

The very objective of adding gender perspective in our research is 'to add value to our research output so that research output becomes contextually more relevant and appropriate, and there is enhanced scope for application and acceptability of research findings'.

As men and women are equal partners in development process and have equal stakes in the use of technology, there is a need for adding gender perspective in our research to obtain gender friendly technologies. Research with gender perspective would also generate information of value and new knowledge that can be used in planning gender based research programmes. To realize this, there has to be a change in the mindset and actions of researchers. In other words, the scientists should be gender sensitive, and responsive enough to discuss, debate, understand and incorporate gender in their own field of work.

Summing up

Understanding and applying gender perspective in agricultural R & D is very important in the present context of social, cultural, technological and economic changes that we are facing. Such a paradigm shift is needed to obtain crucial gender related information and knowledge based on which measures for mainstreaming gender concerns in agriculture can be initiated.

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SEAGA TOOLS FOR GENDER ANALYSIS IN AGRICULTURE

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The present issue of global concern is gender equality and women empowerment. Now, the researchers and policy makers have realized the importance of gender equality. Therefore, to bring equal status, gender analysis is a must to understand the gender issues, their roles, responsibilities, needs, etc. A number of tools/frameworks are available for gender analysis as following.

Gender Analysis Tools/Frameworks

1. Harvard Analytical Framework
2. Moser (triple roles) Framework
3. Levy (web of institutionalization) Framework
4. Gender Analysis Matrix (GAM)
5. Equality and Empowerment Framework (Longwe)
6. Capacities and Vulnerabilities Framework (CVA)
7. People Oriented Framework (POP)
8. Social Relations Framework (SRF)
9. SEAGA Approach of FAO

SEAGA tools: SEAGA is a technique for gender analysis which has been developed by FAO. SEAGA is an approach stands for socio-economic and gender analysis and helps in participatory identification of priorities of women and men to bridge the gap between them. It helps the participants to better understand the ground realities of the women and men, to identify the gender issues with respect to activities, access to and control over resources, decision making, needs and problems and also to formulate projects for gender mainstreaming in research and extension. On the other hand, it is for analysis of the current situation and planning for the future.
Broadly, all the tools are classified into three categories of gender analysis as:

a) **Development context toolkit:** Here, the focus remains on current situation (What is) for learning economic, environment, social and institutional patterns that act as supports or constraints for development.

b) **Livelihood analysis:** Here, the focus is on current situation (What is) for learning the flow of activities and resources for living.

c) **Stakeholders' priorities**: Here, the focus is on future (What should be) for planning development activities based on women's and men's priorities.

A. **Tools under Development Context:**

(i) Village Resources Maps
(ii) Transects
(iii) Village social map
(iv) Trend lines
(v) Venn Diagrams
(vi) Institutional profiles

(i) Village Resources Map: Helps for learning about the environmental, economic and social resources in the community. This map focuses on available resources like roads, buildings, houses, water bodies, agriculture land, grazing land, forest area, shops, health clinics, educational institutions, religious institutions, bus stop, etc.

(ii) Transects: It gives more details about environmental, social and economic resources in a community and provides a cross sectional picture of an area through direct observation. Helps for learning about the community's natural resource base, land forms, and land use, location and size of farms or homesteads, and location and availability of infrastructure and services and economic activities.

(iii) Village Social Map: It gives a perceptional picture of resources existing in the community. It helps for learning about the community's population, local poverty indicators and number and location of households by type (ethnicity caste, female-headed, wealthy, poor, etc.).

(iv) Trend lines: It is a simple graph depicting change over time. It gives a picture of what is getting better and what is getting worse over time. It helps for learning about environmental trends (deforestation, water supply); economic trends (jobs, wages, costs of living), population trends (birthrates, out-migration, in-migration), and other trends of importance to the community.

(v) Venn Diagrams: Through this tool we can identify the potential conflicts between different socio-economic groups. It helps for learning about local groups and institutions and their linkages with outside organizations and agencies.

(vi) Institutional Profiles: It helps for learning about the goals, achievements and needs of local groups and institutions.

B. Tools under Livelihood Analysis:

(i) Farming system diagram
(ii) Benefits analysis flow chart
(iii) Daily activity clocks
(iv) Seasonal calendars
(v) Resource picture cards
(vi) Income and expenditure matrices

(i) Farming Systems Diagram: It is a diagram to highlight the farming systems in family. It helps for learning about household members' on-farm (crop production), off-farm (fuel collection) and non-farm (marketing) activities and flow of resources to and from the home. It shows how livelihood depends upon various types of agro-eco-systems like forest, river, grazing land, etc which are in common use.

(ii) Benefits Analysis Flow Chart: Through this analysis, we may be able to understand what the 'fruits' are from people's livelihood activities and who enjoys that. It also helps for learning about benefits use and distribution by gender. The bi-products are the result of any resource. Example, 'tree' as resource has bi-products like leaves, bark, fruits, seeds, fiber, fuel wood, fodder, etc, Here, who is the gender to enjoy these can be understood.

(iii) Daily Activity Clocks: It gives a total picture of activities performed by gender in a day and who does more and also who does less. Helps for learning about the division of labour and labour intensity by gender and socio-economic groups. It helps to identify the workloads and leisure time for the community people including men, women, rich, poor, young and old. The clear picture comes that who works for longest hours and who does little activities.

(iv) Seasonal Calendars: Helps for learning about the seasonality of women's and men's labour and seasonality of food and water availability and income and expenditure patterns and other seasonal issues important for the community. The calendars can be used to know the changes in income over the time and the work opportunity for the people at different periods of time.

(v) Resources Picture Cards: Helps to know the gender based resource use and control within the household. This exercise facilitates us to know who is likely to be looser and who is likely to be gainer because of a particular development activity. It gives idea about who has access over the household resources (land, livestock, trees) and who takes decisions for its use.

(vi) Income and Expenditures Matrices: Helps to find out about sources of income, sources of expenditures and changes in expenditure at crisis. Analyzing their items of expenditure the priorities and limitations can be understood. It helps to understand the security or vulnerability of livelihood, meeting basic needs and saving if possible for rainy days.

C. **Tools under Stakeholders' priorities**:

(i) Pair wise Ranking Matrix
(ii) Flow Diagram
(iii) Problem Analysis Chart
(iv) Preliminary Community Action Plan
(v) Venn diagram of Stakeholders
(vi) Stakeholders Conflict & Partnership Matrix

(vii) Best Bets Action Plans

(i) Pair wise Ranking Matrix: Helps to know the most important problems in the community, the priority problems of women and men and of different socio-economic groups.

(ii) Flow Diagram: This analysis helps to identify about the causes and effects of their problems and can be used for possible solutions. This identifies the major problem in the community and decides which problem to be solved by the community, which can be solved by the external source and which has no solution like natural disasters.

(iii) Problem Analysis Chart: It is used for bringing together the priority problems of all the different groups in the community, to explore local coping strategies and to identify opportunities to address the problems.

(iv) Preliminary Community Action Plan: It is helpful for planning possible development activities, including resources needed insider and outsider groups to be involved and timing.

(v) Venn diagram of Stakeholders: Stakeholder is anyone who has interest in and is going to be affected in any developmental work. It helps us to know who is going to be affected by the proposed development plan. Gives a picture about the insider and outsider stakeholders for each action proposed in the Preliminary Community Action Plan. The extent of interest of a stakeholders is determined by the size of their stake in it.

(vi) Stakeholders Conflict and Partnership Matrix: This analysis helps for learning about conflicts of interests and common interests between stakeholders.

(vii) Best Bets Action Plans: Facilitates for finalization of action plans for development activities meeting priority needs as identified by women and men of each socio-economic group

Based on their communities, priorities and needs these tools for gender analysis can be used by the researchers with little modification

SOURCE: *FAO SEAGA FIELD TOOL KIT. GENDER ANALYSIS FOR SUSTAINABLE LIVELIHOODS*

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GENDER DISAGGREGATED DATA – ANALYSIS AND IMPORTANCE

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Gender-disaggregated data means every data that is cross-classified by gender, presenting information separately for women and men, boys and girls. Gender-disaggregated data reflect roles, real situations, general conditions of women and men in every aspects of the society. For instance, the literacy rate, education levels, business ownership, employment, wage differences, dependants, house and land ownership, loans and credit, and debts are all included. Without gender-disaggregated data, it will be more difficult for us to identify the real and potential contributions of half of the population to our country, and could hinder the development of effective policies. Statistical analytical procedures remain same for analysis of gender disaggregated data. The only important part is to consider gender as one component which must be incorporated in the whole procedure during analysis and such analysis helps not only to know the current status of involvement of gender component in projects, programmes, plans, policies etc. and the current development pattern of the nation but also it helps in developing appropriate gender mainstreaming strategies and there by policy making and development process.

Gender-disaggregated data can be applied to
- Find out the different conditions of women and men, including changes over time;
- Consider and track the impacts of national activities on women and men;
- Find out and further define the problems, and then develop options and choose the most effective and beneficial one for both gender;
- Allocate resources and work in a fairer way;
- Evaluate and monitor outcomes and conclusions by gender;
- Present the progress or lack of women by indicators and regular data publications

There is a need to generate gender-disaggregated information/ data and performance indicators for monitoring purposes. Knowledge of appropriate tools for data collection and analysis is therefore required for proper interpretation from the collected information. Few important statistical tools enlisted in this article are described briefly. The details on all statistical procedures may be obtained from any standard statistics book.

The prerequisite of analysis of gender disaggregated data is collection of quality data and understanding about the data types (qualitative and quantitative). Once the data has been collected, the next step is to understand the data using descriptive and exploratory analysis using different graphical, tabular and statistical tools. The following are some of the tabular and graphical methods widely used for describing and exploring the qualitative and quantitative variables.

Methods	Qualitative Data	Quantitative Data
Tabular	○ Frequency distribution ○ Relative frequency distribution ○ Percent frequency distribution ○ Cross tabulation	○ Frequency distribution ○ Relative frequency distribution ○ Cumulative frequency distribution ○ Percent frequency distribution ○ Cross tabulation
Graphical	○ Bar graph ○ Pie chart	○ Dot plot ○ Stem and leaf display ○ Histogram ○ Scatter diagram ○ Ogive

Apart from the tabular and graphical methods, there are number of statistical tools (numerical measures) for descriptive and exploratory analysis of quantitative variable. The statistical tools include measures of central tendency/ location, measures of dispersion/ variability, shape of distribution, measures of association etc.

	Measures			
	Central tendency	**Variability**	**Shape of distribution**	**Association**
Descriptive Statistics	○ Mean ○ Median ○ Mode ○ Percentile ○ Quartile	○ Range ○ Interquartile range ○ Variance ○ Standard deviation ○ Coefficient of variation	○ Skewness ○ Kurtosis	○ Covariance ○ Correlation coefficient

For descriptive and exploratory data analysis along with the usual graphical and tabular tools measures of central tendency and measures of dispersion also play an important role to describe the gender disaggregated data. Many times the data must be visually observed using proper graphical tools to understand the behaviour of the data or interrelationship between/among the variables, but the measures of association helps in quantifying the interrelationship between variables. A list of some of the important statistical measures are briefly mentioned as follows:

Measures of Central Tendency

Mean: The mean of a data set is the average of all the data values. The sample mean ($\bar{x}$) is the point estimator of the population mean (μ).

Sample mean $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$; n is the sample size, x_i is a random variable

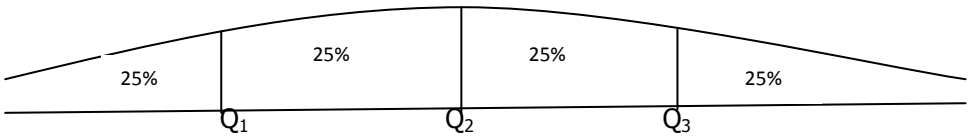
Population mean $\mu = \frac{1}{N}\sum_{i=1}^{N} x_i$; N is the population size, x_i is a random variable

Median: The median of a data set is the value in the middle when the data items are arranged in ascending order. With an odd number of observations, the median is the middle value. An even number of observations has no single middle value.

Mode: The mode is the value that occurs with greatest frequency. Situations can arise for which the greatest frequency occurs at two or more different values. In these instances more than one mode exists. If the data contain exactly two modes, we say that the data are bimodal. If data contain more than two modes, we say that the data are multimodal. In multimodal cases the mode is almost never reported because listing three or more modes would not be particularly helpful in describing a location for data. The mode is an important measure of location for qualitative data.

Percentile: A percentile provides information about how the data are spread over the interval from the smallest value to the largest value. For data that do not contain numerous repeated values, the p^{th} percentile divides the data into two parts. *The p^{th} percentile is a value such that at least p percent of the observations are less than or equal to this value and at least (100-p) percent of the observations are great than or equal to this value*. Colleges and universities frequently report admission test scores in terms of percentiles.

Quartile: It is often desirable to divide data into four parts, with each part containing approximately one fourth, or 25% of the observations.



Q_1 = first quartile, or 25th percentile
Q_2 = second quartile, or 50th percentile (also the median)
Q_3 = third quartile, or 75th percentile

Measures of Dispersion

Range: The simplest measure of variability is the **range**. Although the range is the easier of the measures of variability to compute, it is seldom used as the only measure. The reason is that the range is based on only two of the observations and thus is highly influenced by extreme values.

Range = Largest value - Smallest value

Interquartile Range: A measure of variability that overcomes the dependency on extreme values is the interquartile range (IQR). This measure of variability is simply the difference between the third quartile, Q_3, and the first quartile, Q_1. In other words, the interquartile range is the range for the middle 50% of the data.

Interquartile Range (IQR) = Q_3-Q_1

Variance: The variance is a measure of variability that utilizes all the data. If the data are for a population, the average of the squared deviations about population mean is called the population variance (σ^2). For a population of *N* observations and with μ denoting the population mean, the definition of the population variance is

Population Variance $$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2$$

When we compute a sample variance, we are often interested in using it to estimate the population variance. It can be shown that if the sum of the squared deviations about the sample mean is divided by *n*-1, and not *n*, the resulting sample variance provides an unbiased estimate of the population variance. Therefore, the sample variance is

Sample Variance $$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$$

The units associated with the sample variance often cause confusion. Because the values being summed in the variance calculation are squared, the units associated with the sample variance are also squared. The squared units associated with variance make it difficult to obtain an intuitive understanding and interpretation of the numerical value of the variance.

Standard Deviation: The Standard Deviation is defined to be the positive square root of the variance. *s* is used to denote the sample standard deviation and σ to denote the population standard deviation. The sample standard deviation s is the point estimator of the population standard deviation σ.

Sample standard deviation $= s = \sqrt{s^2}$

Population standard deviation $= \sigma = \sqrt{\sigma^2}$

The standard deviation is measured in the same units as the original data. So the standard deviation is more easily compared to the mean and other statistics that are measured in the same units as the original data.

Coefficient of Variation: The coefficient of variation is a relative measure of variability; it measures the standard deviation relative to the mean. The coefficient of variation is usually expressed as a percent.

Population Coefficient of Variation $= \frac{\sigma}{\mu} \times 100\%$

Sample Coefficient of Variation $= \frac{s}{\bar{x}} \times 100\%$

In general, the coefficient of variation is a useful statistic for comparing the variability of variables that have different standard deviations and different means.

Further, for understanding and interpreting data, more and more statistical tools are available. Type of statistical analysis of gender disaggregated data depend on: number of populations; number of variables; type of variables; parameter types; sample size; sampling methods, assumptions, auxiliary information etc.

- Number of populations – one /two/more than 2
- Number of variables – one/two/more than 2
- Type of variables – nominal/ordinal/interval/ ratio
- Parameter types – mean, variance, median (mostly)
- Sample size – small; large. Sampling – with/without replacement
- Assumptions – distribution assumption (normal); continuous/discrete; independent observations; constant variance etc.

A collection of statistical tests/ procedures for analyzing gender disaggregated data based on above criteria can be found in http://bama.ua.edu/~jleeper/627/choosestat.html (developed by Dr. James D. Leeper).

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GENDER AND EXTENSION PERSPECTIVES IN INTEGRATED FARMING SYSTEMS

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Introduction

The Indian economy is predominantly rural and agricultural. But the declining trend in average size of landholding poses a serious challenge to the sustainability and profitability of farming. The average size of the landholding has declined to 1.1 ha during 2010-11 from 2.28 ha in 1970-71. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020, and would be further reduced to 0.32 ha in 2030 (Agriculture Census, 2010). As per estimates, more than 95% of the holdings will be under the category of small and marginal holders in 2050. The smallholders are major (78%) contributors to the total production but weak in terms of generating adequate income and sustaining their own livelihood. The livelihoods of the smallholder farm families are the major concern. In fact, our past experience has clearly evinced that the income from cropping alone is hardly sufficient to sustain the smallholder's livelihood. Hence, it is imperative to promote integration of different farm enterprises in the existing socio-economic condition of smallholders for additional employment and income generation round the year. Under the gradual shrinking of land holding, it is necessary to integrate land based complementary enterprises on small farms which require less space, less external inputs, optimum resource utilisation and give maximum returns. This kind of synergies and complementarities between different farm enterprises form the basis of the concept of Integrated Farming System (IFS).

Integrated Farming System (IFS)

It refers to agricultural systems that integrate livestock and crop production. IFS is judicious mix of one or more enterprises with cropping having complimentary effect through effective recycling of wastes and crop residues and encompasses additional source of income to the farmer. It could be crop-fish integration, livestock-fish integration, crop-fish-livestock integration or combinations of crop, livestock, fish and other enterprises. IFS activity is inter-dependent, inter-related and inter-linked production system. Crops, livestock, birds and trees are the major components of any IFS;

a) Crop may have subsystem like monocrops, mixed/intercrops, multi-tier crops of cereals, pulses, oilseeds, fodder, vegetables, etc.
b) Livestock component may be cows, buffaloes, goats, sheep, pigs, etc.
c) Bird component may include poultry, duckery, etc.
d) Tree component may include timber, fuel, fodder and fruit trees.
e) Other enterprises may include apiculture, sericulture, mushroom cultivation, etc.

Benefits of IFS

a) **Productivity:** IFS provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises.
b) **Profitability:** Use waste material of one enterprise at the least cost as input for other enterprise. Thus, reducing the cost of production, by utilizing of waste material and elimination of middleman interference in most input used.
c) **Sustainability:** Organic supplementation through effective utilization of by-products of linked component is done thus providing an opportunity to sustain the potentiality of production base for much longer period.
d) **Balanced food:** IFS links components of varied nature enable to produce different sources of nutrition for farm families.
e) **Environmental safety:** In IFS, waste materials are effectively recycled by linking appropriate components, thus minimize environmental pollution.
f) **Income round the year:** Interaction of enterprises with crops, eggs, milk, mushroom, honey, fish, cocoons, etc. provides source of income to the farmers round the year.
g) **Adoption of new technologies:** Money flow round the year due to IFS gives an inducement to the small and marginal farmers to go for the adoption of new technologies.
h) **Saving energy:** By effective recycling technique, the organic wastes available in the system can be utilized to generate biogas. Energy crisis can be postponed to the later period.
i) **Meeting fodder crisis:** Every piece of land can be utilized by planting of perennial fodder trees on field borders. These practices can address the problem of non-availability of quality fodder to the animal.
j) **Solving fuel and timber crisis:** By linking agro-forestry the production level of fuel and industrial wood can be enhanced without determining effect on crop production.
k) **Employment generation:** Combing crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of unemployment to a great extent. IFS provide enough scope to employ family members round the year.
l) **Agro–industries:** When the farm production in IFS is increased to commercial level there is surplus production leading to value addition which leads to the development of allied agro-industries.
m) **Increasing input efficiency:** IFS provide good scope to use inputs in different components efficiently and effectively.

Women in Agriculture

Today women are central to both farming and household activities. Women represent more than 40% of the global labour force and 43% of the global agricultural labour force. Agriculture employs $4/5^{th}$ of all economically active women in India. 48% of India's self-employed farmers are women. In India 79% of women continue to be engaged in agriculture and allied activities as against only 63% of men. But still women in agriculture remain untapped resource which is contributing significantly to socio-economic development of the country. Women's subordinate position is a cause of concern especially when increasing men farmer's suicide, their declining

interest in farming and migration to nonfarm activities are forcing women's to shoulder household as well as farm responsibility. Agricultural research is mostly focused on the generation and refinement of production technologies for men farmers rather than women farmers. Hence, strengthening women perspectives in agricultural technology generation is need of the hour. 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 farmers. 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 issues in integrated farming systems

The term *'gender'* was derived from the french word '*gendre'* means kind, type or sort. Gender refers to socially constructed roles, behaviours and expectations. It refers to a set of qualities and behaviours expected from males and females by society. Some important gender issues need to be addressed for sustaining livelihood of smallholder women farmers. Integrated farming system can address these gender issues as it involves both the male and female farmers, and both the counterparts are equal contributors in various activities of the different enterprises. IFS can integrate gender perspectives and different farm enterprises in the existing farming system. The issues pertaining to gender are;

a) **Women's triple role:** Women play reproductive, productive and community management roles in the society. Hence, time constraint is important issue of women in agriculture. Women spend less time on farm activities but work longer on reproductive activities which are not valued. The child care, household responsibilities and socio-cultural norms limit mobility of women in and outside the society.
b) **Invisible face:** Agriculture is the major activity in which 83.30% of workforce is comprised of women but this increased participation has not translated into equal employment opportunities or equal earnings for women. The census enumeration has consistently ignored the contribution of women in the unorganized sector.
c) **Access to and control over productive resources:** According to the Food and Agriculture Organization (FAO), even though women are major producers of food, they lag well behind men in ownership of agricultural land and access to income from land. It is mainly caused by cultural and traditional behaviours and norms, and can be mitigated through gender sensitive interventions.
d) **Access to extension services:** There is huge gap in number of men and women extension workers in India. About 85% of extension workers are men in India (NSSO survey, 2005). Women farmers have less contact with men extension workers than men farmers. In fact, agricultural knowledge is transferred inefficiently from men to women and vice-versa.
e) **Access to financial services:** Women have less access to credit services because of less control over economic assets, illiteracy, socio-cultural barriers, the nature of their economic activities, and inability to provide collateral requirements.
f) **Access to markets:** Despite their major role in the crop and livestock production, women frequently have poor access to markets than men, and play a limited role in the

commercialization of farm products. This tendency often arises from poor marketing skills, low levels of literacy and customary practices that prevent women from freely leaving the house premises.

g) **Participation and decision-making power:** Both men and women have differences in access to productive resources, information, literacy and attitude towards suitable work for them which limit their active participation in agricultural activities. In many rural areas, cultural and social norms tend to prevent women from actively engaging in the decision-making process. Women's lower status and input into household decisions gives them restricted control and decision-making power over productive resources and income generated from farming activities.

h) **Occupational health and safety:** Women and men's close proximity to crop and animals expose them to various health risks and hazards. Women are traditionally the household members responsible for handling food for both family consumption and sale. As a result they tend to have greater exposure than men to occupational hazards and diseases.

Extension strategies for gender mainstreaming

Women farmers are less productive because they do not have enough access to technical information, credit facilities, extension services, inputs and markets. This less productiveness occurs despite their working longer hours than men. Hence, it is pertinent to build their capacity and ability to shoulder new challenges and increase their efficiency. Important extension strategies to improve women's access to productive resources are as follows;

a) **Gender balanced extension system: A**gricultural knowledge is transferred inefficiently from men to women and vice-versa. Hence, there is need to increase number of women extension workers thus leading to a gender balance in extension system. Thus, women farmers will have easy access to agricultural information and technologies.

b) **Mass media support:** The access of farm women to mass media is limited due to number of reasons. But it has potential to carry messages to a large number of farm women. However, we should examine how different media support and extension model can contribute to the dissemination of farm information and technologies to the women.

c) **Women friendly technologies:** The scope of agricultural knowledge & technologies for women farmers is increasing gradually. 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 demonstrating their benefits thus empowering women. Extending the women friendly tools and technological innovations will reduce the burden, and save time and energy of women.

d) **Credit and technical support:** Technical support should be provided to farm women which facilitates their multiple tasks. Credit facility should be given to women SHGs to increase income by way of developing micro-enterprises.

e) **Capacity building of women:** Different agricultural training programmes in different areas will largely improve the access to agricultural knowledge and information among farm women. Therefore, gender sensitive extension training materials should be developed.

f) **Reorientation of extension and research system:** Extension and research system should be reoriented and priorities should be given to women farmers.
g) **Women farmer groups:** There is need to organise the women farmers into groups in order to strengthen their way from subsistence cultivator to commercial cultivator. Extension workers can be trained to work more closely with women and organise them into groups.
h) **Women friendly IFS model:** Involvement of women in crop and livestock production varies according to the type of crop grown and livestock reared, and socio-economic conditions. There is need to develop scientifically designed, economically profitable and socially acceptable integrated farming systems models especially for women farmers having integration of women friendly farm enterprises.

Some women friendly farm enterprises

a) Apiculture
b) pond fishery
c) Vegetable cultivation
d) Vermicomposting
e) Backyard Poultry
f) Goatary
g) Kitchen garden
h) Piggery
i) Duckery
j) Marigold cultivation
k) Mushroom cultivation
l) Nursery
m) Value added agro-products
n) Biogas

The smallholder farmers having sufficient farm resources can integrate horticultural crops *viz;* fruits, vegetables and flowers as an additional enterprise along with prevailing ones. Marginal farmers living nearby fruit orchards can integrate apiary and mushroom. Farmers having sufficient irrigation water or living in low lying riverbed areas can choose fishery as an additional enterprise. Farming systems under small land holdings can only be made profitable if farmers adopt a conservative approach at all stages of farming. For this they have to utilize each and every piece of land for raising suitable crops, select viable enterprises for diversification, recycle all farm wastes and crop residues within the system itself and make productive use of farm boundaries and waste lands. They can make use of renewable sources of energy such as solar and biogas.

Constraints encountered in practicing different integrated farming systems

The integrated farming systems with different enterprise combinations practiced by farmers have some inherent constraints and can reduce some constraints of farm family. These are;

Constraints in practising IFS:

a) High initial capital investment
b) Difficult to manage various enterprises simultaneously
c) Difficulty in intercultural operations
d) Competition for resources
e) Effect of shade and defoliation on yield
f) Long transition period in tree component
g) Difficulty in animal care during peak agricultural season
h) High skill requirement
i) Difficult to market of diverse farm products

Constraints can be addressed through practising IFS:

a) Nutritional insecurity to farm family
b) Dependency on single income source
c) Low crop residue recycling
d) Off season unemployment
e) Financial risk
f) Dependency on external inputs
g) Unutilization of waste land
h) Shortage of fuel and fodder
i) Difficulty in sustaining livelihood

Participatory Rural Appraisal (PRA) tools for studying farming systems

PRA is a methodology for interacting with farmers, learning from them and analyse their strengths, weaknesses, opportunities and threats to formulate research plan. The problems involved in farming systems can be understood through PRA. There are some important PRA tools to identify the farming systems and scope for integrating different farm enterprises as follows;

a) Transect walk: Transect is the walk through the village in a particular direction along with some key informants. A transect walk is a tool for describing and showing the location and distribution of resources, features, landscape, main land uses along a given transect. The main objective of transect walk is to understand and study the cause and effect relationships among topography, natural vegetation, cultivation, and other production activities.

b) Agro-ecological map: Agro-ecology map indicates the relation between agriculture and environment which includes average temperature, average rainfall, fragmentation of holdings, natural vegetation, drainage system, weeds, etc. It indicates the macro and micro ecological features. The flora, fauna, basic land use pattern such as agro-forestry, forest cover and wasteland are also depicted in the map.

c) Bio-resource flow: It is made to study bio-resources and their utilization in different farm enterprises. The purpose is to study the limitations in existing bio-resource utilization and suggesting alternatives for sustainable bio-resource flow. Bio-resource flow diagram reflects the inflow and outflow of farm produce and its by-products from and to the household as well as among different farm enterprises.

d) **Seasonal calendar:** It depicts month-wise activities for different farm enterprises (crops, animals, etc.) in a year. Seasonal calendar of agricultural practices depicts the time-to-time different farm enterprises related operations being carried out on the farm.
e) **Gender disaggregated seasonal calendar:** The gender disaggregated seasonal calendar indicates the differential involvement of men and women in different farm enterprises according to agricultural seasons.
f) **Livelihood analysis:** This is an analytical technique of exploring behaviours, decisions and coping strategies of households with different socio-economic backgrounds. While analyzing the livelihoods, all the household members including both men and women should be involved. The livelihood analysis indicate the major enterprise on which farm families are dependent, their income and expenditure patterns of the enterprises, thereby enabling for planning the developmental activities based on their livelihoods.
g) **Technology map:** The technology map indicates the technology decision behaviour of the farmers in terms of adoption, over adoption, reinvention, rejection and discontinuance with reference to the agricultural technologies. Technology map comprises of type and frequency of adoption of latest farm technologies. It helps scientists and extension workers to identify the problems of the farmers in technology adoption.

Conclusion

As one of the most populous nations with a high percentage working in agriculture, this is time to focus on women's skill improvement, women friendly technology development, organisation of women groups, providing equal access to and control over productive resources, collecting gender-disaggregated data for designing women friendly policies and bottom-up gender sensitisation will help in creating space for women farmers in Indian agriculture. Generating educated, trained, self-reliant, self-motivated, innovative, responsible and visionary women farmers who can lead our agriculture out of their multiple roles is the great challenge ahead especially when India is on the verge of a second green revolution. The choice of enterprise and crops in any combination should take into account the available resources, crop geometry and environmental conditions. The marketing channels for inputs and outputs for a particular enterprise combination should not be excessively risk-prone. The particular enterprise combination can be successful once credit, information about know-how, market and other farm inputs are well established. Potential improvements and increased productivity from the various enterprises can only come from a better understanding of the nature and extent of the interactions various enterprises and natural resources, economic benefits, as well as the impact on the livelihoods of small farmers and the environment. Research on these aspects provides major challenges for sustainable agricultural development through integrated farming systems in the future.

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ROLE OF KVKS IN ENGENDERING INTEGRATED FARMING SYSTEM

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In recent years, there is gradual realization of the role of women in the field of agriculture & allied areas. Besides domestic work, they are involved in various types of field works relating to production of crops, vegetables, fruits, milk, fish, meat, egg, mushroom, honey bee and other materials. Worldwide women play a major role in agriculture; including fisheries, forestry and livestock production. The nature and extent of their involvement is different in various agricultural production systems. Their role is diversified from management to landless labourer. In overall farm production, on an average women's contribution is estimated at 55 to 66 per cent of the total labour (Singh, 2013).

Agriculture sector employs nearly 80 per cent of all economically active women in the country (Bhatt, 2013). This sector is found to be the highest employer of women labourer to the extent of 84-97 per cent in India. Farm women carry out 75-80 per cent of agricultural work and more than 90 per cent of livestock work (Arunachalam, 2005). The activities of farm women are more pronounced in small and marginal farm families. Devi and Reddy (1984) observed that farm women belonging to low economic categories perform all agricultural activities in plateau ecosystem, their involvement is more in strengthening the economic status of the family as they engage themselves both in farming as well as activities relating to income earning from forest resources. In the north-western plateau zone of Odisha, Nath et al. (2012) also observed that though farm women's role in various activities in farming is more than the men, yet they lack in decision making. In small and marginal farm families, they not only do the most drudgerious work but also contribute the major share in the household and off farm activities.

In spite of several efforts, there still exists gender gap in the field of agriculture and allied areas for which economic empowerment of farm women is still not up to expectation in the rural areas. Many women suffer from discrimination, illiteracy, poverty and exploitation. Women play vital role in livelihood security as they are the backbone of agricultural work force. With enterprises combination of alternate farming system, farmers of Bangladesh and the women members of their family are involve in rearing poultry & livestock, kitchen gardening, sewing cloths for household use and nursery raising (Sadika *et.al*, 2012).

Table-1: Gender participation of selected farm household in Bangladesh

Gender participation	Poultry rearing	Cattle rearing	Milch cow rearing	Goat/ sheep rearing	Sewing	Vegetable production	Vegetable seedling raising	Forestry seedling raising
Male	2	55	50	30	0	15	85	40
Female	98	45	50	70	100	85	15	60

Krishi Vigyan Kendras are present across the country for effective transfer of technologies on agriculture and allied areas. With a team of multi-disciplinary scientists, the Krishi Vigyan Kendras are transferring up-to-date technologies through various extension processes such as skill oriented training, on-farm testing, front line demonstration etc. Support is also provided on market information, arrangement of inputs, linkage with financial institutions etc. for empowerment of women with regards to economic and social aspects. For gender related activities, the KVKs are equipped with :

- Qualified women scientists to address the problems of farm women
- Well maintained demonstration units to provide skill training for both men and women farmers
- On-farm testing and frontline demonstrations in farmers' field involving both the gender.
- Promotion of allied vocations such as mushroom cultivation, backyard poultry, goat rearing, value addition of fruit and vegetable, nursery raising, vermi-compost preparation etc. for economic empowerment of farm women, through skill training and demonstrations.

  In the process of agricultural development, farm women can make significant contribution not only through farm operations, but also through farm decisions. Empowerment of farm women depends mainly upon access, knowledge and involvement in decision making process and control over the resources. But there is limited access to technological information and capacity building. The scientists of KVKs are working tirelessly to empower women in these regard.

Status of women involved in agriculture

Basing on region and social situation, the status of farm women is different from place to place and society to society.

- Women are usually responsible for food production, food storage, transportation, marketing, processing etc.
- In spite of their crucial role in the family and household economy, women have not given equal rights in social and economic fields
- The women agricultural labourers are low paid in comparison to their male counterparts
- Access and control over the family assets are unevenly distributed and particularly women are discriminated
- Majority of rural women are ignorant of various Government schemes, plans, privileges and legal provisions
- Lack of awareness and low level of literacy are creating hindrance in the progress and prospect of rural women.
- In farm families of small and marginal sector, women are engaged in almost all crop production activities except land preparation, application of fertilizer and use of pesticides
- They are also involved in various animal husbandry activities.

Constraints of farm women

There exist several constraints of farm women due to gender related issues. Therefore, it is necessary to address such problems through gender analysis and sensitization of various stakeholders. Farm women encounter several constraints both in the family and work place, which need to be addressed for necessary improvement in their work efficiency and life style.

- High drudgery and low efficiency in agricultural work
- Dominance of male oriented technologies
- Poor health affecting work efficiency
- Restricted exposure
- Dual pressure of domestic and agricultural work
- Less freedom for decision making
- Low income from off-farm activities

Issues relating to farm women

Several issues are observed with relation to farm women, which need to be properly attended for women empowerment.

- Poor knowledge about enterprises
- Poor access to inputs
- Very limited contact with various sources of information
- Limited exposure and involvement in various developmental programmes
- Inadequate facilities of the financial institutions to extend credit to farm women
- Inadequate attempt for community organization and capacity building
- Women's work is unaccounted
- Women face food insecurity
- Roles, needs and problems of women are neglected

Why engendering agriculture?

- Agriculture is by and large an enterprise, which engages women and men in different activities with varying degrees of their participation.
- Productivity of women compared with men farmers remains low relative to their potential as they are left behind in trainings, skill development & extension support service etc.

Suggestions for reducing gender gap

The difference between man and woman can be narrowed down with several programmes and activities as follows.

- Gender sensitization programmes are to be taken up at the grass root level.
- The issues of role ambiguity among male and female counterparts are to be streamlined by creating awareness.
- The economic empowerment of the families below poverty line is to be done through selection of suitable activities for both men and women.
- The family members are to be educated and scientifically oriented in agriculture and allied sectors.
- Women friendly technologies in agriculture and allied sectors are necessary for gender mainstreaming.

- There should be adequate number of field level functionaries in various departments for women empowerment.
- Training should be given depending on the local need of the farm women.
- The women SHGs should take up special enterprises for economic upliftment of the members.

To bring the farm women into the mainstream of agriculture development process, the following strategies may be thought of.

- Recognizing women as farmers
- In the development process, men and women are equal partners
- Organizing Women Groups such as women SHG, milk producers' society etc.
- Developing women friendly farm implements and technologies
- Capacity building of farm women
- Involvement of farm women in decision making process

Strategies for entrepreneurship development of farm women

With initiative of KVKs, there are some women entrepreneurs emerging in the state with various vocations. Systematic effort can be commenced to encourage women in various parts of the state to become entrepreneurs in agriculture and allied areas.

- Identification of training needs and problems of farm women
- Prioritization of their problems and problem-cause analysis
- Solution through skill oriented training, demonstration and exposure visit of women SHGs for capacity building on specific enterprises
- Ensuring easy availability of inputs including quality seeds and planting materials etc.
- Formation of women cooperatives for large scale production and marketing.
- Developing decision making abilities.
- Getting up-to-date market information.
- Good linkage with other SHGs of the locality, lead banks, marketing cooperatives and NGO sectors.

Enterprises for farm women

Several feasible enterprises are identified by KVKs during process of technology transfer for economic empowerment of farm women. To enhance their family income, these enterprises can be adopted by farm women either individually or through groups.

- Nursery raising and seedling production
- Value addition of agricultural produce.
- Processing and value addition of fruits and vegetables.
- Off season vegetable cultivation
- Floriculture
- Mushroom cultivation
- Bee keeping
- Dairy farming and goat rearing
- Back yard poultry
- Pisciculture
- Production of vermi-compost

- Chalk, phenyl, agarbati and candle preparation
- Appliqué work and coir work
- Preparation of sabai grass and golden grass products.
- Sal leaf plate making

Conclusion

The gender difference between men and women, many a times, possess hindrance for providing equitable share to both with respect to knowledge, technology, skill and financial resources. Sensitization of the personnel working in agriculture and allied sectors in relation to gender balancing can help to empower farm women. Involving women with economically productive work will enhance their contribution to overall improvement of the state net domestic product.

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OPTIMIZING WATER PRODUCTIVITY THROUGH INTEGRATED FARMING SYSTEM MODELS

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The International Organisation of Biological Control (IOBC) describes Integrated Farming as a farming system where high quality food, feed, fibre and renewable energy are produced by using resources such as soil, water, air and nature as well as regulating factors to farm sustainably and with as little polluting inputs as possible.The integrated farming system approach introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purposes in the integrated system. A judicious mix of agricultural enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agro-climatic conditions and socio-economic status of the farmers would bring prosperity in the farming.

Components of Integrated Farming System

- Crops, livestock, birds and trees are the major components of any IFS.
- Crop may have subsystem like monocrop, mixed/intercrop, multi-tier crops of cereals, legumes (pulses), oilseeds, forage etc.
- Livestock components may be milch cow, goat, sheep, poultry, bees.
- Tree components may include timer, fuel, fodder and fruit trees.

What is water productivity?

It is the physical mass of production or the economic value of production measured against gross inflows, net inflow, depleted water, process depleted water, or available water.

WP= Agricultural benefit/ water use

It is normal to represent WP in units of kg/m^3. If production is measured in kg/ha, water use is estimated as mm of water applied or received as rainfall, convertible simply to m^3/ha (1mm = 10m^3/ha). Alternative notations include food (kcal/m^3) or monetary value (Rupees/m^3).

Crop water productivity is defined in either physical or monetary terms as the ratio of the product (usually measured in kg) over the amount of water depleted (usually limited to crop evapotranspiration, measured in m^3).

In case of **irrigation water productivity** the denominator refers to irrigation water only, not to rainfall. Obviously, values of irrigation-water productivity cannot be compared with water productivity with depleted water in the denominator.

Economic productivity is the gross or net present value of the product divided by the value of the water diverted or depleted, which can be defined in terms of its opportunity cost in the highest alternative use.

In an agro-ecosystem context, **fisheries water productivity (FWP)** may be defined as the ratio of beneficial fisheries goods and services produced in an agricultural system to the amount of water depleted in producing them.

We define **livestock-water productivity** (LWP) as the amount of water depleted to produce livestock and livestock products and services, including farm power or as the ratio of beneficial livestock goods and services generated in an agricultural system to the amount of water depleted in producing them.

Basin water productivity takes into consideration beneficial depletion for multiple uses of water, including not only crop production but also uses by the non-agricultural sector, including the environment.

Water productivity definition is scale-dependent. For a farmer, it means getting more crop per drop of irrigation water. But, for society as a whole, concerned with a basin or country's water resource, this means getting more value per unit of water resource used. Increasing water productivity is then the business of several actors working in harmony at plant, field, irrigation-system and river-basin levels.

Why integrated farming system for optimizing water productivity?

The agriculture is of fundamental importance in India's economy contributes about 20-21% of gross domestic product (GDP) and generates two third of employment. Total food grain production, which was only about 51 million tons at the time of 1st five year plan, has gone up to 213.45 million tons in 2003-04. But in spite of all these impressive achievements, net sown area in the country remained at about 141.1 M ha and per capita availability of land is decreasing. Water sustains life and is primarily used for growing crops, household uses, as input to industries, power generation, recreations and for sustaining earth's ecosystems. Presently, this essential natural resource is under threat as evident from the following facts. India covers 2.42% of the total land area of the world and supports 16.8% population of world with only 4.2% of water resources. Though India gets about 400 M ha m of water due to an average annual rainfall of 1194 mm, but it varies from 150 mm at Jaisalmer to 11690 mm at Mawsynram near Cherrapunji. About 60% of the area is rainfed and we are also unable to store desirable quantity of water in uplands of the country for agricultural use. Also per capita water availability is continuously declining from 5176 m^3 in 1951 to 2209 m^3 in 1991, 1820 m^3 in 2001 and 1703.6 m^3 in 2005. In order to meet the challenge of feeding ever increasing population of our country, there is an urgent need to produce more food from less water. This could be only possible by enhancing the water productivity through integrated farming systems.

In recent years, country is frequently experiencing natural calamities like floods, droughts, cyclone, etc. In India, by the year 2025, high rate of population growth is likely to result in about 1333 millions people while the low growth projections place the number at nearly 1286 millions. The projected food grain demand for 2025 would be 320 M tones (high demand scenario) and 308 M tones (low demand scenario). The quantum of water used for irrigation by the last century was of the order of 31.8 M ha of surface water and 20.6 M ha of groundwater, total 52.4 M ha. The estimates indicate that by the year 2025, the water requirement for irrigation (both surface and groundwater) would be 56.1 M ha for low demand scenario and 61.1 M ha for high demand scenario. A reduction in share of water for agriculture from present level of 83% to 72% by 2025 is expected due to competing demand of water for industries,

municipalities and environmental needs. A large coastal tract of India has either saline water ingress or at many places a thin layer of fresh water floats over saline water. Also poor and degraded quality waters pose a challenge for effective utilization in non-consumptive domestic and production system through IFS technology. In order to meet the challenge of feeding ever increasing population of our country, there is an urgent need to produce more food from less water. This could be only possible by enhancing the water productivity through IFS.

Water Productivity terms

Pure **physical productivity** is defined as the quantity of the product divided by the quantity of the input – for example, yield per hectare or yield per cubic metre of water either diverted or depleted. Combined physical and economic productivity is defined in terms of either the gross or the net present value of the crop divided by the amount of water diverted or depleted.

Economic productivity is the gross or net present value of the product divided by the value of the water diverted or depleted, which can be defined in terms of its opportunity cost in the highest alternative use.

Crop water productivity is defined in either physical or monetary terms as the ratio of the product (usually measured in kg) over the amount of water depleted (usually limited to crop evapotranspiration, measured in m^3). Occasionally – for example, in the context of supplemental irrigation – there is a felt need to express the productivity of the applied irrigation water. In that case, the denominator refers to irrigation water only, not to rainfall. Obviously, values of irrigation-water productivity cannot be compared with water productivity with depleted water in the denominator.

Basin water productivity takes into consideration beneficial depletion for multiple uses of water, including not only crop production but also uses by the non-agricultural sector, including the environment. Here, the problem lies in allocating the water among its multiple uses and users. Priority in use involves the value judgment of either the allocating agency or society at large and may be legally determined by water rights.

Irrigation methods that require less water, such as saturated-soil culture and alternate wetting and drying can reduce unproductive outflows and raise water productivity at the field level without a reduction in crop yield per hectare.

Other approaches that may increase water productivity include the incorporation of the C4 photosynthetic pathway into rice, the use of molecular biotechnology to enhance drought-stress tolerance and the development of 'aerobic rice', which refers to rice varieties that yield well under non-flooded conditions. The shift towards aerobic rice will affect water conservation, soil organic-matter turnover, nutrient dynamics, carbon sequestration, weed ecology and greenhouse-gas emissions. Some of these changes lead to greater crop water productivity and are seen as positive; others, such as the release of nitrous oxide from the soil, are seen as having a negative impact.

It is estimated that investments in agricultural infrastructure and agricultural research may have higher payoffs than investments in new irrigation systems in order to accelerate this increase in water productivity and hence ensure food security in the next 25 years.

Principles for improving water productivity

The key principles for improving water productivity are:

(i) to increase the marketable yield of the crop per each unit of water transpired;

(ii) to reduce all out flows (e.g.: drainage, seepage and percolation, including evaporation outflows, other than the crop stomatal transpiration), and

(iii) to increase the effective use of rainfall, stored water and water of marginal quality.

The three principles apply at all scales, from plant to field and agro-ecological levels. However, option and practices associated with these principles require approaches and technologies at different spatial scales.

IFS for enhancing water productivity

Integrated farming system for waterlogged area management

A study was conducted for development of pond based integrated farming system for management of waterlogged area in Khurda district. There was a patch of 3 ha area under severe waterlogging. Continuous waterlogging has converted that land to wasteland. No crop was possible to be grown in those fields and it was remaining fallow in almost all years. The soil pH observed ranged from 3.5 to 6.5; soil texture is sandy clay loam; soil organic carbon was low (< 0.5%); soil available nitrogen was low (< 280 kg ha^{-1}); soil available potassium was medium (50-170 mg/kg of soil); soil available phosphorous was medium (5-10 mg/kg of soil); iron toxicity was present. Depth of groundwater table was ranging from 20-40 cm as minimum and 50-150 cm as maximum from ground surface during December to June. During monsoon it is above ground surface. The yield of shallow aquifer is low. The land was unsuitable for ploughing except during the months of May and early June, and was left fallow in almost all years.

For determining the design and dimensions of the ponds, collection and analysis of climatic data (rainfall, pan evaporation etc.) for the period 1975-2003 for Bhubaneswar was done. The climatic parameter analysis and water balance study resulted the design dimensions of the experimental ponds which were 27 m x 27 m, 30 m x 30 m, and 34 m x 34 m at the top with 2 m depth and side slope 1:1 in experimental plot 1, 2 and 3 respectively. The excavated soils were spread around the pond to elevate the surrounding area so as to keep the water table below 2 m from ground surface. Hume pipes of 30 cm diameter and 4 m length were used as inlet and emergency outlet of the pond. Since the objective of the study was to store excess water for reclamation of waterlogged area, the area of the ponds are kept within 20 to 25% of the total area considering the water balance component of the study area.

Design and construction of three micro water resources covering water surface area of 625 (P_1), 785 (P_2) and 1025m^2 (P_3) was completed by March 2006. Treatment implementation and stocking of fish fingerling (*Magur*, 12.2g MBW) was done as the first crop. Population density was maintained at 1200, 2100 and 1700 for P_1, P_2 and P_3 respectively. The recorded mean minimum and maximum values of various water quality parameters were: water temperature 27.9 - 32.3 ^{0}C; water pH 6.7 - 8.7; dissolved oxygen 3.6 - 9.1 ppm; total alkalinity 78 - 127 ppm; dissolved organic matter 1.4 - 6.4 ppm; nitrite –N 0.006 - 0.077 ppm; nitrate-N 0.06 - 0.57 ppm; ammonia 0.01 - 0.34 ppm; transparency 39$\pm$3 – 52$\pm$4; total suspended solid 169 - 367 ppm and total plankton count 14.9x 10^3 to 19.8 x 10^4nos/liter. Average primary production in the first month of rearing ranged between 121.4-149 mg C m^{-3} h^{-1}, which improved further (533$\pm$41.3 mg C m^{-3} h^{-1}) with the advancement of rearing period. TSS and

DO concentration showed a decreasing trend with the advancement of rearing period while, gradual increase in nitrite, nitrate, ammonia were attributed by intermittent fertilization, increased level of metabolites and decomposition of unutilized feed. At any given point of time, other water quality parameters did not register any specific trend. In this experiment, average growth performance of *Magur*was highest inpond-1 (P_1)(163.5g) followed by pond-3, (P_3) (141.0g) and pond-2 (P_2)(130.5g). In this experiment, reductions in growth did not appear to be due to poor water quality, as water quality did not differ significantly among various treatments, may be due to behavioral interaction or physiological response to density itself. Relatively moderate survival rate (61-64.75%) was mainly due to cannibalism at the initial stage of rearing. In this, crop yield of fish ranged between 1632-1710kg/ha/ 200days, survival rate (SR%- 61-64.75), feed conversion ratio (FCR)- 1.39-1.47, per day increment (PDI) was 0.595-0.623 g/day.

Indian major carps (IMC) were taken as subsequent crops in coming years and were released during 4th week of August. All growth parameters were undertaken regularly. The catla has recorded a maximum growth in comparison to rohu and mrigal. As age of the pond increased the quality of water improved as the sides of the bunds have been stabilized, hence IMC was undertaken in place of magur to reduce the input cost and preference in market.

Under on-dyke horticulture activities, there were 114 papaya, 89 banana, and 16 coconut plants around 1st pond, 69 banana, 9 papaya and 4 coconut plants around 2nd pond and 70 banana plants were planted around the 3rd pond (Plate 1). Besides another 90 banana plants were planted in adjacent area. The different varieties of tissue culture banana planted are *G-9, Bantal, and Robosta*. Papaya variety was *"farm selection"*.

In the first year under on-dyke horticulture activities vegetable such as bottle gourd in 386 m^2 area (7.8 t/ha), tomato in 252 m^2 area (2 t/ha) and brinjal on 66 m^2 (1.52 t/ha) were taken up. Different varieties of paddy such as *Khandagiri, Swarna, CR-1009 and Surendra*were grown in four different plots showed average yield of 2.72 t/ha.

In subsequent years on an average 220 bunches of banana were harvested. Different varieties of paddy such as *Khandagiri, Swarna, CR-1009 and Surendra*were grown in four different plots. During *kharif* the yield of Khandagiri was 2.1 t/ha, Surendra gave 3.2 t/ha and Swarna showed average yield of 2.7 t/ha. During *rabi*Khandagiri paddy gave a yield of 2.3 t/ha. Different vegetable were taken as on-dyke horticultural activities as well as intercrops such as brinjal (6.25 t/ha), cowpea (1.5 t/ha), Bean (2 t/ha), ladies finger (4.9 t/ha) and 200 kg of bottle gourd was also obtained.

Integrated farming system with aquaculture in the pond such rearing magur in the first year followed by Indian major carps in subsequent years is highly profitable and helps in improving the livelihood options of poor farmers. On-dyke horticulture such as banana, papaya and other vegetables as intercrop is possible in the system and helps in crop diversification and rural livelihood option.

Plate 1. Integrated farming system in a waterlogged area

Integrated farming system in Mahanadi delta

Where nothing is feasible i.e. drainage measures/alternate waterlogged resistant paddy crop, etc., there pond drainage with integrated farming system is recommended. The entire waterlogged area is converted into an integrated resource management unit where fishery, duck rearing, poultry or birds go together with horticulture, forest and other economic crops in bunds and vegetables in between.

One such unit was developed in Khentalo village of Barmania Pat (waterlogged area) where water logging was up to 2 m depth. Out of 2.47 ha waterlogged area of the farmer, 1.64 ha was converted into grow-out pond for fish and prawn culture while vegetable, flower and fruits were grown on 0.83 ha of raised embankment all around the pond since 1989. Poultry sheds were also constructed for rearing 4000 birds in such a way that their droppings could fall into pond as organic manure and feed for fish. The average productivity of low land high yielding paddy was 3.5 t ha^{-1} as compared to 9.4 t ha^{-1} per annum fish equivalent (fish + prawn). Gross and net returns from fish and prawn culture alone during 2002 were Rs. 6,17,160 (Rs. 3,76,317 per ha) and Rs. 3,31,065 (Rs. 2,01,868 per ha) respectively. This accounted to Rs. 14.00 per m^3 of water productivity in the pond system alone. Whereas the gross and net returns from the whole system of 2.47 ha during the year 2002 were Rs. 6,51,110 (Rs. 2,63,607 per ha) and Rs. 3,62,515 (Rs. 1,46, 767 per ha) respectively. The farmer initially invested Rs. 1,23,910 in 1988 towards construction of the pond plus infrastructure and earned a net return of Rs. 40,554 per ha of whole system in 1989, which gradually increased up to Rs. 1,32,894 per ha in 1997. He again invested Rs. 1,30,000 towards stone pitching in 1998 and Rs. 3,20,000 towards poultry shed and the net return (after adjusting investment) was Rs. 2,17,600 (Rs. 88,097 per ha) during 1998 and a net loss of Rs.

1,16,900 during super cyclone year in 1999. The net returns per ha again increased steadily after cyclone from Rs. 27,465 in 2000 to Rs. 1,37,894 in 2001 reaching up to Rs. 1,46,767 (35 times higher of the paddy cropping) in 2002.

Adjacent to the developed integrated farming system, the farmer is cultivating 2.4 ha waterlogged paddy field giving net return of Rs. 4,166 per ha only (2.8% of the integrated farming system). IIWM has designed a deep water high density rice-fish integrated system of 1.2 ha out of the 2.4 ha waterlogged paddy field system and it is estimated that it will give net return of Rs. 1.5 to 1.6 lakh per ha per year. Revival of poultry component and addition of milch cattle in the system is going to make it more profitable and more sustainable utilizing surface and ground water of the waterlogged area. This is going to be a replicable integrated farming model for the coastal Orissa. It may also be replicated in irrigated alluvial land of other regions.

IFS in cyclone affected coastal Odisha

IFS around sub surface water harvesting structure was implemented in participatory basis for 22 locations in coastal waterlogged ecosystem devastated by 1999 super cyclone where saline aquifer exists beyond 3-7 m below ground level, and fresh water aquifer floats over it. This fresh water was harvested by constructing sub surface water harvesting structures up to a depth of 3 m and the stored water was utilized for aquaculture and irrigation of the crops grown on the bund and in surrounding area. Introduction of integrated farming system approach (aquaculture, water chest nut, on dyke horticulture and vegetables in the pond command area) in those structures resulted in gross water productivity of Rs. 12.93 to Rs. 47.20 per m^3 of water used. The impact of this technology resulted in construction of 135 such new structures (SSWHS) by farmers in the coastal tract of Erasama. Consequently, significant increase in crop production (3-4 fold), water productivity (Rs. 12.93-Rs. 47.20 per m^3) and cropping intensity (103-230%) has led to the socio-economic upliftment of the resource-poor farmers with diversified livelihood options. The findings can be replicable in different waterlogged eco-systems of India.

Integrated farming system in deep water condition

In a farmer's field at Khentalo of Cuttack district, 2 ha waterlogged area was converted into two units of deep water rice-fish system with another 1 ha land exclusively for deep-water rice. Periodic observation of water quality, soil quality, fish and prawn growth parameters, yield and yield components, hydrological and water balance related studies were carried out at regular intervals at the experimental site. In the first year the water level went up to as high as 65 cm above ground surface in 34^{th} standard week and remained above the surface during 25^{th} to 48^{th} week. During driest period the water table went down to 167 cm below ground level. This was a precarious water logging condition prohibiting growing of any other crop than paddy with very low return. Under this scenario, construction of refuge that acts as a drainage system and helps in lowering the water table was adopted for rice-fish culture in reclaiming waterlogged degraded area. Comparison of weekly rainfall and evaporation revealed that the rainfall is higher than the evaporation during 24^{th} to 43^{rd} week causing water congestion. Hence excess water was stored in the rice-fish culture field for aquaculture and for irrigating rabi crop. During 3^{rd} year of the study the water level went up to as high as 32 cm above ground surface in the 1^{st} week of October. There was no visible difference in water table from mid-October till

December. However during summer, water table went as deep as 3.3 m below ground level indicating lowering of water table.

The yield of deep water paddy was 2.97 and 2.42 t/ha in rice-fish system and control respectively. Average post paddy second crop (black gram) yield was 0.75 t/ha, yield from on-dyke horticulture was 463 and 495 kg for brinjal and ladies finger respectively. Net water productivity for only deep water rice was Rs. 0.46/m^3 where as it was Rs. 7.46/m^3 for only fish & prawn culture.

Conclusions/ Recommendations

Integrated farming system with aquaculture in the pond such as rearing magur in the first year followed by Indian major carps in subsequent years was highly profitable and helps in improving the livelihood options of poor farmers. On-dyke horticulture such as banana, papaya and other vegetables as intercrop was possible in the system and helps in crop diversification and rural livelihood option. IFS around sub surface water harvesting structure are very advantageous and profitable in cyclone affected areas of coastal area.Deep water rice-fish system in deep waterlogged area is very much profitable.

The different advantages of Integrated Farming System are

- Higher food production to equate the demand of the exploding population of our nation
- Increased farm income through proper residue recycling and allied components
- Sustainable soil fertility and productivity through organic waste recycling
- Integration of allied activities will result in the availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins
- Integrated farming will help in environmental protection through effective recycling of waste from animal activities like piggery, poultry and pigeon rearing
- Reduced production cost of components through input recycling from the byproducts of allied enterprises
- Regular stable income through the products like egg, milk, mushroom, vegetables, honey and silkworm cocoons from the linked activities in integrated farming
- Inclusion of biogas & agro forestry in integrated farming system will solve the prognosticated energy crisis
- Cultivation of fodder crops as intercropping and as border cropping will result in the availability of adequate nutritious fodder for animal components like milch cow, goat / sheep, pig and rabbit
- Firewood and construction wood requirements could be met from the agroforestry system without affecting the natural forest
- Avoidance of soil loss through erosion by agro-forestry and proper cultivation of each part of land by integrated farming
- Generation of regular employment for the farm family members of small and marginal farmers.

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RICE-BASED INTEGRATED FARMING SYSTEM FOR LIVELIHOOD OF FARM FAMILIES

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Introduction

Rice being the staple food is grown in the country in around 43.5 million (m) ha under various ecologies of which about 50 % area is rainfed. More than 80% of the rice farmers belong to small and marginal groups and the average per capita land holding in India is only about 0.17 ha. In view of the population growth, competition of land with industrialization and urbanization, declining farm holding size and the dietary nutrition requirement of the farm families, it is necessary to look for the optimum use of resources through shift from conventional rice farming to integrated farming systems. Rice based farming system involving rice, other field and horticultural crops, agro-forestry, fish birds livestock and further income generating enterprises will be the right approach in this respect. However, this will be more relevant in the risk prone *rainfed* ecologies which are mostly located in the eastern part of the country. Rice based integrated farming systems can provide household food, nutrition, income and employment without degrading the environment.

Farming family in tropical India is mainly dependent on *rainfed* farming with high risk of weather uncertainty. In a constant struggle to survive, the small and marginal farmers over the years have evolved techniques which have benefited them immensely. But without knowing the scientific basis of such integration they have been practicing the system for a long time. In India, traditionally, farming has been family based and majority of them are smallholders. The success of farming family lies not in 'specialization' but in practicing farming to meet diverse household needs rather than market opportunities alone. Hence, income from seasonal field crops alone in small and marginal farms is hardly sufficient to sustain the farming family. As such agriculture in India is facing the challenge to achieve sustainable food security with shrinking land resources by producing an additional 50 million tonnes of food to meet the requirement of prognosticated population of 1000 million in the country. Because of declining per capita availability of land in India, there is hardly any scope for horizontal expansion of land for food production. Hence, intelligent management of available resources including optimum allocation of resources is important to alleviate the risk related land sustainability.

Integrated farming system- a promising approach

Integrated farming system is the potential approach and powerful tool for management of vast natural and human resources in developing countries, including India to meet the multiple objectives of poverty reduction, food security, competitiveness and sustainability of small and marginal farmers. The approach aims at increasing income and employment from small-holding integrating various farm enterprises and recycling crop residues and by-products within the

farm itself (Behera and Mahapatra, 1999; Singh *et al*., 2006). Under the gradual shrinking of land holding, it is necessary to integrate land-based enterprises such as dairy, fishery, poultry, duckery, apiary, field crops, vegetable crops and fruit crops within the bio-physical and socio-economic environment of the farmers to make farming more profitable and dependable (Behera *et al*.,2004). Integrated farming systems are often less risky, because if managed efficiently, they benefit from synergisms among the enterprises, leading to diversity in produce and environmental soundness (Lightfoot, 1998; Pullin, 1998).

The Traditional Rice based farming System in India

In irrigated rice ecology, carp fingerlings of natural stock are collected by traps in the inlet/outlets from rice fields irrigated from Godavari river in East Godavari district of Andhra Pradesh with fish yield of 3 kg/ ha. In rainfed lowlands and deepwater rice ecologies capture fisheries are mainly followed realizing around 3 to 300 kg of fish /ha during and after rice growing period in the rice field seeded/planted with mostly traditional rice varieties yielding around 1.0 to 3.0 t grain / ha.(Dehadrai, 1988, Ghosh, 1992)). The productivity of fish and prawn in coastal saline areas ranges from 100 to 2000 kg / h a / y r (Ghosh, 1992). In Meghalaya rice-fish farming as flow through system in the terraces and also in valleys/ plains. Trap-sum method is followed in *few* areas in the coastal part of Orissa (brackish water areas). In flood prone areas of Brahmaputra valley, rice-fish farming is extensively practiced. In West Bengal Rice-fish farming is practiced by the farmers mostly in rainfed and some irrigated areas mainly in Midnapore and 24 Parganas districts The field design includes one pond refuge of about 1.5 to 2 m deep covering around 8-10% of the area and raised bunds all around. Mostly Eucalyptus trees are planted 3 to 4ft apart since this plant is preferred because of fast growing and a cash crop, in demand for construction and fuel purpose. In this type of farming, a crop after rice (mostly Jaya cross in Midnapore district) taken in *rainfed* condition during *kharif*. Capture fisheries of mostly catfish, perch and murrel types are trapped in the pond along with the water and later harvested after drying of the field. Around Rs. 1,500/- to 2,000/- are obtained by the farmers from fish in one acre unit.

Improved rice based integrated farming system

Rice –fish farming system:

Eastern India, in particular with about 5.6 m ha irrigated area and 14.6m ha rainfed lowlands of the total 26.58 m ha rice area, offers high potential for rice-fish farming system, especially in view of the resources, food habits and socio-economic needs of the people. Rice-fish farming system with higher water and land productivity and employment opportunities can ensure food, nutrition and livelihood security for the farming communities, particularly for the largest groups of small and marginal farmers. Rice-fish culture systems can be mixed or concurrent, sequential or rotational. However, the techniques differ based on the physical, biological and socio-economic profiles of the target agro-ecosystem.

Rice –fish diversified farming system for rainfed lowland areas

In order to improve and stabilize farm productivity and income from rainfed water logged lowland areas, national Rice Research Institute, Cuttack has developed an adoptable technology of rice-fish diversified farming system. Farm size may vary from minimum of about one acre to

one hectare or more. Field design includes wide bunds (Dykes) all around, a pond refuge connected with trenches on two sides(water harvesting come fish refuge system) and guarded outlet. The approximate area allotments will be, 20 % for bunds, 13 % for pond refuge and trenches and rest 67 % for main field. The pond refuge measures 10 m wideand 1.75m deep constructed in the lower end of the field. The two side trenches of 3 m width and average 1 m depth have gentle(0.5%) bed slope towards the towards the pond refuge. Small low cost (Thatched/asbestos top)duck house and poultry unit are constructed on bunds with a floor space of about 1.5 sq.ft. for each duck and 1 sq.ft. for each poultry bird. Poultry unit maybe projected upto 50 % over the water in the pond refuge to utilize the dropping as fish food and manure in the system. In such case birds can be housed in cage of made of wire net. A small goat house is made on the bund with floor space of about 2 sq.ft for each animal.

Production Technology

Production Technology broadly involves growing of improved photo-period sensitive semi tall and tall wet season rice varieties with field tolerance to major insect pest and diseases. The suitable rice varieties are Gayatri, Sarala, CR Dhan 500, CR Dhan 505, Jalmani, Varshadhan for Orissa, Sabita, Jogen, Hanseswari for West Bengal, Sudha for Bihar, Madhukar and Jalpriya for eastern uttar Pradesh and Ranjit, Durga and sabita for Assam. Management of insect pest in rice crop is done with the use of sex pheromen traps, light traps and botanicals (Netherin/ Nimbicidin spray at 1%). Indian major carps(Catla, Rohu , Mrigal) *Puntius sarana*, exoctic carps (common carp, silver carp silver barb) and fresh water giant prawn (*macrobrachium rosenbergii*) are grown along with the rice crop and later in the refuge after the rice crop is harvested. Fish fingerlings of 3-4" size and prawn juveniles of 2-3" size are released in a ratio of 75 % and 25 %, respectively at 10,000 per hectare of water area after sufficient water accumulation in the refuge and in the field. Fish and prawn are regularly fed at 2% of total biomass with mixture containing 95 % of oil cake +rice bran (1:!) and 5 % of fish meal. After ric, various crops like watermelon, mung sunflower, groundnut, sesame and vegetables are grown in the field with limited irrigations from the harvested rainwater. On bunds different seasonal vegetables are cultivated round the year including creepers on the raised platform, spices and pineapples are grown in shades. The fruit crops on bunds include varieties of dwarf papaya, banana T x D coconut and arecanut. Flowers like tuberose marigold etc. are also cultivated on the bunds. Both straw and oyster mushroom cultivation are done in the thatched or polythene enclose. Bee rearing is practice in 2-3 bee boxes on bunds. Agro-forestry component on the bund include short term plantation of mainly *Accacia* spp. (*A. mangium, A. auriculiformes).* Animal component constitutes improved breeds of duck, poultry birds and goats. Ducks are raised in the rice field upto the beginning of flowering stage and later in an enclose in pond refuge till the harvest of rice crop. Live *Azolla* is released @0.5 -1.0 t /ha and is maintained to supplement duck feed and also to some extent fish feed, besides nutrition to the rice crop. Fresh water pearl culture is integrated in the system using the host mussel (*Lamellidens marginalis)* which is normally available in the lowland rice ecology. Components can however, be included in the system based on location –specific requirements.

Productivity and economics

The rice fish farming system can annually produce around 16 to 18 t of food crops, 0.6t of fish and prawn, 0.55 t of meat, 8000-12,000 eggs besides flowers, fuel wood and animal feed as

rice straw and other crop residues from one hectare of farm. The net income in the system is about Rs. 76,000 in the first year. Subsequently this increases to around 1, 30,000 in the sixth year. This system thus increases farm productivity by about fifteen times and net income by 20 folds over the traditional rice farming in rainfed lowlands. The rice fish system also generates additional farm employment of around 250 – 300 man-days/hectare/year.

Rice-Fish-prawn-horticulture-agro-forestry based farming system for deep water

With the aim of enhancing farm productivity in deep water areas (5—100 cm water depth), a multi-tier rice-fish –prawn horticulture crops-agro-forestry based farming system model has also been developed in 0.06 hectares area at NRRI, Cuttack. The design of the system includes land shaping in the form of uplands(Tier I and tier II) covering about 15 % of field area followed by rice field area of 40% as *rainfed* lowland (tier III) and deep water (tier IV). This rice field is connected to a micro water shed cum fish refuge (pond) of 20 % area for growing of fish and prawn with the rice crop. Raised and wide bunds are made all around using 25 % of the farm area. The production technology includes growing of high yielding varieties of *rainfed* lowland rice (Gayatri, Sarala)in teir III and deep water rice (Durga and Varshadhan) in tier IV along with the fish and prawn during wet season. Dry season crops like sweet potato, mung, sunflower, groundnut, vegetables are grown after lowland rice in tier III. Dry season rice is cultivated after the deep water rice is harvested in their IV. Harvested rain water in the pond refuge is used for irrigation of the dry season crops. Improved varieties of perennial (mango, guava, sapota) and seasonal fruit crops (Papaya, Banana, Pineapple) are grown in upland (tier I). Round the year different seasonal vegetables and tuber crops (sweet potato, elephant foot yam, yam bean, colocasia and greater yam) are cultivated in tier II(Upland). Agro-forestry (*Acacia mangium*) and plantation crops (Coconut and areca nut) are planted on the northern side of the bunds. Greater yam is grown with the support of trunk of agro forestry tree. The productivity of the system is about 8 t of rice crop/hectare, one tone of fish and prawn per hectare, 20-25 t of vegetables/ha and 8.5 to 51.7 t of tuber crops/ha. The cropping intensity in this system greatly increases to 170 % in field and 360 % in the upland.

Rice-ornamental fish culture

In order to utilize the rice ecology for value added aquaculture, the technique of breeding and culture of ornamental fishes in irrigated waterlogged rice field has been developed at NRRI, Cuttack. The rice field is renovated to make a pond refuge and raise bunds all around. Ornamental fishes like Blue gourami, Red gourami, Pearl gourami, Guppies are bred and cultured with rice (lowland varieties) crop during wet season. During the dry season, rice (Naveen)crop is grown along with ornamental fishes with irrigation. About 25,000- 6, 00000 ornamental fish/ha can be produced in the system, in addition to 3.5t and 5.0t of rice grain during wet and dry season, respectively. Such farming can be taken up by women farmers including Self Help Groups.

Rice based farming system under irrigated condition

With the objective of improvement of livelihood of small and marginal farmers, rice based integrated farming system model for irrigated areas has been developed at NRRI, Cuttack

Production Methodology

Site selection and layout : About an acre of integrated farm area is required for the farming system. 30% of the area is converted to two rice fish fields of 600 sq.m area each with a refuge of 15 % area and another 30 % area is developed into two nursery fish ponds of equal size of fingerlings rearing. The remaining 40% (1500 m2) area is utilized as bunds for growing vegetables, horticultural crops and agro-forestry. Three rice crops are grown in the sequence of kharif rice (var.,sarla/Durga) followed by rabi rice (naveen/Satabdi) and then summer rice(vandana/ Sidhant). Yellow stem borer pest is controlled by using sex pheromone traps or by applying1 % Nethrin/Nimbecidine. Fish culture is taken up with catla, rohu and mrigal species. The fish fingerlings are reared in the two nursery ponds and are used for culture with rice crop in the system. The excess fingerlings are sold out. On the bunds agro-forestry plants like teak, Accacia, sisoo, neem, aonla and bamboo are planted on the northern and southern bunds. Horticultural crops such as banana, papaya and arecanut are grown on the bunds. Pineapple and spices are cultivated in the shade.

Flowers like marigold. Hibiscus and Jasmine are also cultivated in the western bund in $50m^2$ area. Two plants of lemon and each of guava, jackfruit, mango and litchi are also planted on the southern bund near the farm house to meet the household requirement. One poultry and one duckery unit are integrated in the system in which 40 poultry birds are raised during the dry seasons.(October to April) and 20 ducks are reared during the wet season (July to December).

Productivity and economics

Three crop of rice yields 800 to 1000 kg of grain per year. Entire produce is sufficient to cater the need of the small farm family. The straw is used for the cattle feed, mushroom base and roof of the farm house. Rest of the straw is sold to earn Rs. 500-1000 per year. Afetr two – three months of rearing, fish fry worth of Rs. 4000- 5000 is sold to the other farmers. Fish are harvested according to the need after the size becomes 250-300 g after 6 months or 0.5-1.0 kg after a year. The income from fish rearing in the system is Rs. 20,000. Pulses (mungbean, blackgram and pigeonpea) taken on the slope and bunds are just enough to meet the protein requirement of the farm family.

Crop Enterprises from the bunds

Seasonal vegetables grown on the bunds are the source income to the farm family and this practice is also labour intensive. Staggered sown vegetables on the bunds give a good return of Rs. 25-30/2.5 m^2/30 days. Binjal and chilly are the most profitable crops as these can be taken by rationing without much labour input in an area of about 200 m^2. Cucurbits taken on the bamboo frame over the trench give a good return. When the whole bund area managed properly with regard to unit area per unit of time, it fetches a return of Rs. 8000- 10,000. From the bund area, 50-60 bunches of banana and about 20 kg of papaya plant can be harvested in a year and the produce is used for consumption as well as sale. The surplus produce gives the net return of Rs 2000 to 3000 which can meet the mid term money requirement of the farm family. An additional amount of Rs 1600 t 1800 per year can be achieved from the disposal of arecanut, aonla, bamboo after 3-4 year, which will go up to Rs. 16000 to 18000 from fifth years onwards with the disposal of 15-20 sticks of bamboo per year, 5-6 quintals of arecanut, 40-50 kg of aonla and 30-40 kg of spices (turmeric and ginger)/ 20 m^2. This monetary return can be

utilized by the farm family for the personal needs and the purchase of farm inputs. As the tree like Teak, Sisoo, Acacia have high monetary value after 20-25 years, a farmer can expect a high return upto rs. 1 lakh to 3.5 lakhs from the trees of farm unit. From the bird unit 40-50 kg of meat from red leghorn/ Giriraj is produced every two – three months which give a net return of Rs. 8000-10000 per year. Apart from the meat the 10-12 kg of poultry dropping is used as a manure. Mushroom beds each of $2m^2$ taken on the bunds is sold at a profit of Rs. 10 per kg with the expenditure of Rs. 40 per bed. Though flouri-culture is not a profitable but can be used to meet the household religious activity and aesthetic requirement. The system in the subsequent years provides net earnings of Rs. 1,500-3,300 per month besides, high employment generation of 450-500 man days per year, thus restricting the migration of farm community (Sinhababu *et al*., 2007)

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OPPORTUNITIES FOR WOMEN IN HORTICULTURE SECTOR

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Gender issue in agriculture has been matter of discourse since long. Their role and opportunity especially in horticulture is not well documented though their involvement in very high. Six decades of independence, still India is struggling to get the status of developed country in the world because of untapped potential of women outside of the family and social spheres. Indian women constituting 49% of the population could play important and active role in speeding up the process of economic growth and development of the country, if they are involved in different sectors of Indian economy based on their working abilities, skill, experience and knowledge. There is need to identify the suitable sectors where the capabilities of women could be utilized efficiently for her economic security and for empowering the nation. Indian economy is mainly agriculture based economy. Agriculture contributes 17 percent to the total GDP and called backbone of Indian economy. Horticulture is one of the largest sectors of Indian agriculture. It contributes around 28 percent of the GDP from about 13.08 percent of the area and 37 percent of the total exports of the agricultural commodities. Our country has witnessed tremendous growth in this sector, which has brought out economic prosperity to the nation through 'Golden Revolution'. The area under this sector was 0.76 million hectares in 1950-51 which has increased to 24.2 million hectares in 2013-14 with a production of 277.4 million tonnes. Today country has got the status of 2nd largest producer of fruits and vegetables in the world.

Horticulture is extremely diversified component of Indian agriculture that deals not only with the cultivation and harvesting of wide range of crops viz., fruit crops, vegetables crops, tuber crops, ornamental crops, medicinal and aromatic crops, spices and plantation crops but also with the production of planting material, post harvest management, marketing, processing and value addition. This vibrant sector with a wide range of low volume high value crops provides lot of employment opportunities directly or indirectly for diverse group of women *i.e.* illiterate, less educated and highly educated. According to Joshi *et al.* (2003) horticultural crops are important contributor to employment opportunities in developing countries. Their production provides twice the amount of employment per hectare of production compared to cereal crop (Ali *et al.*, 2002).

The opportunities lying in horticulture for women are being discussed below-

A. On farm and off farm employment opportunities as labourer: Around 35% of Indian women are illiterate and could be engaged in following activities as labourer-

· **Nursery and seed production:** Commercial fruit and vegetable nurseries is flourishing trade as the demand for quality planting material is increasing day by day. This sector provides better opportunities for a farm woman to earn handsome money due to ease of operation and flexibility of timing. Traditionally they have been in those nursery activities which require less skill and machinery viz., bed preparation, seed treatment, line

sowing, filling of polythene preparation, weeding, watering, fertilizer application and seedling bundle preparation. They do not contribute much in grafting and plant protection measures due to lack of technical know- how and the amount of drudgery involved. Therefore, training on grafting and use of women friendly agricultural equipments could be very helpful in empowering them in nursery related activities.

Disease and pest management is very important for nursery seedling production. For this purpose regular need based application of pesticides is necessary which is generally done by knapsack sprayer. The womenfolk find it difficult to shoulder the sprayer and operate by cranking the lever. Cart based pneumatic women friendly sprayer are available to counter this constrains. These are easy to operate and use. Farm women can easily spray pesticides to seedlings with the help of long delivery pipe, without taking the sprayer to all parts of nursery. Women can also be involved in production of quality seed both in vegetable and ornamental crops. Women can perform various seed processing operations like harvesting, threshing, cleaning, drying, sieving and packaging (weighing filling in packets, stapling, labelling, etc.) efficiently.

· Horticultural crop production: Traditionally illiterate or less educated women have been working as labourers in various activities of fruit, vegetable and flower cultivation which are labour intensive, simple and low prestige tasks of cultivation viz., collection of seeds, weeding, hoeing, irrigation, harvesting, transport of the produce to short distance and processing. In general they do not take part in operations requiring more physical strength, heavy implements (spade, machines etc.) viz., ploughing, pit digging, spraying of chemicals, mixing of manure, diverting water for irrigation etc. and those requiring greater skill, viz., orchard layout, planting, grafting, pruning and training etc. According to Tripathi *et al*. (2015) women contribution in fruit cultivation includes weeding (80%), field preparation (40%), irrigation (40%), collection of harvest (40%), and sorting and grading (40%). Bhat and Bhat (2014) reported higher involvement of women than the involvement of men in apple cultivation for certain specific horticultural operation such as carrying cow dung on head, digging under plants, application of fertilizer, plucking of apples and transporting of boxes.

Tripathi *et al*., 2015 in two districts (Khurda and Ganjam) of Odisha revealed that women participation is more in cultivation of vegetables as compared to fruits and flower crops. They are playing major role (60-80%) in field preparation, stubble collection, sowing of vegetable seeds, transplanting of seedling and weeding. According to Mankar *et al*., (2013) in Vidarbha region of India farm women engaged in marigold cultivation activities are performing major role in top dressing of fertilizer (40.00%), grading (30.00%), packing (25.00%) and marketing of flowers (40.00%).

· **Industrial processing plants**: Horticulture provides raw material to many industries viz., coir, food processing (jam, jelly, squash, chips, pickle, sauce, ketchup etc.), dry flower, perfumery etc. Coir industry is one of the major sectors that is dominated by women. The role of women in coir sector is as high as 80 per cent and 60 per cent in coconut processing and broom making, respectively. Involvement of women in coconut based handicrafts is up to 40 per cent.The demand for the processed food material is increasing day by day due change in our life style and purchasing power. Women with limited knowledge and skill could be engaged various steps of processing viz., washing,

grading, sorting, packing. They have employment opportunities in dry flower sector as they are very creative in nature.

B. Horti-preneurship and self employment opportunities

· **Beekeeping:** It is an ideal, economically-viable enterprise that can be taken up by farm women as a profession as it requires less labour, attention, investment and no permanent holding. Besides, we have available with us the high yielding exotic *Apis mellifera*, commonly called Italian bee. Women can easily learn various operations involved in beekeeping viz., hiving of bees and bee swarms, occasional feeding, queen introduction, prevention of absconding, swarm control, honey extraction etc. A few bee colonies (boxes) kept in a kitchen garden or backyard of the house would add to the income of the farmer woman.

· **Mushroom Cultivation:** Mushroom cultivation is considered one of women friendly enterprises as it is simple, low costing and home bound. It provides great opportunities of income generation to farm women in both semi-urban and rural areas. Women possess skill and patience required for important operation like- harvesting of mushrooms, which are picked at the desirable stage very skilfully without damaging bed and neighbouring pin heads; trimming mushrooms before packing for sale. Other operations like filling of compost, spawning, casing, spraying etc. can be carried out easily by women since these do not require moving out of homes. Women can also be engaged in packing processing, processing and preservation activities. Thus, women can play a vital role in mushroom cultivation without sacrificing their household responsibilities.

Undoubtedly, mushroom cultivation can go a long way in raising overall economic level of women. Therefore, there is an urgent need to impart technical know- how to women so that they can adopt mushroom production as an income generating activity. Manju *et al.* (2012) and Biswas (2014) found the significant impact of awareness and training programmes in disseminating the knowledge of mushroom cultivation.

· **Processing and value addition:** Indian women have been traditionally doing some processing and value addition in fruits and vegetables on small scale like preparation of dehydrated products, preserves, pickles etc. Improved technologies for drying, preparation of minimally processed product (ready to cook vegetables and ready to eat fruits) and diversified processed products (Jam, jelly, murabba, pickle, candy, squash, nectar, ready to serve drinks, marmalades, etc.) from horticultural crops are now available various technologies which could be adopted by women. Many simple farm-produce-processing technologies have been developed using minimum equipment and small investments. Women could be trained easily for handling these equipments/gadgets.

· **Horti-consultancy and vocational training:** Women with diploma and degree in horticulture subject can earn handsome amount of money by providing advice on various aspects of crop cultivation to the growers and entrepreneurs and by providing skill developing vocational training to them.

· **Floral decorator and landscaping** architect: There is a great demand for these personnel from Government agencies, landscape architectural firms and resorts to beautifying the parks, recreational areas, campuses, industrial sites, institutional grounds, shopping mall etc. This job requires sound knowledge of cut flower, loose flowers, potted plants, foliage, grass, dry flowers, floral arrangements and land landscaping.

· Commercial nurseries and protected cultivation of vegetables are another area where women have opportunity to earn their livelihood.

C. Job opportunities for highly educated women in Government sector

Generally a good job in horticulture sector requires degree in this discipline. College level education provides more in depth knowledge of the field and offers job opportunities at supervisory or managerial levels while post graduation and doctorate level degree provide very good jobs in the field of horticulture to conduct research or impart teaching.

· In research: Though, our country has achieved a great success in horticulture and witnessed "Golden revolution" yet, there are many challenges viz., declining land and water resources, rising energy, taxes and production cost, mounting demand of horticultural produce and climate change, confronting to keep the pace of growth and development in this sector. But this sector is committed to produce surplus to meet the growing demand of ever increasing population. Therefore, in this sector there is lot of demand for the researchers so that new innovative and improved technologies could be developed time to time. Women with master degrees and PhD degree in the horticulture subject may get employment as scientist and subject matter specialist. Besides they can also work as research associates and senior research fellow on contractual basis.

· In education: Lecturer, Reader, Assistant Professor, Associate Professor in Agricultural Universities and Colleges.

· Training Organizer & Training Associate in Krishi Vigyan Kendra (KVK).

· Civil Services: Examination conducted by Union Public Service Commission (U.P.S.C) for IAS/IFS

· As District Horticulture Officer/ District Agriculture Officer through examination conducted by State Public Service Commission

· Technical Assistant / Technical Officers in Agricultural Universities ICAR, DRDO, IARI, & CSIR

· Horticulture Inspector / Fruit & Vegetable Inspector / Marketing Inspector

· Training Assistant in Krishi Vigyan Kendra (KVK)

· Farm Supervisor

· Section Officer (Horticulture / Landscaping), Horticulturist or Supervisor (Horticulture)

· Horticulture Development Officer

· Village Level Worker

D. Job opportunities for highly educated women in private sector

· As Horticulturist / Horticulture Officer or Supervisor (Landscape) in Industries, Farm Houses, Hotels, Golf Courses & Construction Companies etc.

· As Horticulture officer in processing companies of agriculture production

· Marketing jobs

Impediments affecting the opportunity for women in Horticulture

Drudgery: Most of the horticultural activities performed by farm women involve considerable amount of drudgery because most of them are done manually. They use very old tools and equipment which also used by the gents and are not suitable for them. They are performing

tasks repetitively with very awkward static posture such as squatting, bending, sitting which is responsible for musculoskeletal disorders and leads to occupational health hazards. Pain in upper and lower limbs, injuries in finger, nail & palm, allergies & injuries in skin are the major problems one can identify easily.

1. Illiteracy: Majority of the farm women are illiterate and are facing serious constraints in carrying out horticulture production activities because of inadequate technical competency. They have less access to information, technology, inputs and credit than men. This has compelled them to follow age old practices which in turn result in poor work efficiency and drudgery.

2. No self decision making power: Although women play an important role in horticulture production, their role in the decision making process regarding buying inputs, selection of crop, selection of variety, planting crops, planning the budget, hiring labour, disposal of produce, etc. is not significant and they play a supportive role.

3. No ownership on land: Though, Indian legislation permits equal rights to men and women, still women do not have ownership on land and pattas are allotted in their husband's name.

4. Limited access to inputs and credit: Farm women have less access to most of the crucial input and credit as they are not land owners.

5. Household responsibilities: She is overburdened due to her multidimensional at home and at farm. Women agricultural labourers are paid much lower wages because of the belief that women have less physical strength than men.

Measures to improve the opportunity for women in Horticulture

- Capacity building: The technical skills of farm women can be developed through organizing training programmes, exposure visits, vocational trainings, group discussions, involving them in national and international trade fairs etc.
- Self help group: The performance of women in horticulture can be enhanced through self help group as they mostly work in groups.
- Development of women friendly horticultural technologies: Many farm women friendly horticultural technologies have been developed in India with a view to reduce the drudgery, to reduce occupational health hazards and to enhance the work efficiency of farm women engaged in Horticulture. Finger Guard for picking flower and vegetable crops, Ring cutter for plucking vegetables like okra, Face protector for reducing occupational health hazards during weeding and harvesting hazards, Protective clothing for reducing occupational health hazards and Fertilizer Trolley etc are some innovative machines which can be used in horticulture
- Access to ICT tools: Access to the information and communication technology is essential for farm women to get the information on various aspects of horticultural crop production viz., packages of practices of crops, weather forecast, mandi prices etc., and to get updated with the recent technological advancement in horticulture.
- Infrastructural facilities like road, electricity, cool chain, etc. must be developed in rural areas for increasing entrepreneurial opportunities
- Family support

Conclusion

Horticulture with a wide range of low volume high value crops e.g. fruit crops, vegetables crops, tuber crops, ornamental crops, medicinal and aromatic crops, spices and plantation crops ,is the fastest growing sector of Indian agriculture. It provides lot of employment opportunities directly or indirectly for diverse group of women *i.e.* illiterate, less educated and highly educated. Besides providing on farm and off farm employment opportunities as labourer, it offers self employment and jobs in government and private sector. While working as labourers, women are exposed to considerable amount of drudgery because most of them are done manually. Women friendly horticultural technologies are available and are needed to be popularized to enhance the working efficiency of women labourer. Training programmes, exposure visits, vocational training, access to ICT tools, formation of self help group and family support could play a vital role in motivating women to opt horticulture as source of self employment. Women youth is needed to be encouraged to opt for horticulture as a subject for higher studies. Thus, opportunities are vast in horticulture sector and are waiting to be tapped by the women.

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SECONDARY HORTICULTURE: A POTENTIAL SECTOR FOR GENDER MAINSTREAMING

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Agriculture is the mainstay of Indian economy which supports the livelihood of about 2/3rd of population. In order to achieve self sufficiency, India has adopted various institutional interventions, technology, crop diversification programme, natural resource management, human resource development, skill upgradation and policies as the key drivers to guide the agriculture sector. On the one hand we have fluctuating agricultural growth and on the other we have distress in farm sector. The reducing farm size, dwindling profitability, resultant indebtedness and farmers' suicides are a matter of concern. The farmers most often complain that they are not properly rewarded for their production efforts. We produce various crops but the supply chain for most agricultural commodities is highly fragmented with multiple intermediaries contributing to the inefficient handling and high transaction costs. The supply chain is characterised by lack of sufficient and efficient facilities like processing, product-specific transport models, grading, certification and packing.

The secondary agriculture provides value addition to agricultural products, creating facilities for primary processing and stress management in agriculture and adds value to the basic agro commodities to allow farmers to get better returns from their harvest. It also creates a new job in the rural sector to grow rural economy which is entirely based on agriculture. Moreover, secondary agriculture has potential to add two to three-fold value to primary agriculture. ICAR is going to shift its focus from primary to secondary agriculture in the 12th five year plan (2012-17). Secondary horticulture can be employed primarily in horticultural produce viz. processed products from fruits and vegetables, essential oil, medicinal and herbal products, etc. Value addition to agriculture produce can easily be promoted and established at village level which will prepare products of local importance for sale in the local markets. It can increase farm income up to 40 per cent and will create additional job opportunities and will also improve nutritional status of the people. The export of processed food has also increased from US$ 16,312 million in 2008–09 to US$ 36,212 million in 2012–13. This sector provides employment to about 8.53 million people in India along with a wide range of contributions to revenue.

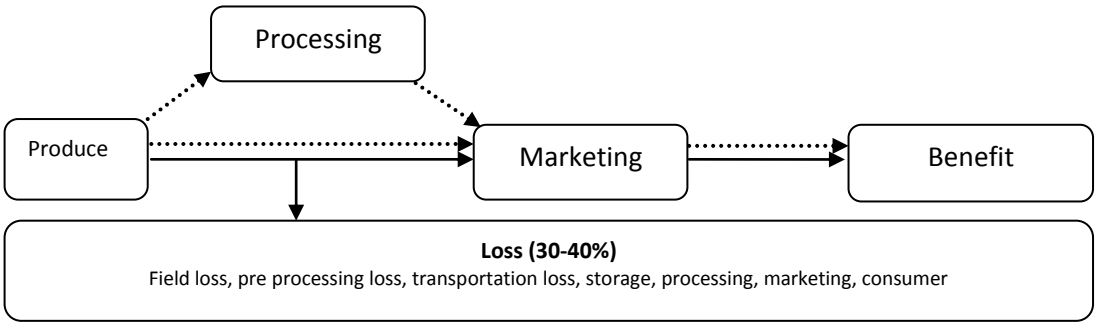
India's horticulture production has crossed all time high of over 280 million tonnes (NHB, 2014). Horticulture occupies 8.5% of the cropped area only however it contributes over 30% to the gross agricultural output. Among horticultural crops, fruits and vegetables have the lion's share of more than 85% (254 million tonnes) of production; however they also experience high PHT losses (30-40%). Considering whooping post harvest loss the actual production of fruits and vegetables is 170 million tones and consequently the per capita availability of fruits and vegetables reduced to less than the ICMR recommendation of 120 g/day and 300 g/day fruits and vegetables, respectively. The economic growth and changes in dietary patterns have made both the production and consumption of fruit and vegetables increasingly important. The fruit

and vegetable sector has a vital role in farm income enhancement, poverty alleviation, food security, and sustainable agriculture, especially in developing countries. This sector, however, suffers greatly from postharvest losses. Some estimates suggest that about 30–40% of fruit and vegetables are lost or abandoned after leaving the farm gate. Secondary horticulture has the potential to address the problem of post harvest loss.

Importance of secondary agriculture (Post-harvest technology) lies in the fact that it has the capability to meet food requirement of growing population by eliminating losses making more nutritive food items from raw commodities by proper processing and fortification. Importantly, Post-harvest technology has potential to create rural industries which can be a great asset for Indian economy as 80 percent people live in the villages and 70 percent of them depend on agriculture. Industrialization in urban areas has resulted in capital drain from rural to urban areas, decreased employment opportunities in the rural areas balance trade in favour of urban sector and mismatched growth in economy and standard of living between rural and urban people. It is possible to evolve appropriate technologies which can establish agricultural based rural industries. The farmer whose role has been reduced to producer can be transformed into producer cum processor and thus getting more dividends for hard labour, input, kind of risk taken and generating resource for socio-economic advancement keeping pace with the modern times.

The key role played in the past by women in agriculture including horticulture was largely unacknowledged in government statistics and decision-making even though they possess first-hand knowledge and insights into such things. This situation has changed over the last two or three decades, and much has been achieved in giving recognition to the importance of women in the agricultural sector. The empowerment of women engaged in farming is gathering pace in many parts of the developing world. Gender mainstreaming, as a strategy, has developed out of a major shift in the focus of efforts to promote gender equality and equity in recent years. The gender mainstreaming strategy focuses on the fact that men and women should be benefitted equally. The concept of mainstreaming recognizes that the empowerment of women can only be achieved by taking into account the relationships between women and men. The advantage of a gender mainstreaming approach is that it allows for the advancement of gender equality and equity regardless of whether it is women or men who are disadvantaged and whose position needs to be addressed. The secondary horticulture will have better say of women since they are more proficient in carrying out different activities of processing and value addition. The role of women is likely to be more critical and there are immediate opportunities for community-led ventures to be successful in rapidly developing markets. Given the extensive participation of women in all aspects of agricultural production, the mainstreaming of gender into the horticulture sector is a key strategy not only for the promotion of equality between men and women, but also for sustainable agricultural and rural development. However the major constraints of processing sector in India are poor infrastructure, technical knowhow, and Poor market linkages and poor coordination between the R&D institutes and processing units. Secondary agriculture is complex, as it involves old as well as new technologies, capital investments, improvements in rural infrastructure, marketing and some critical changes in Government regulations. However, this sector has potential to bring women in the mainstream

of development by improving their livelihoods. The supply chain can be made more economically viable with the processing of fruits and vegetables which more prone to wastage.



Post harvest management, processing, storage and utilization of horticultural produce are generally the domain of women at home scale. The rural and tribal women have obtained expertise in the traditional foods and formulations through inherited knowledge. The commercial utilization of these formulations and products by small scale enterprises may be helpful in the income enhancement and additional employment of women. Further the new products and changing preferences of the consumers are opening new avenues for the small and medium scale enterprises in post harvest handling and value addition. The post harvest and value addition industry are expanding to utilize new opportunities. Since women are traditionally engaged in this sector more women need to be trained on the new technologies and policies in the post harvest handling and processing of various horticultural crops to fulfill the growing needs of the sector.Women are involved in the small scale marketing especially in the informal marketing of vegetables in most part of the country**.** In some areas the women comprise 60 to 80 per cent of the workforce in trading of fruits and vegetables. The expertise and the knowledge about the local market practices may be helpful and they can easily be partner in the larger chain of supply of these produces.

Levels of post harvest management

Important sectors in agro processing industries are: fruit and vegetable processing, grain processing, fish processing, milk processing, meat and poultry processing, packaged/ convenience foods and soft drinks etc. As much as 42 per cent of the food industry is in the organized sector and 33 per cent in the small scale, tiny and cottage sectors.

There are three stages of processing.

Primary processing: Purification of produce (fruits, vegetables, spices, cereals, etc) by removing foreign matter, immature grain and then making the raw material eligible for processing by grading in different lots or conversion of raw material into the form suitable for secondary processing.

Secondary processing: Processing of primary processed raw material into product which is suitable for food uses or consumption after cooking, roasting, frying etc. Packaged food like cornflakes, oat, etc is prepared by secondary processing.

Tertiary processing: Conversion of secondary processed material into ready to eat form.

Food items are marketed in different forms as raw, primary processed, secondary processed and tertiary processed. Processed products like jam, jelly, pickle, etc are the outcome of tertiary processing.

Value added products

Many value added products are prepared from horticultural crops. However, fruits and vegetables are most commonly used.

Pickle - *Pickles are one of the important consumer products. The important pickles are mango, mixed, chilli, garlic, ginger, etc. Fully matured fresh vegetables or fruits are washed and cut into required sizes and treated with brine water (15%) for 30 minutes. The partially dried materials are addes with spices, salt, and oil and other ingredients in required quantity. The prepared fresh pickles are cured for a week and packed in different sizes for market.*

Squash – Squash contains about 25 per cent fruit juice and 40-50 per cent total soluble solids (TSS) apart from 1.0 per cent acid and 350 ppm sulphur dioxide or 600 ppm sodium benzoate. It is diluted twice or thrice before serving. Orange, mango and pineapple are used for squash. It can also be prepared from lemon, bael, papaya, etc. using potassium metabisulphite (KMS) as preservative or from jamun, passion-fruit, peach, plum, raspberry, strawberry, grapefruit, etc. with sodium benzoate as preservative.

Ready- to - Drink (RTD) – RTD is very common as it is most liked by the consumer. It contains at least 10 per cent fruit juice and 10 per cent total soluble solids besides about 0.3 per cent acid. It is not diluted before taking. Mango, litchi, apple, pineapple, guava, berry, etc. are commonly used for RTS preparation.

Cordial - It is a sparkling, clear, sweetened fruit juice from which pulp and other insoluble substances have been completely removed. It contains at least 25 per cent juice and has 30 per cent TSS. It also contains about 1.5 per cent acid and 350 ppm of sulphur dioxide. Lime and lemon are suitable for cordial. This is very suitable for blending with wines.

Nectar - This type of fruit beverage contains at least 20 per cent fruit juice / pulp and 15 per cent total soluble solids and also about 0.3 per cent acid. It is not diluted before serving.

JAM - Jam is a thick consistent product made by boiling fruit pulps with sufficient amount of sugar to a reasonably firm enough to hold the fruit tissues in position. Apple, papaya, plum, sapota, peach, strawberry, raspberry, mango, grapes and muskmelon are used for preparation of jams. It can be prepared from one fruit or more than one fruit (mixed).

Jelly - Jelly is a transparent semi solid product prepared by boiling a clear, strained juice of pectin-containing fruit, with sugar and acid. A perfect jelly should be well-set, but not too stiff, and should have the original flavour of the fruit. It should be of attractive colour and keep its shape. Guava, plum, karonda, loquat, papaya and goose-berry are generally used for preparation of jelly. Apricot, pineapple, strawberry, raspberry, etc. can be used but only after addition of pectin powder, because these fruits have low pectin content.

Marmalade - This is a type of fruit jelly in which slices of the fruit or its peel are suspended. The term is generally used for products made from citrus fruits like oranges and lemons in which shredded peel is used as the suspended material. For preparation sweet orange and sour orange are used in the ratio of 2:1 and the shreds of sweet orange peel are used.

Candy – Candy is prepared from whole fruit / vegetable or its pieces impregnated with sugar syrup, and subsequently drained free of syrup and dried. The most suitable fruits for candying

are ash gourd, aonla, karonda, pineapple, cherry, papaya, apple, peach, and peels of orange, lemon, grapefruit and citron, ginger, etc. Covering of candied fruits / vegetables with a thin transparent coating of sugar, which imparts them a glossy appearance, is known as glazing or glazed candy.

Preserve - A mature fruit / vegetable or its pieces impregnated with heavy sugar syrup till it becomes tender and transparent is known as a preserve. Aonla, bael, apple, pear, mango, cherry, karonda, strawberry, pineapple, papaya, etc. can be used for making preserves.

These products could be easily prepared by rural women with requisite skill. However, rural infrastructure is required to initiate the secondary agriculture at the place of production.

The secondary horticulture is critical to India's development as it establishes a vital linkage and synergy between the Industry and horticulture. India is the world's second largest producer of fruits and vegetables and holds the potential to acquire the driver's sit with sustained efforts. The enormous growth potential of this sector can be understood from the fact that food production in the country is expected to double in the next 10 years, while the consumption of value-added food products will also grow accordingly. The growth of processing industry will bring immense benefits to the women and in turn the economy by creating employment and improving livelihood of rural farm women areas. Moreover, round the year availability of raw materials, social acceptability and vast domestic market further increase the scope of processing industry. However, emphasis should be put on the establishment of new agro-industrial plants in the production catchments to minimize transport cost, create employment opportunity in the rural sector and utilize process waste and by-products for manure and animals. It is evident that the viable way to cope with the present situation is to give a massive thrust on reduction of post harvest losses in order to make available more food from the existing level of production.

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LOW COST PROTECTED CULTIVATION OF VEGETABLE CROPS: A WOMEN FRIENDLY TECHNOLOGY

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Vegetables cultivation is considered as an important technology for women in agriculture. It not only provides good income by huge production and use of suitable varieties but also ensures nutrition of the farm family. Presently India produces about 162.89 million tonnes of vegetables from an area of 9.39 million hectares with an average productivity of 17.3 t/ha (NHB, 2014). India has a wide range of diverse agro-climatic conditions but cultivation practices of vegetables in India have been generally restricted to regional and seasonal needs. Though there has been phenomenal increase in area (1.67 folds), production (2.78folds) and productivity (1.66 folds) of vegetables in our country during the last 2 decades, still there is huge gap between present production and availability and the major reason of low production of vegetables is still the technology used and practices followed are pre-dominantly traditional, resulting in low productivity and poor quality of vegetable produce supplies to various markets in the country. Production of vegetables under protected condition is the best alternative to reduce this gap and use the land and other resources more efficiently. Protected cultivation technology is considered as a drudgery reducing technology and women friendly technology. By adopting protected cultivation, year round availability of quality produce for both domestic and export purpose can be assured. Cultivation of high value vegetables under protected conditions in India is gaining more importance. Presently the area under vegetable production in protected conditions is 5000 ha., while the national potential is one lakh ha.

In several parts of the country, especially in northern plains, the soils are highly fertile but extremes of temperature, ranging from 0 to 47^0C during the year does not allow year round outdoor vegetable cultivation. Similarly, in several parts of the country several biotic stresses, more specifically during rainy and post rainy season, also does not allow successful production of vegetables like tomato, chilli, okra, sweet pepper etc. in open field condition. As a result of various biotic stresses most of these vegetables are severely damaged. In hilly areas, cold desert conditions prevails where the temperature is extremely low (-10^0C to -30^0 C) during winter season and most of the hilly region cut off from rest part of the country from November to March due to very heavy snowfall. Therefore, it is very difficult to cultivate and supply vegetables in this area.

In many countries in world like European countries, USA, Japan, China, Israel, Morocco, Turkey etc, where climate prevents or reduces the choices for year round out door crop production, crops are being produced under protected environments. Greenhouse being the most efficient means to overcome climatic diversity, greenhouse vegetable production makes the use of recent advances in technology to control the environment for maximizing crop productivity and increasing the quality of the vegetable crops.

Although, the world greenhouse area as a whole is only a tiny part of that denoted to worldwide agricultural operations but in some cases, the income can be a significant factor for improving a country's income and foreign exchange earnings from exports (i.e. Israel commands the off-season markets in Europe).

India has entered into the area of protected vegetable cultivation more recently and the total area under protected vegetable production is not more than 20000 hectares. India being a vast country with diverse and extreme agro climatic conditions, the protected vegetable cultivation technology can be utilized for year round production of high quality vegetable crops, for raising disease free seedlings, production of off-season vegetables, hybrid seed production of high value vegetables. The thrust on protected cultivation of vegetables in addition to use of better varieties, better management practices, etc. have played a significant role in the productivity enhancement of cash crops in country.

Prospects of protected cultivation of vegetable crops in India

The introduction of protected cultivation technologies in India has a time lag in relation to many countries. Incidentally, China began to use the protected cultivation technologies almost at the same time when India made a beginning. But China has surpassed almost all the countries in the world in the use of these technologies. While India moving steadily to expand the area under protected cultivation, the pace of progress could be increased several folds if government of India continues to support protected cultivation efforts strongly in the country. Greenhouse cultivation of horticultural crops is reasoned to be the next logical step to open field agriculture. Because one million hectares of area under greenhouse cultivation is efficient to increase the production of vegetables alone about 80-100 million tonnes. This can also create about one million additional jobs in the rural sector where unemployment problem is more acute. Greenhouse vegetable production has tremendous scope in peri-urban areas of the country because of continuous increase in demand and availability in the markets and continuous changing preference of consumers towards off-season and high quality produce of different horticultural crops. The vegetable growers who are having agriculture land 80-100 km around the big cities like Delhi, Mumbai, Kolkata, Chennai, Bangalore, Jaipur, Ahmedabad etc. have tremendous potential to go ahead with vegetable production under protected condition for high productivity and high quality vegetables to take the advantage of the available in market in those cities. Farmers can also fetch good price of their off-season produce in those cities (Sirohi and Singh, 2002, Singh and Sirohi, 2004).

Now the next question arises which vegetable crops should be grown under greenhouses. In fact the choice of the vegetable crop and variety to be grown in a greenhouse is normally made on the basis of the climatic conditions of the area, physical size of the structure and availability of market for that produce. However, greenhouses have tremendous potential in increasing production and productivity of vegetables like size of tomato, broccoli, coloured sweet peppers, parthenocarpic cucumbers including some rare vegetables, medicinal and ornamental plants especially under adverse climatic conditions. Now-a-days nursery raising of vegetables has also become a specialized and technical job with increasing susceptibility of vegetables to various biotic and abiotic stresses and very high cost of hybrid seeds. The utility

of greenhouse for raising virus free healthy seedlings of various vegetables during rainy and post rainy seasons and for raising off season nursery of cucurbits during peak winter months for off season production of these crops may be very successful and can be adopted as a commercial venture by the farmers and unemployed agriculture graduates of our country in major vegetable growing pockets and specially in peri-urban areas of the country (Singh, 2004 and Singh et al., 2005).

Protected cultivation technology suitable for various climatic conditions

All kind of protected technologies may not be economical and useful to the farmers in India, because of their very high initial, running and maintenance cost, but some protected technologies are simple, suitable and highly profitable under Indian conditions and more specifically under peri-urban areas, which can be adopted by Indian farmers for production of different horticultural crops in the following manners. Recently in Haryana, protected cultivation is becoming popular. There all structures are maintained under the supervision of the experts and providing all facilities like fertigation, drip irrigation, cooling, exhausting seeds etc. They are charging Rs 2/ plant and Rs 1/ plant (Those purchased seed own cost) from the farmers

1. Plug-tray seedling production technology

To ensure high productivity and high quality of the produce, raising of high quality seedlings through use of good quality seeds at right time and at a appropriate place is one of the cheapest but most important way. Most of the Indian farmers are raising their vegetable seedlings under open field conditions, which are always inferior in quality, as the seedlings are mostly infected with virus when raised in open field conditions and especially during rainy and post rainy season. On one side soil borne fungus and nematodes create severe problem for raising the seedlings in soil media in open fields during hot summers and rainy season but on the other hand the very high cost of hybrid seeds in vegetables has also warranted the farmers to change their traditional nursery raising method to increase the productivity and quality of vegetables. Protected nursery raising in vegetable crops is already working as a full scale industry in several European countries, Israel, USA, Morocco, Turkey, Japan and China. Under this system seedlings are raised in multi-celled plastic pro-trays in artificial soil-less media in especially designed greenhouses or other protected structures. Large number of virus free healthy seedlings of different vegetables can be raised in a small area of green house in multi-celled plastic pro-trays by using soil-less media for growing vegetables either in main season or during their off season. With the use of this technology it is now almost possible to even raise healthy, vigorous seedlings of different cucurbits, otherwise it was not possible in the traditional system of nursery raising. The farmers or unemployed agriculture graduate or postgraduate youths of our country can successfully start nursery raising as a small scale industry in major vegetable growing pockets of the country. By this way the vegetable growers will easily and timely get the virus free healthy and even off-season nursery as per their requirement and it will also generate employment in agriculture sector. Therefore, this is the first and most important step for protected vegetable cultivation.

2. Plastic low tunnel technology for off season vegetable cultivation

In most parts of our country the farmers are growing various vegetables during their main season of cultivation, but the prices of vegetables are very less and sometime the vegetable growers are even not able to get back the cost of cultivation of those vegetables, but the same vegetables are sold on very high price during their off-season in various cities of our country. The demand of off-season vegetables is increasing day by day in several big and medium sized cities of the country, which provide a wide scope for protected vegetable cultivation through off-season cultivation of vegetables mainly the cucurbits in peri-urban areas of the country. Plastic low tunnel technology is a simple, suitable and profitable technology for off-season cultivation of cucurbits during the winter season in northern plains of the country. Crops like summer squash can be grown as a complete off-season crop, whereas other cucurbits like muskmelon, bottle gourd, cucumber, bitter gourd, watermelon can be advanced by 30- 40 days over their normal growing season (Singh et al., 2001, Singh et al., 2003 and Singh et al., 2005). Plastic low tunnels are flexible transparent coverings that are installed over single or multiple rows of vegetables to enhance the plant growth by warming the air around the plants in the open field during winter season normally when the temperature is below 10^0C. Plastic low tunnels are often used to promote the growth of plants during the period of winter season. Plastic low tunnels are supported above the plants by using hoops of GI wire and a clear or transparent plastic of 30-50 micron is covered or stretched over the hoops and the sides are secured by placing in soil. The plastic is vented or silted during the growing season as the temperature increase within the tunnels. The farmers can grow different varieties of summer squash, which is an emerging crop along with cultivation of netted muskmelon varieties in place of traditional varieties. Bitter gourd, bottle gourd and cucumber are other crops with increasing demand and which usually fetches very high price during off-season and can be grown successfully by using the plastic low tunnel technology. This technology is suitable and profitable for the farmers of northern plains of India.

3. Use of Insect proof net house technology for safe vegetable cultivation

Usually the farmers are growing their vegetable crops like tomato, chilli, sweet pepper, okra etc under open fields. But during rainy and post rainy season it is very difficult to grow these crops successfully due to leaf curl and yellow vein mosaic and other viruses, respectively. These viruses are mainly spread by insect vectors like whitefly or aphids. The population of white fly after on start of monsoons is very high and it remains in the environment up to mid November depending upon the temperature. The farmers are spraying several insecticides to control these vectors, even they could not control these vectors and their tomatoes, brinjal, sweet pepper, chilli or okra crops are highly infected with viruses. The second most common and most severe problem in tomato, brinjal and okra is the fruit borer against which also the growers are using huge amount of insecticide even they are unable to control this insect perfectly. The only way to control the virus and fruit borer is to put a mechanical barrier between the crops and open environment and this is possible with the use of insect proof nylon nets of 40 or 50 mesh densities in form of net houses or insect proof net covered walk in tunnels. By this way the growers can directly reduce the use of insecticides and they can grow virus and borer free crops of tomato, brinjal, chilli, sweet pepper and okra during rainy or post rainy season. But for

growing these crops under insect proof net houses, it is necessary to raise virus free healthy seedlings of these crops either in the greenhouse or by covering the nursery beds with insect proof net. The farmers can erect these insect proof net houses by using half inch size GI pipes after bending them in half circle shape. Other insect proof net houses can also be made by covering all sides and top with insect proof net of 40 or 50 mesh, but the nylon net should be UV stabilized. Under these net house crops like sweet pepper, tomato chilli, brinjal and okra can be grown successfully without infestation of viruses or other insects like fruit borer etc. Thereby the use of insecticides can be minimized in vegetable cultivation and such vegetables are treated as safe vegetables for health.

4. Naturally ventilated greenhouses for cultivation of high value vegetables

Naturally ventilated greenhouses are the protected structures where no heating or cooling devices are provided for climate control. These are simple and medium cost greenhouses which can be erected with a cost of Rs.500-600 m2 and these greenhouses can be used successfully and efficiently for growing year round parthenocarpic slicing cucumber, off season muskmelon, tomato and sweet pepper crops. These structures are having a manually operated cross ventilation system as and when required. Looking to the year round, increasing demand of high quality parthenocarpic slicing cucumber in markets of the metro and other big cities of the country, this is one of the most suitable and profitable crop for cultivation under naturally ventilated green houses in peri-urban areas of the country. Three crops of cucumber can be grown in a naturally ventilated greenhouse in a period of nine months. Tomato and sweet pepper crops can be successfully grown over a period of 8 to 9 months for higher yield and good economics.

5. Climate and semi-climate controlled greenhouses for production of high value vegetables

High value vegetables like slicing tomatoes, cherry tomatoes and coloured peppers are three crops which can be grown for long duration (10-12 months period) under climate control greenhouse conditions. In metro cities like Delhi there is year round demand of these high quality vegetables in the markets *viz*., five star hotels, shops of embassies or high commissions of various countries situated in Delhi. They are ready to pay very high price for the high quality produce therefore, it may be a profitable venture only if this technology is adopted around metro cities of the country.

Although the initial and running cost of the climate controlled greenhouse is very high, which restrict the adoption of this technology. But now the time has come when the vegetable growers around metro cities can use the green house technology for cultivation of high value vegetables for higher profits. High value vegetables produced under climate and semi-climate controlled greenhouses can also be exported to the other countries.

Type of protected structures and their economics for cultivation of vegetable crops

We must consider the market for the eventual product well before construction or fabrication of the greenhouse or a protected structure. The economics of the protected cultivation largely

depends upon the initial cost of fabrication of the protected structures, running and maintenance cost of the structures, available market for the product produced under a particular protected structure. Economics of some vegetable crop cultivation under different kind of greenhouses and low cost protected structures have been worked out at Indo-Israel Project of IARI, New Delhi have been given in table 1 (Singh et al, 2004, 2005). Generally the low initial cost of protected structures viz., naturally ventilated greenhouses, insect proof net-houses and plastic low tunnels are suitable and economical for protected vegetable cultivation under Indian conditions. Vegetable cultivation under climate-controlled greenhouses may be economical if the produce is supplied to five star market of the big cities or if it is directly exported to overseas markets on a premier prices.

Table 1. Comparison of cost of production of vegetables under different protected structures

S. No.	Kind of protected structures	Cost (Rs./m^2)	Suitable crops	Duration crops (days)	Yield (t/1000m^2)	Cost (Rs./kg)
1	Climate controlled greenhouse	3200-3500	Tomato Sweet pepper Cucumber	320 300 360(4 crops)	25.0 6.0 18.0	22-25 45-50 20-25
2	Semi-climate controlled greenhouse	1400-1500	Tomato Sweet pepper Cucumber	290 260 280 (3 crops)	20.0 5.0 15.0	15-18 35-40 15-18
3	Naturally ventilated greenhouse	500-600	Tomato Sweet pepper Cucumber	270 240 280	16.0 4.0 15.0	8-9 18-20 7-8
4	Insect proof net-house	80-100	Sweet pepper	200-240	3.5-4.0	15-16
5	Plastic low tunnels	5-6	Summer squash Musk melon Bitter gourd Bottle gourd	90-95 110-120 110-120 80-90	5.0-6.0 2.0-3.0 1.0-1.5 2.0-3.0	1.5-2.0 3.0-4.0 4.0-5.0 3.0-4.0

Major constraints in protected cultivation of vegetable crops

Greenhouse vegetable cultivation in India, though very ancient, is in its infancy. Very little efforts have been made to exploit vast potentials of protected vegetable cultivation. Some major constraints and problems which restrict vegetable cultivation under protected conditions in India are as follows:

1. The basic cost of construction and operational cost of the climatic controlled greenhouse is very high, which do not suit to the Indian growers without a strong government support.
2. Uninterrupted and regular power supply is required for operating cooling and heating system of the greenhouse, which is not available almost in all parts of the country.
3. Very little work on standardization of designs of greenhouses and other protected structures have been done for different agro-climatic regions of the country.
4. Cladding material of required quality is not readily available or is very costly. There is also a lack of suitable instrumentation for environment control in greenhouses. .
5. Greenhouse cultivation technologies entail higher investments per unit area as compared to open field agriculture. Low interest bank loans should be made available to the users for establishment of greenhouses.
6. There is a lack of specific research program on greenhouse vegetable production in the country.

Conclusion

It is well accepted that women are playing major role in all activities viz., production and post harvest handling of horticulture crops and their role in continuously increasing day by day due to various factors. Protected horticulture is a labour intensive industry, which provides a great opportunity for Indian horticulture products in overseas markets. There is no doubt that protected cultivation of vegetables in India will become increasingly important in near future. Protected cultivation of vegetables is consider a women friendly and drudgery reducing technology. Protected cultivation of vegetables has tremendous opportunities for employment generation nutritional security and income generation for women and can contribute to over all livelihood security of rural and peri urban areas people. There is need to standardized protected cultivation technology which will be economical profitable and manage by women so that women folks become empower and consider a part of mainstreaming.

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LIVELIHOOD ENHANCEMENT OF FARM FAMILIES BY INTEGRATING TUBER CROPS IN IFS

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1. Introduction

ICAR 2050 vision document emphasizes raising of agricultural income and employment opportunities (ICAR, 2015). Per capita availability of land has been declining continuously in India. It has declined from 0.5 ha in the year 1950 to 0.15 ha during 2000 A.D (Mahapatra, 2008). It is expected to reach 0.08 ha by 2021. Hence, income through arable farming alone is insufficient for small and marginal farmers. Activities such as piggery, dairy, poultry, pisci-culture, sericulture, biogas, agro-forestry, agro-horticulture *etc*. assume critical importance in

supplementing farm income. It fits well with farm level infrastructure and ensures fuller utilization of byproducts such as poultry manure as fish feed in poultry-fish farming system. The only alternative left for the small and marginal farmers is Farming System Approach (FSA). Etienne (2011) writes that the next stage of green revolution may be more complex and knowledge based. He also highlighted the importance of availability of energy and connectivity.

2. Farming system approach

2.1. Definition

The term 'farming system' can also mean different things to different people. To avoid ambiguity and confusion, both terms 'farming' and 'system' should be clearly understood. Farming is the process of harnessing solar energy in the form of economic plant and animal products and the system implies a set of inter related practices/processes organized into a functional entity.

Farming System therefore defined as '*a set of agricultural activities organized while preserving land productivity, environmental quality and maintaining desirable level of biological diversity and ecological stability'*.

The emphasis is more on a system rather than on gross output. In other words, farming system is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of the farm household while preserving the resource base and maintaining high environmental quality. The farming system in its real sense will help in productivity, profitability, potentiality/sustainability, balanced food, recycling resources and employment generation to lift the economy of Indian agriculture and standard of living of the farmers of the country as a whole.

2.2. Basic principles of FSA

FSA is based on the following basic principles:

Make the farm household self sufficient; make the farm free from being vulnerable to external forces. Enterprise diversification aims to increase income, minimizes the spread risks, enhance natural resources and the environment and improve the diet of farm families.

Farming system seems to be the answer to the problem of increasing food production, for increasing income and for improving nutrition of the small-scale farmers with limited resources without any adverse effect on environment and agro-ecosystem.

2.3. Advantages of farming system

Farming system aims at maximum utilization of on-farm inputs and minimum of purchased inputs for higher productivity. Byproducts of one enterprise (i.e. poultry manures) are used as input (i.e. fish feed) into other enterprises, which can reduce the cost of production. **2.3.1. Productivity**

Farming system provides an opportunity to increases economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises. Time concept by crop intensification, space contact by building of vertical dimension through crop and allied enterprises are the ways to increase the productivity indicated above.

2.3.2. Profitability

The system as a whole provides opportunity to make use of the produce /waste material of one component to another component at the minimal cost. Thus the cost of production is reduced in the components and the profitability per rupee invested is enhanced by eliminating the interference of middle man in most of the input use. While working out the net income for the farm as a whole, the benefit cost ratio increases.

2.3.3. Potentiality

Of late, within enthusiasm to produce more and more food from the land area available to meet the requirement of population increase of 2.2% per year (Srinivasulu Reddy and Nedunchezhiyan, 2008), huge quantity of inorganic fertilizers, pesticide and herbicide are applied. Thus soil and environment are becoming increasingly polluted. Once when we loose large land areas by such degradation the productivity of the soil gets drastically reduced in course of time. In farming system organic supplementation through effective utilization of byproducts of linked components is done thus providing an opportunity to sustain the potentiality of production base for much longer periods.

2.3.4. Balanced food

In the farming system, components of varied nature are linked to produce different sources of nutrition viz. protein, carbohydrates, fat, minerals, vitamins etc. from the same unit area. This will provide an opportunity to solve the malnutrition problem that exists in the diet of the average Indian.

2.3.5. Recycling

Farming system establishes its stability due to effective recycling of produces/waste materials of any one of the components as input to the other component linked in the programme. Thus by way of recycling his/her own material at the farm level, the farmers could reduce the cost of production and increase the net income of the farm as a whole.

2.3.6. Nutrient management

In farming system the nutrients requirement of the crop is met through the use of on-farm available resources. Further in farming system nutrients are applied considering whole cropping patterns and cropping sequences. Hence nutrient losses through various farms are minimized in farming systems.

2.3.7. Soil microbial productivity

Intercropping stimulates horizontal transfer of beneficial rhizospheric microorganisms such as non-symbiotic N_2 fixing bacteria (*Azospirillum* spp.), phosphorus solubilizing bacteria, sulphur oxidizing bacteria etc. among the component crops rhizosphere (Ghai and Thomas, 1989; Schnurer et al., 1986). It ensures enhancement in microbial numbers and biomass dynamics in the cropping system and is influenced by seasonal changes.

2.3.8. Employment generation

Combining crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problem of under employment to a great extent. Farming system provides enough scope to employ family labour round the year.

Various enterprises that could be included in the farming system are crops, dairy, poultry, goat rearing, fishing, sericulture, agro-forestry, horticulture, mushroom cultivation etc.; thus, it deals with whole farm approach to minimize risk and increase the production and profit with better utilization of wastes and residues. It may be possible to reach the same level of yield with proportionately less input in the farming system and the yield would be more sustainable because the waste of one enterprise becomes the input for another, leaving almost

no waste to pollute the environment or to degrade the resource base (soil and water). To put this concept into practice efficiently it is necessary to study the linkage and complementarities of different enterprises in various farming systems.

2.3.9. Climate changes

Over 80% of our farms are less than 1 ha in size and mostly mono cropped. It will be extremely difficult for small and marginal farmers to face individually the adverse impact of climate change leading to higher frequency of drought and flood. Under such situations the immediate need is introduction of multitier cropping system which can confer on farmers with small holding the power and economy.

3. Farming system classification

Predominant farming systems classified based on the net returns which are more than 50% derived from single enterprise. Horticultural farming was identified as the pre-dominant farming system in the western zone of Tamil Nadu and it was practiced by 46.2% of total farmers followed by agriculture farming (17.2%) and livestock farming system (9.0%) (Saravanakumar et al., 2012). Diversified farming was the major farming system being practiced by all categories of farmers where the income derived from cereals, vegetables and livestock sources (Saravanakumar et al., 2012).

Labour scarcity, high input cost, non-availability of time sensitive critical inputs and low price of outputs were the major constrains faced by the farmers under various farming systems which was also reported by Saravanakumar and Jain (2008).

4. Tropical tuber crops

Tropical tuber crops are the most important food crop after cereals and grain legumes. They are known as energy banks of nature serving either as primary or secondary staple to one fifth of world's population. Tuber crops have myriad and complex roles to play in the food and nutritional security as well as hunger reduction. They are used for food, medicine, animal feed and raw material for starch based industries. International Food Policy Research Institute (IFPRI), Washington has predicted that there is likelihood of shortfall of 41% in food production in India by 2020 and need to produce 300 m t of food by 2010. To meet out food requirement, Indian agriculture has to go for horizontal as well as vertical increase in crop production. As the cultivable area is decreasing year after year, increasing cropping intensity by multiple cropping has little scope; however, the vertical increase in production has tremendous potential. Further, most of the crops have reached its genetic potential and achieved yield maxima. Tuber crops are however yet to exploit its genetic potential with sustainable production technologies. The commonly cultivated tropical tuber crops are: Cassava (*Manihot esculenta*), Sweet potato (*Ipomoea batatas*), Elephant foot yam (*Amorphophallus paeoniifolius*), Taro (*Colocasia esculenta* var. *anticorum*), Bunda (*Colocasia esculenta* var. *esculenta*), Swamp taro (*Colocasia esculenta* var. *stoloniferum*), Tannia (*Xanthosoma sagittifolium*), Lesser yam (*Dioscorea esculenta*), Greater yam (*Dioscorea alata*), White yam (*Dioscorea rotundata*), Aerial yam (*Dioscorea bulbifera*), Yam bean (*Pachyrhizus erosus*), Chinese potato (*Solenostemon rotundifolius*), Arrowroot (*Maranta arundinacea*) etc.

Tuber crops are capable to utilize available resources more efficiently especially in partial sunlight and residual moisture (Nedunchezhiyan and Laxminarayana, 2006). Great

flexibility in planting and harvesting are additional characters of these crops which are optly suitable to include in any farming systems.

Tuber crops based farming system includes growing tuber crops with other seasonal, horticultural and silvi-cultural crops either mixed/intercropping or sequential cropping; utilization of tubers and leaves in animal production either in fresh or processed form. Further byproducts of tuber crops such as cassava bagasse are utilizing in allied activities.

5. Cassava

Cassava is a popular crop among all the tropical tuber crops. It is grown in Asia, Africa, South America and Latin America. In India, cassava is being cultivated on an area of 0.24 m ha with a production of 6.7 m t (FAOSTAT, 2005). Cassava is an important crop in South India (Kerala, Tamil Nadu and Andhra Pradesh) and is slowly spreading to Western (Maharastra) as well as Eastern (Orissa) and Northeastern (Assam, Meghalaya and Tripura) India.

Cassava tubers are utilized primarily as human food after boiling, frying, baking or steaming. They are used in a variety of food products like sago, noodles, wafers, rava, jam, chips, flakes, puddings and other confectionary items. Leaves and tubers also form an important component of animal feed and are extensively used in feed for cattle, poultry and swine. The other uses of cassava are in industry where it is used for production of starch, liquid glucose, dextrin, high fructose syrup, alcohol and preparation of biodegradable plastics.

The biochemical constituents in cassava tuber on fresh weight basis are as follows: dry matter 40%; starch 32.5%; total sugars 0.5%; protein 0.8%; fibre 0.5%; fat 0.2%; ash 1%; calcium 0.05%; phosphorus 0.04%; vitamin C 0.025%; cyanoglucoside 25-400 µg cyanide/g of tuber. The biochemical constituents in cassava leaf on fresh weight basis are as follows: dry mater 22%; starch 8%; protein 8%; fibre 2%; fat 1.7%; ash 1.5%; calcium 0.125%; phosphorus 0.08%; vitamin C 0.25% and cyanoglucoside 350-600 µg cyanide/g (Kay, 1987; Bradbury and Holloway, 1988). Some cassava genotypes are rich in β-carotene. The rind of the tubers and seed extract are found to have biopesticidal properties especially for nematodes and insect pests.

5.1. Cassava and livestock production

Farmers' part of their cassava produce can be fed to livestock by properly storing and processing. This will reduce the purchase of feed from out side sources. Cassava dried chips are fed to livestock and poultry in India, China, USA and South East Asian countries. Cassava foliage made into silage is fed to livestock in Brazil. In animal feed, both fresh and dried cassava tubers in different forms such as sliced, chopped, grounded and pelleted are used. In the European countries large quantities of cassava chips, pellets and meals are being imported for animal feeding. Inclusion of cassava up to 65% in pellet form had not affected health, carcass quality or overall performance of pigs. Feed formulae for cattle wherein cassava chips form ingredients from 24 to 43% has been recommended in Kerala, India (KAU, 2001). As cassava tubers contain low amount of protein (1-2%), its use as animal feed for monogastric animals is limited. However, it is found that cassava meal could be included in poultry rations up to 40% without any detrimental nutritional effect, provided nutrient content of ration meet the poultry requirements (Kompiang *et al*., 1994). Raw chopped cassava tubers supply major source of energy for growing finishing pigs if properly supplemented with protein, minerals and vitamins. Pigs given chopped raw tubers with a protein supplement gained less weight but feed conversion ratio (FCR) was similar when

compared to maize-soybean (*Glysine max*) meal ration (Ly *et al*., 2008). Under humid conditions, it is difficult to dry cassava tubers and hence, root silage can be processed. The silage feeding had similar performance for growing and finishing pigs as those were given with fresh cassava tubers (Buitrago *et al*., 1978). One of the major factors for restricted use of cassava tuber in swine diets is the presence of cyanogenic glucosides and linamarin. Various processing methods like boiling, chopping, crushing followed by sun drying remove cyanogenic glucosides (Maner, 1973; Tewe, 1992). The low cyanogenic glucosides varieties can be used in feed preparations.

In Central Vietnam, cassava roots are preserved by making silage under village conditions for feeding pigs. After harvesting, the roots are cleaned, grated and mixed with 0.5% salt. The mixture is put into large plastic bags of 20-30 kg, the wet mass is compacted to expel inside air and the bags are tied. The roots are left to ferment naturally. The mixture can be ready in 2-3 weeks after ensiling and is stored for 6-8 months (Ly *et al*., 2008).

Cassava meal is prepared by chopping whole tuber followed by drying. Cassava meal can substitute maize about 16% crude protein (CP) diets (Sankaran *et al*., 2008). A slight decrease in ADF was noticed as the level of cassava meal is increased. But intake was similar indicating that palatability is not a problem in cassava meal based diets. A level of 680-770 g ADF could be reduced using cassava meal based ration. Piglets from weaning to 20-25 kg body weight (BW), given diets containing 20-25% cassava meal showed similar performance as those given with maize-soybean meal ration (Sankaran *et al*., 2008). Cassava bagasse, a byproduct of starch extraction from cassava tubers can be successfully used as feed for growing and lactating cows which possesses 2.0% digestible crude protein (DCP) and 64% total digestible nutrients (TDN) (Ranjan, 1980).

The crude protein content (dry basis) of cassava tubers can be increased by solid state fermentation with *Aspergillus niger* from 3 to 18-42%. The product is named as protein enriched cassava or 'Cassapro", brand name which is quite popular in Indonesia (Kompiang *et al*., 1994). The dried fermented cassava tubers may be fed directly to ruminants or may be grounded to a 1.0 mm mesh before feeding to monogastrics.

Cassava leaf yield is ranged from 2-8 t of dry matter /ha/year depending up on variety and soil fertility. The leaves are high in crude fibre (CF) and crude protein as compared to tubers. Cassava leaf meal is deficient in methionine but rich in lysine. Ensiling of cassava leaves is an appropriate way to conserve them. Nutritional value of cassava leaves may be increased by fermentation with *A. niger* using a similar process as for cassava tubers. Other advantages obtained through this process are that the toxic content of cyanogenic glucosides in leaves may be significantly reduced and fermented product may be stored for an extended period as they are in the form of powder and easily transported to other places if required. The bioprocess technology using *A. niger* to cassava leaf meals increased protein content and digestibility of dry matter and protein (Darma, 1994, 1995). As cassava leaf meal is an important source of β-carotene, it has great potential as feed for poultry and fish. Ensiling cassava leaves with either rice bran or cassava root meal at 5 or 10% or with fresh grated cassava roots at levels of 20-50% (on fresh weight basis) produced good quality

silage that could be stored for up to five months (Ly *et al*., 2008). Under village conditions using 20-60% ensiled cassava roots in the diets (as DM) of growing pigs increased the live weight gain, decreased the feed conversion ratio and reduced feed cost by 7.3-18.3% (Ly *et al*., 2008). Using a 13-15% of DM inclusion of ensiled cassava leaves in the pig ration containing 30% ensiled cassava roots (as DM) as replacement for sweet potato vines and partial replacement of fish meal in diets of growing pigs did not significantly affect the growth rate but reduced feed cost/kg gain by 12-26% (Ly *et al*., 2008). Supplementation with 0.1% methionine in diets containing 30% ensiled cassava roots and 15% ensiled cassava leaves of growing pigs improved the performance of these pigs (Ly *et al*., 2008). Ensiled cassava leaves can also be used as a supplemental source for feeding pigs (Ly et al., 2008). In Hue province of Vietnam, ensiled cassava roots and leaves were used for pig feeding. In 2003, there were 1172 households used this technology for feeding 2910 pigs and obtained gross income of 185.060 million VND over three years (Ngoan, 2008).
During harvesting season cassava stems are available in plenty which have many uses in rural areas. Dried stems after removal of bark are used as fuel and the stem scrapping are fed to cattle. Tender stems are used for feeding livestock after crushing into pieces.

5.2. Cassava and fish production

Starch is one of the important ingredients in fish feeds. It is the source of energy as well as excellent binder. Cassava is being utilized as fish feed ingredient in several parts of the world. In fact all parts of cassava are useful in fish culture. Cassava leaf is an excellent fodder rich in protein and can be utilized for feeding fishes like grass carp and *Barbus gonionotus* (Sankaran *et al*., 2008). Cassava stem is an excellent material for periphyton development and fishes like tilapia, rohu, and mrigal browse the partially decomposed skin with periphyton (Sankaran *et al*., 2008). Dried and powdered tubers are utilized as a starch source as well as a binder to have good quality pelleted feed.

Falayi *et al*. (2001) evaluated the economic losses due to leaching of feed nutrients in fish farming at Nigeria and reported that cassava tuber was the most efficient ingredient tested in terms of nutrient retention, higher growth, feed utilization and economic evaluation indices as compared to all other binders tested. Adebayo *et al*. (2003) reported that cassava meal can be used at 2% level to reduce nutritional loss in fish feed. Boscolo *et al*. (2002) reported that cassava meal can be incorporated up to 24% in the feed of Nile Tilapia for reducing feed cost without any adverse effect on its growth and performance. El-Baki *et al*. (1999) reported that the cassava root meal can be incorporated upto 50% replacement of corn meal without affecting performance of Nile tilapia in Egypt.

Oresegun and Alegbeley (2002) reported that 30% of the starch ingredient can be replaced by cassava peel with an addition of 0.4% methionine in pelleted feeds to maintain the serum and tissue thiocyanate concentration for tilapia. Akegbejo-Samsons (1999) reported that cassava flour can replace the yellow maize totally in the fish feed for African catfish. Cassava flour can be used for replacement of starch source without any noticeable change in fish production in common pond fish culture in Tripura, India (Santhosh *et al*., 2006). Cassava is the second most commonly used fodder for integrated fish culture in Malaysia (Ahmad, 2003). The palatability tests conducted using grass carp in Tripura, India also showed that

cassava leaves are preferred by grass carps than other plant materials tested. Better growth rate of grass carp fingerlings were observed when green cassava leaves were fed compared to five commonly used grasses in laboratory level experiments (Santhosh, 2006).

Cassava stem with its soft coating easily disintegrates in pond water and forms a thick mass of periphyton that fishes prefer to browse upon. It is popularly advised to small farmers to go for cassava cultivation around the ponds and feed the fishes with the green fodder produced out of it. Even in lean season, cassava produces good vegetation and can be used for feeding fishes. The varieties which are having luxuriant foliage are ideal for this purpose. Cassava bagasse can be utilized for phytase production after addition of a nitrogen source and mineral salts (Hong *et al*., 2001). Rajeshwarisivaraj *et al*. (2001) found that activated carbons prepared from waste cassava peel are efficient as adsorbents for dyes and metal ions.

6. Sweet potato

Sweet potato is ranked seventh in food crops and next to cassava among the root and tuber crops grown in the world. It is cultivated through out the tropics, subtropics and warmer temperate regions. In India, sweet potato is cultivated in 0.112 million ha with the production of 1.09 million tonnes (NHB, 2013). Odisha ranks first in area (43,460 ha) and production (4,10,100 tonnes) (NHB, 2013). Sweet potato roots and tops are highly nutritious, which can be used to combate nutritional deficiencies in many parts of the developing world. The roots are primarily used as human food after boiling, frying, steaming and baking. Apart from source of energy, roots also contain significant quantities of water soluble vitamins *i.e.,* ascorbic acid, thiamin, riboflavin and niacin. The contents of pyridoxine, folic acid and pantothenic acid may be relatively high. Raw leaves and tender tips are also excellent sources of ascorbic acid and some of the B-vitamins especially riboflavin which is deficient in many Asian diets. However, high percentages of water soluble vitamins are lost on cooking (Woolfe, 1992).

The biochemical constituent of sweet potato tubers are energy 490 kJ/ 100 g; water 65-81%, protein 0.95-2.4%; fat 0.4-6.4%; carbohydrate 25-32%; fibre 0.9%; ash 0.9-1.4%; calcium 30-34 mg/ 100 g; iron 0.8-1.0 mg/ 100 g; magnesium 24 mg/ 100 g; phosphorus 49 mg/ 100 g; potassium 373 mg/ 100 g; sodium 13 mg/ 100 g; carotene trace to 12 mg/ 100 g; thiamine 0.1 mg/ 100 g; riboflavin 0.05-0.06 mg/ 100 g; niacin 0.6-0.9 mg/ 100 g; ascorbic acid 23-25 mg/ 100 g (Kay, 1987; Bradbury and Holloway, 1988; Wheatley *et al*., 1995).

6.1. Sweet potato and livestock production

Culled and damaged tubers as well as green tops are used for feeding livestock (Nedunchezhiyan and Ray, 2010). Sweet potato is the common feed crop for livestock in many countries including China, India, Philippines, Vietnam, Taiwan, Uganda, Papua New Guinea and Indonesia (Naskar *et al*., 2008). In India unmarketable roots and vines after harvest are fed to pig and other livestock. Both root and foliage provides energy and protein respectively which can be used fresh, boiled, dried or fermented into silage (Woolfe, 1992; Ray and Tomlins, 2010). The chemical composition of the tuber shows 17-23% dry matter contents and DM digestibility above 70% (Nedunzhiyan, 2001).

In China which is the leading sweet potato producing country in the world, half of the produce goes to feed pigs (Scott, 1991). It is hoped that higher global prices for corn and strong demand for animal meat will further escalate sweet potato demand as animal feed. Massey *et al*. (1976) reported that increased vitamin A content in milk and increased milk production up to 0.75 kg/cow/day were observed when sweet potato roots were fed. In a pig ration feeding substitution trial, Naskar *et al*. (2008) reported that boiled sweet potato tubers could be fed to the level of 40% of total dry matter intake to the weaned piglet for higher growth rate and nutrient utilization whereas up to 60% of total dry matter intake to grower pig along with good quality protein supplement for better growth performance.

Sweet potato vines can be fed to pigs either in fresh form or after drying. Nedunzhiyan *et al*. (2000) reported supplementary application of sweet potato fresh vines improved the digestibility of the pigs. Vines can be dried and grounded into a meal. Sweet potato vine meal can be used in compounded pig rations, but only at low levels. It should not be used more than 5% level in pig rations.

Sweet potato meal can also be included in poultry ration. In rations of young birds that are less than eight weeks old, sweet potato can be used up to 20%. As the birds grow bigger, it can be increased gradually and in rations of laying chickens it can be used up to 30%. Fresh green leaves of sweet potato can be chopped and given to birds in addition to mash to the tune of 3%.

Dried and powdered sweet potato can be utilized for fish feed along with other ingredients. Sweet potato leaves can be used as a fish feed for grass carp. Mokolensang (2003) reported that sweet potato distillery byproduct increased growth of common carp more than conventional feed in experimental conditions.

Pig manure produced in the farm is decomposed and applied to sweet potato field in China and Northeastern states of India. Pig manure application reduces cost of cultivation of sweet potato (Nedunchezhiyan and Srinivasulu Reddy, 2002). Application of pig manures in sweet field helps to rebuild the fertility status of the soil (Nedunchezhiyan and Srinivasulu Reddy, 2004). The pig-sweet potato system generates additional employment and improves the living standards' of the farmers (Srinivasulu Reddy and Nedunchezhiyan, 2008).

A fast growing sweet potato variety can be used as cover crop in pond slopes. The foliage can check siltation of the pond sand prevent shallowing the fish culture ponds. Thus it serves dual purpose, providing fodder to fish and strengthen the slopes/bunds of the ponds (Palaniswami and Peter, 2008). Harvesting of these cover crops should be restricted because it may loosen the soil.

7. Yam

Yam is grown throughout the tropics and sub-tropics, where rainfall is sufficient for their growth. In India, though yam is cultivated in all most all the state in homestead gardens. Yam is commercially cultivated in certain specific locations in Andhra Pradesh, Bihar,

Gujarat, Kerala, Orissa, Madhya Pradesh, Tamil Nadu and Rajasthan. However no statistical data is available.

Yams are basically carbohydrate foods with relatively high protein and ascorbic acid contents. The edible portion of fresh tuber contains energy 439 kJ/ 100 g; water 72.4%; protein 2.4%; fat 0.2%; carbohydrate 42.1%; fibre 0.6%; calcium 22 mg/100 g; iron 0.8 mg/100 g; thiamine 0.09 mg/100 g; riboflavin 0.03 mg/100 g; niacin 0.5 mg/100 g; ascorbic acid 10 mg/100 g (Kay, 1987). In general avitominosis C (scurvy) is rare in yam growing countries.

8. Elephant foot yam

Elephant foot yam (*Amorphophallus paeoniifoilus*) is cultivated for its edible corms in India, phillipines and Malaysia. In India, it is grown in Andhra Pradesh, Tamil Nadu, Kerala, Orissa, Bihar, West Bengal, Uttar Pradesh, Maharastra and Gujarat.

The biochemical composition of elephant foot yam corms on fresh weight basis are energy 330 kJ/100 g; water 72-79%; protein 1.7-5.1%; fat 0.2-0.4%; carbohydrate 18-24%; fibre 0.6-0.8%; ash 0.7-1.3%; calcium 50-56 mg/100 g; iron 0.6-1.4 mg/100 g; phosphorus 20-53 mg/100 g; vitamin A 434 IU/100 g; thiamine 0.04-0.06 mg/100 g; riboflavin 0.05-0.08 mg/100 g; niacin 0.7-0.75 mg/100 g; ascorbic acid trace-3 mg/100 g. The most of the carbohydrate is starch (75-80%); the starch granules vary in shape and size (5.5-19 microns) (Kay, 1987).

9. Taro

Taro otherwise known as cocoyam is grown throughout the tropical and sub-tropical countries. Nigeria leads in area (0.735 m ha) and production (4.027 m t) in the world and it is followed by Ghana (0.270 m ha; 1.8 m t) (FAOSTAT, 2005). The highest productivity is reported from Egypt (FAOSTAT, 2005). In India, it is grown in all most all the states, but commercially cultivated in Andhra Pradesh, Tamil Nadu, Kerala, Orissa, Uttar Pradesh, Maharastra and Gujarat. However the area and production statistical data is not available.

Corms and cormels are rich in starch; the flesh is mealy to smooth and usually has a somewhat nutty flavor. The composition of the edible portion of the fresh corms has the following: energy 373-406 kJ/100 g; water 73-78%; dry matter 24-26%; carbohydrate 19-21%; starch 15.5-18.0%; total sugars 1.75-1.90%; protein 1.4-3.2%; fat 0.1-1.5%; fibre 0.4-2.9%; ash 0.6-1.3%; calcium 32-44 mg/100 g; iron 0.8-5.27 mg/100 g; phosphorus 64-135 mg/100 g; manganese 0.19-0.26 mg/100 g; potassium 514-575 mg/100 g; sodium 7-9 mg/100 g; carotene trace-67 IU/100 g; thiamine 0.09-0.18 mg/100 g; riboflavin 0.03-0.04 mg/100 g; niacin 0.4-0.9 mg/100 g; ascorbic acid 0.10 mg/100 g (Kay, 1987).

10. Farming system involving tuber crops

10.1. Pond based farming system involving tuber crops

Kandhamal district in Odisha state is a hilly terrain dominated by Kandha tribes. They are resource poor small and marginal farmers. Tribal farmers cultivate extensively but harvest minimum because of their low resource use capabilities. They grow rice and ragi in uplands by direct seeding and low lands by transplanting. Being rainfed ecosystem, they cultivate during rainy season and land remains fallow during post rainy season. Food insecurity is regular feature in their life. Diversification into farming system mode in small holder farming appears

promising to secure future and nutritional security at the grass root level (Singh, 2012). Farming system is integrating existing sub systems on a farm to harness maximum efficiencies and develop sustainable resource use systems which will optimize their use, minimize degradation with consideration to regenerative capacity and increase income and employment for farm families and promote quality of life and environment.

During the year 2013-14, four community pond based farming system involving tuber crops study was conducted at Gadragoan village according to the farmers conditions, resources and needs. The major objective was to develop an appropriate integration of crops, livestock and fish for round the year employment, income and sufficient food to farm family on the farm. Gadragoan was a typical tribal village in Chahali GP, Chakapad Block, Kandhamal District, Odisha state under Tribal Sub Plan programme by the ICAR-Central Tuber Crops Research Institute, Regional Centre, Bhubaneswar. The village was having uplands, medium lands and lowlands. The village was also having four farm ponds and 31 farm families. All the four farm ponds were renovated and able to collect run off water during rainy season. Each farm pond size was approximately 400 m^2. Four community pond based tuber crops involving farming system research was conducted with the components of rice, tuber crops, fish, vegetables, poultry and goat (Table 1). The area and components of all the four community pond based farming system involving tuber crops was same. Each farming system study was 2.5 ha with the total area of 10 ha. Seven to eight tribal families involved in each community pond based tuber crops involving farming system covering 31 farm families. The Goat and poultry manures collected from the sheds were composted and then applied to crops and fish ponds. Sweet potato vines after harvest, and culled and damaged tubers were fed to goats. Broken rice and maize kernels and surplus grains were fed to poultry birds. However, during day time goats were taken for grazing in near by forest and poultry were scavenging in backyards.

Shortage of water was observed for drinking and cleaning of livestock and shed, domestic use of farm family, irrigation to plantation crop during dry months in rainfed farming areas. Therefore for sustaining water availability in the farm, a farm pond and shallow dug well are the essential components of rainfed farming system that helps for life saving irrigation, rabi vegetable production and household domestic needs. A diversified farming with a farm pond received sufficient water to fulfill the water requirement for optimal productivity under limited water supply.

Yields of crops, goat, fish and poultry for the four community pond based farming system involving tuber crops were collected; averaged it and presented in the Table 1. In community pond based tuber crops involving farming system, apart from rice, tuber crops, vegetables etc. were produced along with goat, fish and poultry. The community pond based tuber crops involving farming system produced 19,479 kg of rice equivalent yield and net return of Rs 2,27,980/2.5 ha. Whereas cultivation of rice alone produced 8,960 kg of rice and net return of Rs 91,700/2.5 ha. Part of the yields of grains, pulses, tuber crops, vegetables, egg, meat and fish were sold for cash income. By marketing of vegetable, fruit, flower, and livestock product (milk and meat) a farmer is able to earn sufficient money to meet out daily needs. The cash income from each community pond based farming system involving tuber crops was distributed to the respective numbers of farm families which would be helpful in covering up major

expenditures like festivals, ceremonies etc. Further availability of tubers for household consumption for long period due to high storability along with other vegetables, rice, fish, egg and meat enhanced food and nutritional security of the household. The cash income improved the livelihoods of the farm families.

Table 1. Community pond based tuber crops involving farming system components, yield and economics (Mean of four)

Sl. No.	Crop/animal	Area (ha)	Yield (kg)	Rice equivalent yield (kg)	Gross Income (Rs)	Expenditure (Rs)	Net income (Rs)	Employment generation (man-days)
1	Rice (Gangabali)	1.2	4300	4300	86000	42000	44000	264
2	Sweet potato (Kishan & ST 14)	0.4	4225	1690	33800	16000	17800	60
3	Yam bean (RM-1)	0.4	7540	3770	75400	22000	53400	56
4	Greater yam (Orissa Elite)	0.1	2400	2400	48000	18000	30000	26
5	Elephant foot yam (Gajendra)	0.1	2225	2225	44500	20000	24500	25
6	Taro (Muktakeshi)	0.1	1850	1850	37000	18000	19000	22
7	Cassava (Vellayani Hraswa)	0.1	1895	474	9480	4200	5280	22
8	Fish (pond) (Rogu, Catla, Mrigal)	0.04	150	600	12000	5000	7000	20
9	Vegetables (*Amaranthus*, bhendi, brinjal, beans, potato etc.)	0.02	1800	900	18000	5000	13000	30
10	Poultry (Vanaraja): 20 Nos.	0.02	70	420	8400	1400	7000	10
11	Goat (Ganjam local): 5 Nos.		42.5	850	17000	10000	7000	25
Total		2.5	-	19479	389580	161600	227980	560

Check/Control

Sl. No.	Crop	Area (ha)	Yield (kg)	Gross Income (Rs)	Expenditure (Rs)	Net income (Rs)	Employment generation (man-days)
1	Rice (Gangabali)	2.5	8960	179200	87500	91700	550

Rice: Rs 20/kg; Sweet potato Rs 8/kg; Yam bean Rs 10/kg; greater yam Rs 20/kg; elephant foot yam Rs 20/kg; Taro Rs 20/kg; cassava Rs 5/kg; Fish Rs 80/kg; vegetables Rs 10/kg; poultry Rs 120/kg; goat meat Rs 400/kg

There is no additional employment generated in community pond based tuber crops involving farming system compared to monoculture of rice. This was due to inclusion of tuber crops cultivation. Tuber crops though long duration, cultivation was less labour intensive. But employment was distributed through out the year in community pond based tuber crops involving farming system. Whereas in monoculture rice, the total employment generated was spread within seven months (June-December) only. Thus dependency on out side family labours was much less in community pond based tuber crops involving farming system. Pali et al. (2012) also reported generation of additional 12 days employment in 0.4 ha pond based integrated farming system.

10.2. Farming system involving tuber crops (0.4 ha)

During the year 2014-15, participatory research on farming system involving tuber crops (0.4 ha model) under rainfed ecology was conducted in Khanjuguda (village), Chakapada (Block), Kandhamal (District), Odisha state. Farming system involving tuber crops (0.4 ha) was laid out in 52 tribal researcher fields. Sole rice cultivation 0.4 ha was laid out in four tribal researcher fields as a check. The components of farming system and their area of cultivation were given in the Table 2. The results revealed that farming system involving tuber crops produced 1739.1 kg of rice equivalent yield and net return of Rs 34770/0.4 ha. Whereas rice alone produced 800 kg of rice and net return of Rs 13000/0.4 ha. Farming system involving tuber crops generated 18 man days additional employment. Further the employment was spread throughout the year. Pali et al. (2012) also reported generation of additional 12 days employment in 0.4 ha pond based integrated farming system.

Table 2. Integrated farming system components yield and economics (0.4 ha)

Sl. No	Crop/animal	Area (ha)	Yield (kg)	Rice equivalent yield (kg)	Gross Income (Rs)	Expenditure (Rs)	Net income (Rs)	Employment generation (man-days)
1	Rice	0.20	381	381.0	11430	5500	5930	44
2	Maize	0.03	62	31.0	930	350	580	3
3	Ragi	0.02	25	16.7	500	250	250	2
4	Redgram	0.02	14	23.3	700	250	450	2
5	Sweet potato	0.04	516	172.0	5160	1400	3760	6
6	Yam bean	0.03	514	257.0	7710	1200	6510	6

7	Greater yam	0.02	376	250.7	7520	2000	5520	10
8	Colocasia	0.02	305	203.3	6100	1400	4700	6
9	Elephant foot yam	0.008	115	76.7	2300	700	1600	3
10	Cassava	0.002	38	12.7	380	250	130	2
11	Vegetable (*Amaranthus*, Bhendi, bitter gourd, ridge gourd etc.)	0.01	237	158.0	4740	1500	3240	12
12	Backyard poultry	20 (nos.)	47	156.7	4700	2000	2700	10
Total		0.4	2630	1739.1	52170	17400	34770	106

Check/Control

Sl. No.	Crop/animal	Area (ha)	Yield (kg)	Gross Income (Rs)	Expenditure (Rs)	Net income (Rs)	Employment generation (man-days)
1	Rice	0.4	800	24000	11000	13000	88

Rice Rs 30/kg; Maize Rs 15/kg; Ragi Rs 20/kg; Redgram Rs 50/kg; Sweet potato Rs 10/kg; Yam bean Rs 15/kg; Greater yam Rs 20/kg; Colocasia Rs 20/kg; Elephant foot yam Rs 20/kg; Cassava Rs 10/kg, Vegetables Rs 20/kg; Poultry live bird Rs 100/kg

11. Conclusion

Wider adoptability and greater flexibility in planting and harvesting of tuber crops makes them fit into any cropping/farming systems. Partial shade tolerance of yams and aroids was found highly suitable to intercrop in grown up orchards and plantation crops. High dry matter production potential/ unit area/ unit time coupled with cheap source of energy encourages farmers to use tuber crops in livestock feeding. Tuber crops products can be used in fresh form or dried form or ensiled form in animal feeding, which is the uniqueness of tuber crops. In small holder farming systems growing tuber crops along with seasonal, horticultural and silvicultural crops, feeding green tops and excess/culled tubers either fresh or processed form to animals decreases the purchased inputs and increase the farm net income. In the changing climate, tuber crops are indispensable in small holder farming systems along with cereals, livestock and fisheries. Thus, food and nutritional security can be achieved through tuber crops based sustainable farming systems.

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ENHANCING FARM INCOME THROUGH VEGETABLE CULTIVATION

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Vegetable cultivation as an enterprise is very old, dating from the time of the beginning of civilization. The cultivation trends have undergone drastic changes from shifting cultivation to today's hi-tech cultivation including the protected cultivation under different types of structures to cater to the needs of the increasing population. Vegetable cultivation has recorded landmark improvement owing to the efforts of innumerable workers all over the world whose drops of contributions have resulted in a vast ocean of technologies for the today's farming community. The noteworthy contributions being the development of varieties (improved varieties, varieties with disease / pest / stress resistance, hybrid varieties, varieties developed through mutation breeding etc.), suitable propagation techniques including bio-technology approach, package of practices for different vegetable crops suiting to varied environmental situations, soil amendment practices, growing of off season vegetables in open / controlled atmospheric conditions, improved post harvest management practices including packaging, storage, processing & value addition. Further the Globalization has opened the venue of free agriculture trade that has encouraged quality planting material availability through import and export of vegetables to foreign countries. Thus, selection of appropriate technologies for a particular situation from among the vast basket of technologies, can ascertain maximum profit in vegetable cultivation.

Certain points to be considered for enhancing farm income :

1. **Growing of vegetables suiting to the location that can generate maximum profit for the grower** : for this a home work has to be carried out by the vegetable grower. An annual crop calendar is to be developed through market survey over a few years . That means the rates prevailing in the market for different vegetables in different months are to be documented besides the past data available over years may also be collected. From this the vegetable which fetches maximum prices in different months will be recorded. Say, the brinjal price has been found to be the highest in the month of June. So, it can be planned to sow brinjal in the month of March, so that the brinjal can be harvested in the month of June and maximum return can be achieved . Similar thoughts may be given for other months. However, the most important consideration to be made here is that the appropriate varieties are to be selected taking into the existing environmental conditions. For example all the brinjal varieties sown in the month of March may not produce fruits in June as a result of which the farmer may suffer an entire loss instead of getting maximum profit.
   Another example may also be taken with respect to cauliflower which is a much preferred vegetable crop. Here also in coastal areas after the normal cool season crop is over from second week of April onwards till November the price remains high. The

hot-set varieties are now available for raising crop in summer. If a farmer grows a particular suitable variety without much awareness about the pest incidence also may fail to get maximum returns and might also face loss. In this case also it is to be remembered that the pest incidence drastically increases in cole crops as the temperature rises in the coastal areas. Hence, the grower has to be equipped with sufficient plant protection measures, that too taken up timely, to provide him maximum profit.

2. **Intensive utilization of land** : Here the considerations are to be made to place multiple crops with different periods of harvest in the field so that the total return from the plot is maximized. Planning for different months are to be made well in advance and accordingly the seeds of the required crops must be procured much in advance.
   For example during late September when tomato seedlings are transplanted greens (amaranthus i.e. Chhoti choulai / coriander / fenugreek / mustard / spinach seeds may be broadcasted in the inter-space area in the rows between plants. Care has to be taken to ensure proper weeding before transplanting and seeding of greens and application of sufficient manures and fertilizers. By the end of 25^{th} -30^{th} day these greens will be ready for harvest which can be uprooted and marketed. During this period i.e. Late October the price of greens are very high and the farmer can get a substantial return. After removal of the greens it will correspond to the first top dressing. At this time after removal of the weeds nitrogen is to be applied and soil is to be placed at the base of the plants and staked. Here the width of the ridges will be around 30 cm. The previously raised onion seedlings or garlic cloves or radish seeds may be dibbled, which are shallow rooted crops and will not compete with the tomato crop. This again will give still more additional return besides from the main crop.
   After the tomato plants complete the production of the crop yield the plants may be pruned leaving 15 – 20 cm from the ground level and provided with another dose of nutrients and soil application to the base may be made. This will provide a ratoon crop with a substantial yield.

3. **Growing / popularization of Exotic / un- conventional crops**: It is one of the most important ways for maximizing profit. The crops which are new and un-conventional high demand may be taken up. Here, crops like capsicum, broccoli, parsley, celery may be considered which have high market value and equally important from the health point of view. Cultivation of these crops can provide maximum return to the farmers when grown in time with adoption of appropriate production technology.
   Capsicum : It is known as Shimla Mirch / Shimla lanka (odia) / bell pepper etc. Now, besides the conventional green colour, the coloured capsicum are also gaining importance. The coloured capsicum includes yellow, red and violet colours. These are rich in vitamins A & C and minerals. The use of these as salad provides maximum vitamins and minerals to the body. It improves the taste & flavour of dishes of fast food type.
   Broccoli : Broccoli is available in two colours commonly i.e. green and violet. These are reach in Vitamins A, B & C besides being rich in minerals and contain a fair amount of protein. It is very good for health particularly for heart functioning. The heart

diseases being on rise in the country this crop needs to be more popularized among the people. Its consumption in fresh as salad provides maximum nutrients than boiled and consumed.

Parsley & Celery (Student res. Work) : These are two temperate leafy vegetable crops having multiple marketing value. These are very rich in nutrients. Almost all vitamins and minerals are present in them. These are harvested and used for garnishing of food items esp. non- veg. items. These plants have very good market as dried produce. The plants after harvest are dried and made into small pieces and packed in bottles and marketed. They too have industrial value in enabling the extraction of vitamins from them. Hence these crops have a very good potential in the tropical areas as winter crop.

4. **Resorting to planting material production (own work)** : Certain crops like pointed gourd, spine gourd have heavy demand in the market. The planting material supply is very low. Hence, resorting to this trade can provide more return to the farmer than the main crop itself.
   - **i.** **By cuttings**- The cuttings can be taken from these plants after the plant has put up sufficient growth. It would be wiser if cuttings are taken after the plants have started flowering. Further, if the objective is only production of the planting material then before the death of plants or removal of the vines the male & female plants should be kept separately. Then planting of the tubers in separate blocks of male and female should be taken up at close spacing of 45 x 30 cm. As the vines start growing and reach a length of 15 cm. the cutting process should begin. The minimum length of 5-10cm. can be considered as ideal for terminal cuttings where the inter node length is less. When cuttings are taken from the rest of the vine the minimum length will depend on the inter node length and it should be ensured that at least two nodes are maintained. The cuttings so prepared may be placed in small poly-bags having a soil media (comprising of 8parts of soil + 4part farm yard manure + 4 part cocopit + 1 part vermicompost) @ 2 cuttings per bag after treating with 1000ppm IBA solution. This will produce rooting in 15 days and will be ready for planting in a month time. The establishment is early and growth is vigorous and time saving than the traditional method of rooting in sand placing in poly bag then establishing and planting / marketing. The cost involved per plant establishment is around Re.1.00 and can be sold at Rs. 2/- in wholesale manner. At least one lakh plants can be generated giving a profit of minimum one lakh in three months time. The profit margin may be many fold depending on the sale price normally prevailing at Rs.5/- for pointed gourd and Rs. 10/- for spine gourd. The advantage is that the male & female plants can be grown separately which is very much essential in case of maintenance of the sex ratio in the field.
   - **ii.** **By layering –** This isespecially very much successful in case of pointed gourd. In this case the vines are allowed to trail. The same way of preparing poly-bags with soil mixture are done. Serpentine layering is done placing a node in the

rooting media in each bag. Plant roots in 7 -10 days time and planting material is ready in 15-20 days.

5. **Special agro-techniques for producing early crop (own work) :** It can be practised in spine gourd to get early crop and earn heavy returns.
   Normally the spine gourd plants wither and go to dormancy at the onset of winter. Again after the rains come the plant sprouts and gives rise to the new shoots which bear fruits. To expedite the early sprouting irrigate the spine gourd plots at regular intervals from February. The tubers will sprout and give rise to plants that will bear fruits from April and fetch the highest price of around Rs. 150/- or above per Kg and will continue for a pretty long time.

6. **Perpetuation through cuttings (own work):**
   Some cucurbits like cucumber can be perpetuated through cuttings. As the seed cost of hybrid varieties are very high this method can be helpful in reducing the cost of seeds, crop duration and giving early yield.

7. **Vegetable grafting:**
   Vegetable grafting although was tested almost 40 – 50 years back in attempts of producing potato & tomato by grafting. But in present days grafting of vegetables (brinjal and cucumber) using wild resistant root stocks against wilt and other problems are being successfully carried in brinjal and cucumber. Both root stock and scion are raised from the seeds and when they attain 25- 30 days the scion seedling is grafted over the root stock..
8. **Protected cultivation:**
   During hot period by creating structures that will reduce the environmental temperature value fetching crops like coriander as greens may be grown. It fetches around Rs. 200/- per Kg. as against Rs. 50/- during the normal season.
   Further, if protected structures are available like net house / poly house the farmer can raise 4 crops in a year in his plot. In this case the seedlings will be grown in the sites away from the main field in pro-trays of different sizes depending on the stature of the plant for 30-45 days in the protected structures. By this time the plant will over come the initial juvenile phase in the pro-tray and a months period from the field stand will be reduced. A 120 days crop by this method will overcome .

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SEED MANAGEMENT IN HOME GARDEN FOR FAMILY NUTRITION

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Nutrition garden in homesteads

Malnutrition is a serious public health problem among women and children in developing countries, especially in middle and low income group. Micronutrient deficiency is more common than macro nutrients deficiency in rural area. Indian diets are mainly cereals based depending upon single food grain and very low intake of low cost protective foods such as fruits and vegetables. Low purchasing power, unavailability and ignorance are the major cause of malnutrition and under nutrition. Macro and micro malnutrition have lasting and devastating consequences for individual health and national development, as malnutrition early in life often leads to stunted growth, poor cognitive and physical development and is associated with increased episode of infection throughout an individual's lifetime. In addition, during pregnancy, reduction in micronutrient content can have a significant impact on foetal growth and development which will later affect the child's growth potential and adult height. Many reports indicate qualitative and quantitative gap in terms of foods for the individual and population. This gap is major in the case of pulses, oilseeds, vegetables, fruits and animal protein compared to common cereal food. This gap can be bridged in a phased manner through increased production, nutrition education and health sector.

Several extensive studies done by the ICMR and other agencies on the nutritional profile of our diet indicates that

- Calorie gap of our diet to the extent of 15-20 per cent in adults and children
- Consumption of protective foods like fruits and vegetable is very low
- Intake of vitamin A is very low
- Intakes of vitamin B-complex are marginal
- Intake of minerals such as calcium and iron are low

Recent developments have provided encouraging results in bridging the gap of major food crops, especially cereals which provide the major substance of our population. Efforts are already in progress to increase the production of pulses and oilseeds, milk and milk products, and poultry products. There is need to give similar approach in regard to the production of fruits and vegetables (horticultural crops) and nutrition garden is the best option at small scale. Horticultural crops provide important essential nutrients, such as calorie (tuber crops), protein (leguminous vegetables), minerals as calcium and iron (green leafy vegetables), precursor of vitamin A (green leafy vegetables, yellow and orange vegetable and fruits), vitamin B-complex (common vegetables), and vitamin C (citrus and other fruits). The intake of these categories of foods in our diet is far from satisfaction especially in the low income group. Perhaps the most important reason in regard to protective foods is the lack of nutritional awareness about the low-cost but nutritive value of fruits and vegetables. So nutrition education and establishing the nutrition gardens in the rural area are two important aspects for increasing the consumption of protective foods.

Fruits and vegetables play an important role in the balanced diet of human beings by providing not only the energy rich food but also promise vital protective nutrients. The daily requirements of some of the essential nutrients like proteins, minerals and vitamins can be very well met, if a man, woman or child consumes about 85g fruits, 75-125g green leafy vegetables, 85g other vegetables, 85g root and tubers everyday on a balanced diet pattern. Fruits and vegetables are good sources of carbohydrates (banana, jack fruit, beans and fenugreek), minerals like calcium and iron (dates, almond, green leafy vegetables), β carotene (mango, papaya, green leafy vegetables, sweet gourd), vitamin B complex (apple, apricot, grape fruit, bael, banana) and vitamin C (aonla, guava, citrus, bitter gourd).

Nutrition gardening is one of the world's most ancient food production practices and is commonly practiced throughout the world. Homesteads are the resources that provide major share of livelihood especially for poor farmers. Home gardens generally refer the garden which is located near the residence, contains a high diversity of plants; production is a supplement rather than a main source of family consumption or income. Nutrition garden should be a feature of every farm family whether one live in a village or town if there is some space. Every family, even landless labourers, can grow nutritious vegetables. It is easy and very rewarding: you will save money, improve your diet, and avoid eating pesticide-tainted vegetables often sold in the market.

Types of home gardens

Large gardens (at least 500 sq m)

Almost all types of vegetables can be grown in a large garden, including one or two large fruit plants, such as papaya, guava, lemon, grape, or dwarf mango.

Medium-size gardens (150 to 200 sq m)

Choose from tomato, eggplant, fenugreek, chilli, French bean, bitter gourd, cucumber, spinach, amaranth, radish, turnip, carrot, lettuce, cauliflower, cabbage, summer squash, okra, cowpea, or cluster bean.

Small gardens (less than 100 sq m)

Choose from amaranth, spinach, fenugreek, radish, turnip, tomato, eggplant, chilli, lettuce, mint, or coriander.

Container gardens

Some vegetables grow well in pots or containers placed on sunny terraces, window ledges, balconies, verandas, or on the roof. Fill containers with a mix of sand, soil, and manure. Choose from chilli, tomato, coriander, mint, amaranth, spinach, table radish, kulfa, lettuce, knol-khol, French bean, okra, fenugreek, cluster bean, green onion, garlic, leek, parsley, broccoli, and tomato.

The layout of the nutrition garden of a farm family in village differs from town and extensive method of cultivation is followed. The nutrition garden, if large enough, has the potential to supply most of the non-staple foods and some of the staple foods (e.g. roots and tubers and some pulses) that a family needs each day of the year. In every village there are examples of nutrition gardens which are managed well. These nutrition gardens produce a wide variety of food crops which supply the family throughout the year with fresh fruits and vegetables, roots and tubers, legumes, spices, medicines, etc. The link between nutrition garden and nutrition

seems obvious and the promotion of nutrition garden is often undertaken on nutritional ground. In fact most of the workers advocating nutrition gardens use the need for improved nutrition and income as a major part of their arguments. There should be proper layout of the garden in order to meet daily supply of fresh fruits and vegetables for the family.

Importance of homestead nutrition garden

1. Improves nutritional status as a whole
2. Additional source of household income
3. Improve the nutritional status of women as it is primarily a female activity
4. A way to conserve biodiversity
5. Improves the natural environmental status through recycling
6. Good platform to utilize family labour
7. Best way to utilize leisure time
8. Easy availability of fresh and nutritious fruits and vegetables

Important tips for better nutritional status through nutrition garden

- Establish a nutrition garden in your backyard.
- Grow creeper vegetables on your house roofs.
- Eat at least one green leafy vegetable daily.
- Consume seasonal low cost fruit daily.
- Consume raw vegetables (in the form of salad) daily.
- Prepare snacks with green leafy vegetables.
- Preserve seasonal vegetables by simple techniques such as drying, salting, pickling etc.
- Preserve fruits by preparing jam, jelly, squash etc.
- Feed infants (6 months to 18 months) with boiled and mashed potato, sweet potato, banana, papaya which are rich in micronutrients.
- Aonla is very rich in Vitamin C, during season consume one aonla daily. This will keep our gums healthy.
- Papaya, mango, carrot and spinach are rich in Vitamin A, so protect our eyes.
- Eat green leafy vegetables for iron and vitamin A for anaemia protection.

Table 1: Essential nutrients, deficiency diseases and their fruits and vegetables sources

Nutrient	Consequences of deficiency	Fruit and vegetable source
Calories and proteins	Retarded growth in children,, irritability, apathy and possibly retarded mental development, discoloration of skin and hair, swelling of the face and lower part of legs and feet, fatty liver and extreme emaciation	Calories: Tapioca, sweet potato, yams, colocasia, potato, banana, jack fruit Protein: Peas, winged bean, cow pea, amaranthus, drumstick leaves
Vitamin A	Night blindness, immune impairment	Carrot, spinach, palak, amaranth, sweet potato, sweet gourd, pumpkin, mango, papaya, tomato
Vitamin B	Beriberi, cracks at corners of the	Peas, broad bean, garlic, tomato, apple,

complex	mouth, raw red cracked lips, pellagra	banana, bael
Vitamin C	Bleeding gums, depression, impaired wound healing, loose teeth, tiredness	Green chilli, amaranth, coriander, drumstick leaves, bitter gourd, cauliflower, papaya, guava, lemon, orange, aonla
Calcium	Osteoporosis, tooth decay	Curry leaves, amaranth, drumstick leaves, coriander, palak, custard apple
Iron	Anemia, spoon shaped nails, pale lips	Drumstick leaves, amaranth, coriander, palak, raisins, guava, dates, pomegranate

Nutrition garden management

- Sow or transplant seedlings in rows or lines with proper spacing.
- Remove some seedlings if plants are crowded.
- If many seedlings die, plant more to take their place.
- Irrigate after transplanting.
- Remove weeds between the rows and between plants.
- Vegetables need regular watering for good growth and yield.
- On larger plots, irrigate lightly every third or fourth day during summer and once every one or two weeks in winter.
- Farm yard manure, vermi-compost and compost are great fertilizers for vegetable gardens. Mix them in the soil about a week before sowing or transplanting.
- Apply a nitrogenous fertilizer, such as urea, in small quantities in standing crops for higher plant growth and yield. Apply urea only when the soil is moist; otherwise, give a light irrigation after application.
- A few tools can be very useful: spade, hand hoe, watering can, sickle, knife, basket, small hand sprayer, twine, and bamboo stakes.

Planning of a homestead garden

Careful planning is important for a successful nutrition garden. There are a number of factors to be considered.

Location

It is usually located at the backyard of the house. It enables the members of the family to give constant care to the vegetables during leisure hours. The vegetable plots should be located away from trees so that they are not under shade and there is no competition from the wide-spreading roots of trees.

Size

The size of nutrition/kitchen garden depends on the availability of land, the number of persons for whom vegetables are to be provided and time available for its care. For an average family size of two adults and three children, 250 sqm of land is sufficient to supply adequate vegetables.

Space

The space available around the house will determine what techniques and how many vegetables can be produced. However, even houses having small space around can also build

homestead garden. With careful planning, a garden can maximize the efficient use of the space available.

Shade Vs full sun

All plants need sunlight to grow, but too much sun and heat can dry out the soil and burn plants. Trees are good for adding shade to a garden, cooling hot summer temperatures and helping to prevent moisture evaporating from the soil especially in dry areas. However, too much shade prevents sunlight from reaching the plants and obstructs their growth. Tree crops like mango, papaya, banana, drumstick, curry leaf, jack have to be planted in homesteads boundary in such a way that their shade does not affect the growth of annual vegetables. Some crops like partial shade and some crops like full sun. Most of the vegetables like radish, amaranth, cabbage, cauliflower, brinjal, tomato etc. require open sunny space especially morning sun for better growth and therefore the vegetable plots should be prepared in eastern side. The partially shady area or intercrops in between perennial fruit trees can be used to grow shade loving crops such as elephant foot yam, pineapple, ginger and turmeric.

Access to water

Plants need to be watered regularly, especially in dry areas. Therefore access to water must be considered when planning a homestead garden. The waste water from kitchen can also be routed through the perennial plot.

Household labour capacity

The area of nutrition garden may be decided on the basis of availability of household labour and their capacity to do the work.

Layout

The layout of nutrition garden is especially important. A sample layout for preparing a small homestead garden is given in the figure-1. Each plot in the garden should be numbered and should follow crop rotations. By planning ahead, farmers can better utilize the limited space around a house and maximize the production of vegetables and other food crops.

The perennial plants should be located on one side of the garden, so that they may not shade other crops and compete for nutrition with annual vegetables. After establishment of nutrition garden, little care is needed for constant supply of vegetables year after year with little additional cost of labour. Economic utilization of space should be obtained by use of fence on three sides for training cucurbits during the summer and rainy seasons and peas in winter.

- Cropping pattern in the farm of succession and companion are continuously followed.
- The ridges which separate the beds are utilized for growing seeds.
- Raising climbing type of tomato plants on one side and leafy vegetables on the other side of the footpath.
- The principles of crop rotation are followed.
- The compost pits are placed in the two corners of the garden. They are meant for garden and kitchen wastes including house sweeping and ash is also dumped into them.
- Cucurbitaceous vegetables should be trained over these pits to give them shade and also to cut them off from view.
- All the plants after harvest should be put into the compost pits. This will go a long way in obtaining self-sufficiency in manure for nutrition garden.

Cropping pattern

Vegetables may be sown or planted at different dates preferably short duration crops first and later the long duration crops, so as to ensure regular supply of vegetables. Growing more than one crop in a bed in a year enables judicious utilization of the soil nutrients and airspace above. Roof of the house can also be very well utilized as support for vegetable crops like bottle gourd. In general vegetables could be grown throughout the year with few exceptions. In each bed, crop rotation has to be followed. For example, shallow rooted vegetable (onion) may be rotated with deep rooted vegetable (brinjal), leguminous vegetable may be rotated with non leguminous vegetable (brinjal, tomato), a tuber forming vegetable (sweet potato) may be rotated with non tuber forming vegetable (Okra) etc. In case of perennial vegetables like pointed gourd, the bed should be rotated with a leguminous vegetable once in 3-4 years.

Seed management in Homestead nutrition garden

Seed management is the most important factor in sustainability of home garden. Seeds of a large number of crops and varieties are required in variable quantity. Managing the seed for home garden is more difficult than managing seeds for commercial cultivation. The constraints can be characterized as

- Required quantity of seed for small plots is less but the farmwomen has to buy seed packets of minimum quantity which is liable to be wasted.
- Multiple planting needs seeds to be available over long period of time posing problem for storage.
- Maintenance of seed germination is difficult
- Liable to be attacked by storage pests
- Hybrid seeds of vegetables sold by big companies may not be suitable for the home garden.
- Seeds may not be procured at right time posing problem in planting sequence
- High cost of seed

Strategies to manage seed efficiently in homestead nutrition garden

Use of local varieties

Locally available promising farmers varieties are climate resilient, less input demanding, locally preferred and easy for seed multiplication. Use of Local farmers varieties maintains or conserves the local crop diversity.

Seed production in homestead nutrition garden

As very less quantity of seed is needed for home garden, improving skills of farmwomen in seed collection and preservation in the home garden itself can address many issues of home gardening. This will save money and wastage of purchased seed. Local varieties can be cultivated due to availability of seed. There will be no problem for multiple planting.

Community involvement

Community involvement will be beneficial for home gardening. Seeds purchased can be shared in the community. Also every member of the community can take responsibility of collecting and preserving seed of one crop and can develop expertise in it. The seeds multiplied by each member can be exchanged within the community.

Skill development of women in seed production and management

Hands on skill on vegetable seed production, nursery raising and planting material production is essential for seed management. So organizational support for capacity building will be beneficial. Training should be imparted on

- Ability to differentiate between crop and seed crop
- Identification of off types
- Method of supplementary pollination
- Knowledge of proper time of harvest
- Handling of the harvested seed
- Seed extraction
- Drying and processing
- Seed treatment
- Labeling
- Storage

Planting material/ nursery preparation

Preparation of nursery on community basis for raising seedlings and planting materials of vegetables is very much useful for self sufficiency. These can be used for home garden and sold outside the community for utilizing the money in purchase of other inputs.

Conclusion

Nutrition garden is an effective measure for combating family malnutrition and women can play a major role in its proper management. Seed management for home garden is crucial and strategies can be adopted for addressing seed constraints of homestead nutrition garden

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IFS MODELS FOR FOOD AND NUTRITIONAL SECURITY

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Malnutrition is a major public health problem especially in developing countries including India. It is categorized as under nutrition and over nutrition and identified as visible and invisible malnutrition. Malnutrition arises due to shortage, excess or imbalance of nutrients in the diet and leads to ill-health such as, severe stress in the child/adult and in turn, influences the family negatively. As per FAO's latest food insecurity report, micronutrients and vitamin A deficiencies posed greatest health problems in India. Nearly 57 per cent of the pre-school children in India suffered from Vitamin A deficiency against 41 per cent in Sub Saharan Africa and 16 per cent in China. In 2005, in India infant mortality rate was 56. As per NFHS-3, 19 per cent of our children are wasted, 38 per cent are stunted and 46 per cent are underweight, accounting for 39 per cent of world's underweight children.

Food security

Food insecurity and malnutrition are quite common but the relationship between the two differs according to ecological setting, which in turn, is differentiated by sources of income, living conditions, ownership of assets, and habitual diet. Food security is not guaranteed by adequate food grain production or even food availability. It is more fundamentally linked to both physical and economic access to food.

Food security has three components," The first is food availability, which depends on food production and imports. The second is food access, which depends on purchasing power. The third, food absorption, is a function of safe drinking water, environmental hygiene, primary health care and education. The International Food Policy Research Institute (IFPRI) disaggregates food security into three pillars; food production, food access and food utilization (IFPRI, 1995).

The concept of food security refers to the ability of a household to assure all its members sustained access to sufficient quantity and quality of food to live active healthy lives. Such access is likely to be most threatened in times of economic deterioration. Maximizing household income is not always sufficient to maximize the food security of all its members for the same reasons that national food availability does not necessarily translate into household food security. In both regions there is evidence that women appear to take a much greater role in assuring the food requirements of their dependents in situations of economic deterioration. So that situations where women produce and/or control the resources by which their own nutritional needs and those of their families are met are likely to be associated with enhanced food security of all members.

For the 350 million people in India who live below the poverty line, food security is literally a matter of life and death. Agriculture supports nearly 70% of the population in India, most of who own less than 2 hectares of land.

The publication reveals some interesting facts

- In some States like Odisha, Himachal Pradesh, Bihar, Karnataka and Tamil Nadu, Net sown area has been declining. In the process prime agricultural land may shift to non-agricultural uses
- Land degradation has been fairly high in Nagaland, Sikkim and Himachal Pradesh. In some northeastern State, wasteland accounts for 50 per cent of the total geographical areas
- Overexploitation of groundwater has reached danger levels in Punjab, Haryana and Tamil Nadu
- Some States (Madhya Pradesh for example) show high poverty levels at present, yet natural resources are sufficient to sustain agriculture in future In other states (Punjab and Haryana), livelihood access is good at present, but natural resource endowments for future sustainability are below par
- In States like Bihar, Uttar Pradesh and Madhya Pradesh, there is an urgent need to diversify livelihoods to non-crop and non- agricultural enterprises

Nutrition security

Nutrition security is defined as the "appropriate quantity and combination of inputs such as food, nutrition and health services, and time needed to ensure an active and healthy life" (Haddad, Kennedy, and Sullivan 1994). Nutrition depends not only on suitable food but also on good basic health services and, particularly for children and the elderly, adequate care. Food security is one component of nutrition security, together with health security and care security. Nutrition security, in turn, is one component of the broader concept of livelihood security. A poor combination of economic, social, ecological, and institutional factors contributes to food insecurity. A high level of income poverty, poor connectivity, and periodic recurrence of droughts and floods give rise to a situation of chronic and endemic food insecurity.

Food security and nutrition security are different. The FAO's Sixth World Food Survey (Food and Agriculture Organization, 1997) showed that while food inadequacy is more prevalent in sub-Saharan Africa than in South Asia, the incidence of malnutrition based on anthropometric measures is higher in South Asia. Apparently, the discrepancy is largely due to differences in disease patterns. Most life-threatening malnutrition occurs among children, but children do not require very large amounts of food. There can be widespread malnutrition in a population even while food security measures indicate the food situation is relatively good. Millions of children worldwide die each year as a result of diarrhea, for example, but this has little to do with the level of food supply in their communities or even in their households. By this understanding, security refers to anticipated conditions. It is different from status, which is about current conditions.

Improving nutrition security would require introducing some sort of change in the local social and institutional arrangements or training or tools or some other resources that could change

things over the long run. Nutrition interventions should be assessed not so much on the basis of their immediate impact but on the impacts they are likely to have over the long run, long after the interventions have ended.

Food availability

Food availability is one of the major factors that determine the nutrition status. However, nutrition status, as an outcome, results not only from the quality of food but also from the qualities of care and health services. Thus, we can say that nutrition status depends on food status, care status and health status. And similarly, we can also say that nutrition security depends on food security, care security and health security.

Food is the basic need of human beings. The cultural influence of food preferences depends on the properties of food, taboos and social role of food in the family (Atkinson 1992). The natural resources in an ecosystem are the basic energy base for the human beings and they exploit these resources with the help of suitable technology. Technology is a means to explore and exploit the resources.

For most households, the food produced on their land does not feed the family for the entire year. The magnitude of food shortage varies from family to family in a given year and from year to year for a given family. In addition, there are significant expenditures to meet the social and cultural obligations.

Improvement in food consumption is a necessity but there are insufficient conditions for overcoming the problem of malnutrition in India especially in the vulnerable section of the society like children, pregnant and lactating mothers and tribal population living in the remote areas. Hence, it is necessary to build capacity of vulnerable section to enable them to come out of the poverty trap, through proper livelihood sustaining measures (Rajkishore, 2007).

Food and nutritional security & livelihood

Livelihood security is multidimensional that encompasses food and nutritional security, financial security, social and cultural security, emotional security, among others. In the absence of adequate food for the family and to meet the socio-cultural expenditures, household members are forced to go on migration to urban areas. Today, in most of the rural households, migration has become a way of life - a livelihood strategy of its own.

In most of the urban areas and in all rural areas, the means for livelihoods adopted by poor households are different and complex in nature. In rural areas, for fulfilling the various livelihoods needs, these households rely on varied and multiple livelihood sources (such as land, forest, water and so on). Various livelihood needs (such as water, food, fodder, shelter and so on) are fulfilled through multiple livelihood activities (such as forest collection, fishing, wage labor, cultivation). For example, the food for a rural family may come from farm produce, its cash income for buying goods (clothes, oil etc.) may be earned through wage labour, and fuel wood and food-items like forest vegetables, fruits and berries may be obtained through forest

collection activity. Thus, different livelihood needs of the majority of the rural households are fulfilled through various activities using different resources.

Food and livelihood security are two important aspects of peoples' livelihoods and they have to be understood from the peoples' perspective as they determine their decision-making behaviors. These determine technology adoption, peoples' participation in community based organizations, health and educational programmes, etc. Food security is a subjective concept; defined by an individual's own perception as to whether he/she has been able to support the family's food and fodder requirements for a year from all resources he/she owns controls and manages. If food is the symbolic expression for their struggle for livelihood, then the security is the assurance, that the system will assure food. While considering livelihood security, taking cognizance of environmental sustainability becomes necessary, as majority of rural households heavily rely on their surrounding natural resources for their livelihoods. Thus, livelihood security of rural households is closely linked with the environmental sustainability. It is seen in the most of the literature that 'security' is often subsumed in the concept of sustainability and also expressed as 'social sustainability,' implying sustainability against shocks and stresses.

Majority of the India farmers derive their livelihood from agriculture. Agriculture and allied activities support livelihoods of nearly 70 percent of India's rural population. In recent years, land based livelihoods of small and marginal farmers are increasingly becoming unsustainable, since their land has not been able to support the family's food requirements and fodder for their cattle. As a result, rural households are forced to look at alternative means for supplementing livelihoods. Besides the Indian economy is predominantly rural and agricultural, and the declining trend in size of land holding poses a serious challenge to the sustainability and profitability of farming. In view of the decline in per capita availability of land from 0.5 ha in 1950-51 to 0.15 ha by the turn of the century and a projected further decline to less than 0.1 ha by 2020, it is imperative to develop strategies and agricultural technologies that enable adequate employment and income generation, especially for small and marginal farmers who constitute more than 80% of the farming community. The crop and cropping system based perspective of research needs to make way for farming system research conducted in a holistic manner for the sound management of available resources by small farmers (Jha, 2003). Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises like fishery, poultry, duckery, apiary horticultural crops, fodder etc. within the bio-physical and socio-economic environment of the farmers. Farming system approach, therefore, is a valuable approach to addressing the problem of sustainable economic growth for farming communities in India.

Farming System

Farming system is a complex inter- related matrix of soil, plants, animals' implements, power, labour, capital and other inputs controlled in part by farm families and influenced by varying degrees of political, economic, institutional and social forces that operate at many levels.Coneptually it refers to asset of elements or components that are interrelated which interact among themselves. At the center of the interaction is the farmer exercising control and choice regarding the type and result of interaction. It is a resource management strategy to

achieve economic and sustained production to meet diverse requirement of farm household while preserving resource base and maintaining a high level of environmental quality. For example it represents integration of farm enterprises such as cropping systems, animal husbandry, fisheries, forestry, sericulture, poultry etc. for optimal utilization of resources bringing prosperity to the farmer. The farm products other than the economic products, for which the crops are grown, can be better utilized for productive purposes in the integrated farming system approach.

Farming System -Definitions

Farming system refers to the farms wherein two or more enterprises are integrated with the farm resources with an objective of achieving fuller utilization of available resources to realize maximum profits and also to stabilize returns. It provides an opportunity to utilize the land, labour, water, manure and fertilizers more efficiently. Farming system approach examines the full range of farm activities closely related to one another by the common use of farmers land, labour capital and management factors.

Farming System Concept

In farming system, the farm is viewed in a holistic manner. Farming enterprises include crops, dairying, poultry, fishery, sericulture, piggery, apiary tree crops etc.A combination of one or more enterprises with cropping when carefully chosen planned and executed, gives greater dividends than a single enterprise , especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity, such that the end-products and wastes of one enterprise are utilized effectively as inputs in other enterprise. For example the wastes of dairying i.e., dung, urine, refuse etc. are used in preparation of FYM or compost which seves as an input in cropping system.

Characteristics of Farming Systems

The farming system research activities are to be farmer oriented, system oriented, problem solving approach, inter- disciplinary, compliments, mainstream disciplinary research, test the technology in on-farm trials and provides feedback from the farmers. Characteristics of farming system are as under:

- Farmer oriented and holistic approach
- Effective farmers participation
- Unique problem solving system
- Dynamic system
- Gender sensitive
- Responsible to society
- Environmental sustainability
- Location specific of technology
- Diversified farming enterprises to avoid risks due to environmental constraints
- Provides feedback from farmers

Goals of IFS

The Goals of this Integrated Farming Systems are (i) to provide a steady and stable income rejuvenation/amelioration of the system's productivity and (ii) achieve agro-ecological equilibrium through the reduction in the build- up of pests and diseases, through natural cropping system management and reduction in the use of chemicals (in-organic fertilizers and pesticides)

Advantages of IFS

- It improves space utilization and increase productivity per unity area
- It provides diversified products
- Improves soil fertility and soil physical structure from appropriate crop rotation and using cover crop and organic compost
- Reduce weeds, insect pests and diseases from appropriate crop rotation
- Utilization of crop residues and livestock wastes
- Higher net returns to land and labour resources of the farm families
- It provides the food and nutritional security of the farm families
- Encourages the members of farm families to involve working in the IFS.

Conclusion

Food safety, bio-safety, health safety, nutrition safety, gene safety and environmental safety have become major issues in international trade and role of farm women is very important in all these safety issues. In addition, women play a crucial role in ensuring supply of food as food vendors and post-harvest processors of livestock and fishery products. Definitely IFS approach helps the women to get better income, and employment opportunities round the year. However awareness, social acceptability, risk bearing capacity, availability of capital for establishment of a system, feed, fodder and market are the major issues of the new farming systems for adoption. It is concluded that food, nutrition security and livelihood are fragile in case of vulnerable section of the society and therefore, need massive support and interventions from government, non–government and public organizations to adopt farming system approach.

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MUSHROOM CULTIVATION IN ODISHA: OPPORTUNITIES AND CHALLENGES

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Agriculture continues to be the main strength of Indian economy. With the variety of agricultural crops grown today, the country has achieved food security by producing about 260 million tonnes of food grains. However, the struggle to achieve nutritional security is still on. In future, the ever increasing population, depleting agricultural land, climate changes, water shortage and need for quality food products at competitive rates are going to be the vital issues. It is imperative to diversify the agricultural activities in areas like horticulture to meet these challenges and to provide food and nutritional security to our people. Mushrooms are one such component that not only uses vertical space but also help in addressing the issues of quality food, health and environmental sustainability. There is need to promote both mushroom production as well as consumption for meeting the changing needs of food items. Fortunately, mushroom trade has gained importance in recent years possibly for the global shift towards vegetarian food and recognition of mushroom as a functional food. Mushroom cultivation offers an added advantage to recycle agro-waste as carbon pool into good quality protein, much of which otherwise is wasted in the field. This hi-tech horticulture venture has a promising scope to meet the food shortages without undue pressure on land.

Mushroom : The overall scenario

Mushroom farming today is being practiced in more than 100 countries and the production is increasing at an annual rate of 6-7 per cent. Present world production of mushrooms is around 3.5 million tonnes as per FAO statistics. China alone is reported to grow more than 20 different types of mushroom at commercial scale and mushroom cultivation has become China's sixth largest industry. In India, mushroom production shot-up from mere 5000 tonnes in 1990 to over 1,20,000 tonnes in 2013. Today commercially grown species are button and oyster mushrooms, followed by other tropical mushrooms like paddy straw mushroom, milky mushroom, etc. However, the production of white button mushroom is about 70 per cent of the total production of mushrooms in the country.

The research on edible mushroom in Odisha made its humble beginning in the Department of Plant Pathology, College of Agriculture, OUAT, Bhubaneswar in 1972 with a view to generate profitable and sustainable production technology. Having achieved success in developing mushroom cultivation and spawn production technology, research efforts were further strengthened and transfer of technology was initiated with the establishment of 'Centre of Tropical Mushroom Research and Training' in the University with the financial support of Government of Odisha in 1991-92. This research organization paved the way for initiation of commercial mushroom cultivation in the state within two years of its establishment.
In depth study on production of spawn and mushroom cultivation particularly paddy straw mushroom, oyster mushroom, milky mushroom and button mushroom were undertaken.

Farmers training programmes and demonstrations on spawn production and mushroom cultivation were then extended to all over the state. Technical assistance was provided for development of individual/group/private sectors in establishing spawn production units and mushroom production centres. The overall activities of the centre further gained momentum with the establishment of All India Coordinated Research Project on Mushroom in the University during 2009-10 with the financial assistance from Indian Council of Agricultural Research, New Delhi. At present, the total mushroom production of the state has reached an all time high of 12,622 tonnes/annum contributing to over 10 per cent of the country's production.

Paddy straw mushroom (*Volvariella volvacea*), commonly known as the straw mushroom or the Chinese mushroom is considered as one of the easiest mushrooms to cultivate. It is the 6th largest mushroom of the world in terms of production. The flavor is excellent and the cropping cycle is short (21 days). However, this variety has low biological efficiency (15 per cent) and poor keeping quality (12 hours). The production of straw mushroom is very popular in Odisha. Odisha is the only state where straw mushroom is grown commercially for 10 months a year (February-November) involving poor farmers. The cultivation has spread rampantly as a cottage industry involving spawn production in low cost units in villages and outdoor cultivation under the plantations. The rice farmers of the coastal agro-ecological situation in particular have demonstrated a practical way to transform the lingo-cellulosic wastes directly into a highly acceptable, nutritious and delicious food for the people. Odisha produces 8,417 tonnes of straw mushroom per annum contributing to 66 per cent of the total mushroom production of the state.

Oyster mushroom (*Pleurotus* spp.) has species suitable for both temperate and sub-tropical regions. It is the 3rd largest cultivated mushroom of the world. The production figure for the country is 15,000 tonnes/annum. In Odisha, cultivation is restricted to winter months (November-February) and the production stands at 4095 tonnes/annum contributing to 33 per cent of total mushroom production of the state. *Pleurotus sajor-caju, P. florida* and *Hypsizygous ulmarius* are the ruling species of the state. However, for small scale semi-urban and urban units, *P. eous* (pink mushroom) is gaining popularity owing to its attractive colour along with good taste and flavour. The biological efficiency is very high (100 per cent) and the shelf life is better (24 hours) than straw mushroom. Production cost is low with little longer cropping cycle (45 days). Further, it is suitable for post-harvest processing. However, the consumer demand is limited in the state.

Milky mushroom (*Calocybe indica*) is indigenous tropical mushroom of the country. However, the commercial cultivation is restricted to south Indian states only. The mushroom is attractive white with excellent keeping quality (3-4 days). Its biological efficiency is also very high (about 100 per cent). The mushroom is not being grown commercially in Odisha probably because the cropping time for both straw and milky mushrooms is same.

The button mushroom (*Agaricus bisporus*) is most popular variety of the country. At global level it ranks first in terms of production. Punjab is the leading state contributing to 60 per cent of the total production of the country. Being a temperate mushroom, production can be taken up

year round in controlled environment or seasonally during winter months. Odisha has just started the commercial production with 110 tonnes/annum at present and it is likely to grow further in future.

Mushroom cultivation is a profitable enterprise. The cost for raising one bed of straw mushroom of 1.5′ x 1.5′ x 1.5′ size comes to Rs.50/- with a production of one kilogram mushroom within a crop cycle of 21 days. The net return is Rs.50/- per bed assuming the market rate at Rs.100/- per kilogram. Likewise, the cost for raising one bag of oyster mushroom is Rs.30/- with a production of 1.5 kilogram mushroom within a crop cycle of 45 days. The net return is Rs.30/- per bag assuming the market rate at Rs.40/- per kilogram. A model small mushroom production unit (300 sq.ft.) with the investment of Rs.25,000/- accommodating 120 beds of paddy straw mushroom per month during summer and rainy season and 225 bags of oyster mushroom per 1.5 month during winter season, gives an estimated net income of Rs.6,000/- per month.

Mushroom cultivation under protected condition: The need of the day

It is imperative to say that mushrooms cannot be grown year after year with full commercial access, unless proper growing conditions are provided and adequate facilities are available for the control of diseases and insect pests. Possibly, such conditions can be fulfilled in shelf growing, by the construction of properly insulated and ventilated mushroom houses accommodating store room, spawn running room, cropping room as well as packing and preservation room. In Odisha, raising of simplified and low cost thatched mushroom houses are being encouraged for round the year cultivation of mushrooms with greater precision. The houses are appropriately designed to maintain required temperature and humidity inside, besides having access to ventilation. The vertical space in the mushroom house can be utilized effectively by raising three-tiered structures (shelves), mandatory for indoor cultivation. Experiments have shown that these low cost houses perform better than outdoor cultivation in terms of productivity. A small low cost house of dimension, 25′ x 12′ can well accommodate 180 beds of paddy straw mushroom or 125 bags of oyster mushroom in a three-tired structure within a crop period of two months. Such a house can be a livelihood option for a small farmer with a monthly net income of Rs.6,000/-. Various modifications of the thatched houses are being designed now-a-days in order to make it more permanent and mushroom friendly. Shade net houses and houses having asbestos roof are therefore, viable alternatives to the thatched sheds. In view of the higher sale price of the produce, off season or winter cultivation of straw mushroom is gaining popularity in the state. Hence, poly house cultivation is being popularized during winter season wherever growers are interested.

Value addition: An inevitable segment

Mushrooms being highly perishable because of their high moisture content and delicate texture, the produce remains acceptable for few hours only at the high ambient temperature of the tropics and sub-tropics. Thus, understanding of post-harvest handling practices plays a significant role in enhancing the availability of quality mushrooms either in fresh or processed form to the consumers and at the same time ensuring remunerative prices to the producers, low cost preservation methods like drying needs to be popularized among the growers to minimize post-harvest losses of mushrooms. Further, development and introduction of new

products with wider acceptability and comparatively at low price will increase the demand and consumption of mushroom products. This will in a big way sustain the increasing trend of mushroom production in the country in the years to come.

The road ahead

Odisha leads the country in terms of production of straw and oyster mushrooms. Indoor cultivation of button mushroom has been initiated successfully in the recent past and it is expected to grow further. Moreover, the cultivation method of the low temperature tolerant variety of straw mushroom (*Volvariella bombycina*) for winter season it being worked out in the research centre. Possible introduction of the shiitake mushroom (*Lentinus edodes*) in the state is being explored. Cultivation of straw mushroom in controlled environment with higher biological efficiency (30-45 per cent) has already been initiated in the state with profound success. Preservation of straw mushroom through canning has been done successfully in Odisha for the first time in the country. The state is having the highest number (210) of spawn production units in the country. In spite of the phenomenal growth rate of the mushroom industry in the state, constraints do exist, that need addressal for the benefit of growers.

Mushroom crop needs to be recognized as a horticultural crop in the state. An appropriate mechanism should be developed for effective monitoring of the spawn production units for ensuring spawn quality, as production gets deteriorated owing to use of spawn bottles having inferior quality. Like other horticultural commodities, mushroom marketing ought to be streamlined in order to avoid distress sale. Above all, establishment of processing units with FPO license requires to be encouraged in order to facilitate the export potential of mushroom products. The Centre of Tropical Mushroom Research and Training along with All India Coordinated Research Project on Mushroom are making concerted efforts in pushing Odisha ahead of other states in mushroom production. This would probably be the appropriate way to search for alternative nutritional sources for our huge population and help achieve non-green revolution.

Mushrooms are truly health foods and promising neutraceuticals. Odisha has tremendous potential for mushroom production owing to the availability of agricultural wastes in abundance, manpower and suitable climate. Further, there is increasing demand for quality products in domestic and export market. Mushroom being a women friendly crop, could be facilitated well with a strong Mission Shakti existing in the state. To be successful in both domestic and export market, it is essential to produce quality fresh mushrooms and processed products devoid of pesticide residues at competitive rates. It is also important to commercially utilize the spent mushroom substrate left after cultivation for making manure or vermin-compost for additional income and total recycling of agro-wastes. It is worthwhile to mention here that few of our entrepreneurs have got recognition at the national and international levels owing to their excellent endeavor in mushroom production. With the untiring efforts of all concerned, possibly Odisha mushroom industry will see a new dawn in the near future.

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APICULTURE FOR LIVELIHOOD SUPPORT TO WOMENFOLK

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Women are vital and productive workers in the Indian Economy. Their involvement and role in agriculture is well realized. In Asia 50-90% of labour from rice cultivation is comprised by women. Women first domesticated the crop plants and their by initiated the art and science of farming. Still then are treated as the neglected group and are deprived of their basic right. According to our former Prime Minister, Pandit Jawaharlal Nehru," Freedom depends upon economic conditions even more than the political. If women are not economically free and self-earning they will have to depend on their husband or some one else, and the dependant are never free".

Women's contributions in agriculture have become the subject of global consideration. Technology exposure for empowering women in an integrated manner through active participation and learning is a major means to it. According to Jacques Diouf (Ex: DG, FAO) "If women are to be empowered to act as full and equal partners in development, we must realistically evaluate the conditions under which they fulfil their role as providers. We must act concertedly to free women from drudgery and remove the obstacles that limit their access to resources and their active participation in planning and decision making structures and institutions. An environment must be created and nurtured that will ensure not only that women are listened to attentively but, what is most important, that sincere and tangible commitments are made to address their needs and concern".

Dr. M. S. Swaminathan in his forwarding note in the FAO service bulletin on tropical and subtropical apiculture noted that, " In spite of all global resolution on food security, several hundred million children, women and men are going to bed hungry everyday, particularly in the countries of the 'South'. Since the prospects of the global food security system appears to be small at the present moment, it will be for the developing countries characterised by poverty and under-nutrition, to build their own national food security system. In this task, apiculture can play an useful role. At present with little expenditure, honeybees will not only provide food and income, but wil also enhance the productivity of horticultural and other field crops by their pollination services".

Food security essentially means ' A situation that exists when all people , at all times, have physical ,social and economic access to sufficient ,safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. The dangers of food insecurity and unsustainability in the coming millenium are foreseen owing to exploding population and decrease in *per capita* availability if arable land. It is high time that policy makers and planners in South and South East Asia must develop an agenda to ensure sustainable livelihoods, natural resource use optimization and eco-system production through

off farm food and income generation activities. Education can play a major role in raising the status of women and significantly improving household, health and nutrition, reducing infant and child mortality and reinforcing environmental conservation.

AVENUES FOR EMPOWERMENT OF RURAL WOMEN

Home Scientists in KVK with Co-operation of fellow scientists take a vital role for women empowerment. The farm women rural youths through self help groups are trained for self employment and improving their socio-economic on any of the following avenue/enterprise.

1. Mushroom cultivation.
2. Wonders out of mushroom in households.
3. Kitchen gardening.
4. Use of Handy Tools
5. **BEE KEEPING**
6. Nursery raising.
7. Seed treatment.
8. Soil testing.
10. Organic manure.
11. Post harvest technology.
12. Processing of fruits & vegetables.
13. Development of Nutritional Garden using vermicompost.
14. Dietary management for normal and therapeutic diseases conditions.
15. Preparation of low cost recipes from under exploited minor millets.
16. Processing of spices.
17. Preparation of milk products.
18. Tomato preservation
19. Promoting family health through nutrition.
20. Agricultural waste for vermicompost
21. Household remedies for common ailments.
22. Solar cooking at house hold level.
23. Wealth from waste.
24. Crafts from agricultural wastes.
25. Items from palm.
26. Farm scale storage of fruits and vegetable.
27. Storage techniques for sale at farmers market.
28. Extraction of pappain
29. Briquette making.
30. Paper making out of banana waste.
31. Use of traditional medicines.
32. Preserving coconut scrapping
33. Soak pit.
34. Compost pit.
35. Safe drinking water.
36. Preparation of home care products (Phenyl, liquid, blue, washing powder, soap)

37. Preparation of low cost products for income generation (Chalk, Agarbati & Candle)
38. Organization & Management of Crèches/day care centers & nursery schools.
39. Use of non-conventional sources of energy.
40 Bakery Technique

BEE KEEPING

Honey - a gift of God and Mother Nature, is known to mankind since ancient vedic times. The ancient Greeks, Romans, Chinese and Egyptians used honey to heal wounds and cure disease of the gut. In India, honey as a carrier of Ayurvedic medicines is in vogue since time immemorial and it can cure a host of ailments like cold, fever, piles, anemia, and infections in the throat, eye, skin and intestine. Therefore, our ancient civilization was quite aware of the medicinal properties of honey and recent scientific studies have also shown that honey has valid medical use because of its antibacterial activity. Further, honey improves digestive and nervous system. Basically, because of the therapeutic values of honey, efforts were made in the past to get this precious natural food and after the development of the concept of 'bee space' by Lorenzo Lorraine Langstroth in 1851 beekeeping came into existence. However, the potential importance of honey in modern day medicine has restricted its use as a small medicinal dose despite of the fact that it could supply our daily dose of essential nutrients and could be utilized as food (Table-1).

Table-1 Constituents of Honey

Constituent	**Percentage**
Total dissolved solids	70-80
Sugars Fructose Glucose Sucrose Other higher sugars	 38 37 02 0.5
Water	20
Minerals(Potassium,Calcium,Magnesium,Iron,Copper Manganese, Phosphorus, Sulphur, Chlorine,and traces of Chromium, Nickel, Tin, Silver, Gold etc.)	0.5
Acids	0.2
Proteins and Amino Acids	0.25
Enzymes and Vitamins	Traces

Moreover, the calorific value of 1 kg of honey is very high as compared to other products as may be seen in Table-2. Because of its pre-digested form an infant can get direct benefit from honey and it also provides replenishment of energy losses instantly. Therefore, honey is treated as most complete natural food and its use in our daily diet needs attention.

Table- 2. Caloric value of honey *vis-à-vis* other food products

Product	Calories/kg	Product	Calories/kg
Cheese	3480	Milk	670
Peas	3150	Fish	620
Honey	3000	Mushroom	270
Egg	1272	Orange	230
Potato	970	Cucumber	140

Besides, honeybees play vital role in pollinating 60-70% agricultural and horticultural crops. Research studies have revealed that in oilseed crops like sunflower, mustard, safflower, niger and sesame, the seed yield increases from 33.0 to 69.0 % through installing three to five bee colonies per hectare.

In Orissa potential areas for beekeeping with the Indian hive bee, *Apis cerana indica* are wide spread and adoption of such entrepreneurship will not only boost up the honey production of the state but, also enhance crop yields by 2-3 times through cross pollination. Therefore, it can be taken up as an agricultural practice especially in areas where oil seed crops (niger, mustard, sesamum, and sunflower) and horticultural crops (guava, citrus, litchi, coconut, ber etc.) are extensively grown. Further, establishment of apiculture based floriculture (calendula, cosmos, marigold, gladioli, aster, chrysanthemum rose, dahalia, zinnia, etc.) will make beekeeping enterprise more rewarding. An apiculture based farming system should include bee foraging plants as per the following;

Crops (65 % of the area to be covered): *Kharif*: Arhar, mung, niger, pumpkin, sunflower
Rabi: Kusum, mustard, sunflower, mung, sesamum, pumpkin.

Fruit trees (20% of the area to be covered): Drumstick, Ber, Lemon, Mango, Guava, Litchi.

Ornamental/other plants (15% of the area to be covered): Neem and Karanj (products of these two plants will be utilized for suppression of insect pests), Silver oak, Bottle brush etc.

In addition to honey, we also get remunerative benefits from other hive products like bee wax, bee venom, royal jelly and propolis. Technologies are now available for collection and processing of these hive products. The utility of bee products further widens the scope of beekeeping as a remunerative enterprise. Some uses of the hive products are indicated below;

Bee wax: Wax is secreted by 14-18 d old worker bees. Bee wax is used in the preparation of church candles, cosmetics, shoe polish, mason polish, carbon paper, crayon colour pencil, in metal castings and moldings, for polishing optical lenses, in candy and chewing gums, for

musical instruments, for bow strings, in electric and textile industry, in coating drugs and pills, and in beekeeping industry it is used to prepare comb foundation sheets. In India the price of bee wax ranges from Rs.70-120/- per Kg.

Bee venom: It is a pharmacologically active hive product. Venom gland of worker bees and queen bees contain about 100-150 µg and 700 µg, respectively. The normal recovery is 0.5-1.0 µl (0.1µg of dry venom) per bee and one million stings are required to make one gram of dry venom. Bee venom is obtained by Electro-shock method and in human beings it is used for curing rheumatoid arthritis, diseases of nervous disorders. U.S.A. is the main producer of the bee venom and it costs about Rs.4700 – 9400/- per gram.

Royal jelly: It is a mixture of secretions of hypo pharyngeal glands (watery clear) and mandibular glands (milky white) in a ratio of 1:1 and is produced by the nurse worker bees (5-7 d old) for feeding it to the larvae destined to be queen and also for feeding the adult queen bee. It enhances the fertility status and life span of the queen. About 12.6 g of royal jelly per colony can be collected during spring from 120 queen cells. Royal jelly is used as dietary supplement. It is recommended for problems relating to premature babies and those with nutritional deficiencies, old age (70-75 yrs), psychiatry, chronic tuberculosis. Also it is used as ingredient in cosmetics, in dermatological preparations (for skin refreshing and skin rejuvenation) and in creams or ointments for healing burns and other wounds. China is the world's largest producer and exporter of royal jelly. The international whole sale price of royal jelly is US $ 50-80 per kg.

Propolis: It is a sticky / gummy and resinous material collected by bees (especially by the European honey bees, *Apis mellifera)* from flower buds, bark and wounds of plants/trees. Bees use this for plugging the cracks and crevices or unwanted holes in the hive. They spread propolis around the hive entrance to prevent the intruders like ants. Propolis can be collected by scrapping off the hive parts or by using the propolizing plastic screens over the top bars of the bee frames. Extraction of propolis is done either in alcohol (95% ethyl alcohol + 30-40% propolis) or in oil (10 gm propolis + 200 ml olive oil or 100 ml linseed oil). Aqueous extracts can also be obtained by soaking propolis for several days and such extracts show bactericidal and fungicidal properties.

For generating income and for sustenance of beekeeping the following guidelines are considered as most vital.

(A) The income from beekeeping can be generated in various ways such as;

- Through the sales of honey,
- Through the sale of bee products like bee wax, bee venom, and royal jelly.
- Preparing and selling the comb foundation sheets.
- Renting the bee colonies to farmers for effecting the cross pollination in field as well as horticultural crops.
- Renting the honey extractor.
- Trading bee equipments in potential areas.

- Establishing apiculture based floriculture (calendula, cosmos, marigold, gladioli, aster, chrysanthemum, rose, dahalia, zinnia, etc.) or apiculture based farming system.

(B) Further, the promotion and sustenance of beekeeping can be ensured through;

- Mass queen production for sustaining beekeeping.
- Regulated marketing of raw honey / processed honey.
- Establishing the honey processing unit.
- Establishing apiculture based social forestry with plants like bael, kadamba, golab jamun, jamun, cinnamon, amla, eucalyptus, gambari, silver oak, soobabul, litchi, drumstick, karanj, soapnut(Ritha), etc.

(C) The basic tips in achieving successful beekeeping are as follows;

- Ensure the availability of food (pollen & nectare) for bees.
- Maintain populous colonies through regular inspection of bee colonies.
- Replace the queen bee every alternate year or at 1½ years interval.
- Take timely remedial measures against the bee enemies (wax moth, wasp, Thai Sac Brood disease, mite etc.).
- Avoid toxic insecticides particularly dust formulations and plan accordingly.

Conclusively, beekeeping is a fascinating enterprise benefiting the poor or landless to rich farmers and helps in maintaining healthy environment for sustenance of human society. It needs one time capital investment and results a gains of Rs. 2, 000/ hive /annum from a medium scale apiary unit consisting of 10 bee colonies.

The cost/price of different products quoted in this write up are time dependant and may vary with time and location.

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GENDER ISSUES IN LIVESTOCK PRODUCTION AND MANAGEMENT

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The livestock sector is an important tool for livelihood improvement of rural as people as well as peri- urban livestock keepers. It is an important source of income and employment to millions of people in rural and peri-urban areas. The nutritional outcomes of the households rearing livestock comes as an additional benefit of the vocation of livestock keeping. In the last decade the dairy and commercial poultry sector have shown impressive growth. The demand driven growth in the dairy and the poultry sector has been due to the growth in human population, urbanization and changing dietary habits of the Indian population. The livestock sector in India contributes 4.1 percent of the total GDP (2012-13). It alone contributes nearly 25.6% of Value of Output at current prices of total value of output in Agriculture, Fishing & Forestry sector. The milk production now stands at 132.43 million tonnes (2012-13) and it is an important secondary source of income for millions households engaged in dairying. The 70 percent of the workforce engaged in dairying is comprised women. The per capita availability of milk is 295 g per day in India which is higher than the world average. Poultry sector has also shown an impressive growth because of the conducive government policies for commercial poultry production and the focus on family poultry system which addresses livelihood issues. The egg production in India was 69.73 billion in 2013, while the poultry meat production was 2.68 mt. The per capita availability of egg in India is 55 eggs per year. The livestock sector has the potential to provide income and employment and nutritional security to millions of farmers which is yet to be fully tapped. The growth witnessed in the dairy and the commercial poultry sector can be spread horizontally provided it encompasses other livestock species like goats, pigs and backyard poultry which are less capital intensive but have greater impact on the health and well being of the farm families. Although the contribution of women in making the operation flood programme has been immense because they have been shouldering most of the activities related to rearing and management of dairy animals, their abilities and expertise with respect to other livestock species is yet to be fully appreciated especially in the field of small ruminants and backyard poultry.

Women are vital to food security and family well-being and their need for labour saving and income generating technologies are acute. However, until now, most technical solutions have ignored women's actual needs. Studies have shown that livestock contribute significantly to the income of poor households-particularly the income controlled by women, and enables poor and landless women to earn income using common-property resources. The expanding market for livestock products also offers an opportunity for augmenting their income to those who do not have access to land and capital resources.

The domestic animals like goats, sheep, pigs, chickens, ducks and rabbits can be reared easily by women while attending to other household activities and they are also important for household nutritional security. Identifying and supporting women's roles as livestock owners

and strengthening their decision-making power and capabilities are key aspects in promoting women's economic and social empowerment. Recent review conducted by ILRI shows that if livestock technologies are developed in ways that consider the needs, interest and concerns of women and men, they can reduce women's work load, increase productivity and contribute to the generation of income.

Women play an important role in activities dealing with livestock such as care and management or transformation and marketing of certain livestock products. Furthermore, livestock ownership patterns especially for small stock and poultry appear more equitable than that of other assets like land, capital, and knowledge. These reasons have possibly contributed to an increasing inclusion in one way or another of gender aspects in livestock development projects. Gender aspects should be understood as 'practical needs' on the one hand (access to technologies, more access to better welfare) and as 'strategic needs' on the other hand (revised rules and regulations, long term improvement of women's position).

Concerning livestock development, there is a high level of agreement in the literature that socio-economic and institutional frameworks play an important role in determining who does what, and who gets what. Social and cultural norms dictate the division of labour and control over assets. Policy and institutional structures often restrict existing sources of support to women, particularly credit to acquire large ruminants. Values, norms and moral codes embedded in culture and tradition have very strong influence on gender issues as they determine attitudes and the organisational set-up of the whole community system. Like culture and traditions, political, institutional and legal structures also change slowly. Hence, these latter factors often impede the implementation of gender balanced programmes. Hence, it is important to consider the socio-economic factor while implementing livestock programmes from gender perspective. Social and cultural factors determine the possible margin of action of women and their activities. In cases where women are excluded from community meetings, have no access to education and training, and where their capacity to become actively involved is not strengthened, they will always be left behind. Economic factors are the basis for change because with a greater economic independence, self-confidence and possibilities of upward socio-economic movement increase. To achieve a broad-based impact with a particular intervention, gender aspects should be looked at simultaneously and all factors including political, institutional and cultural aspects should be considered.

Gender Issues in livestock production

Women and men livestock keepers typically have different needs and interests, and face different livelihood opportunities and constraints in managing livestock as well as in coping with emerging challenges such as poor access to markets, services and technical information, periodic drought, flood and disease, competing resource use, policies that favour larger-scale producers or external markets, and weak institutions (Table 1). In most system, women provide labour for various tasks related to livestock production but may or may not control the process of decision making, particularly over the disposal of animal and animal products. Similarly, women may be involved in production, but may or may not own the means of production, including livestock, land and water.

Table 1: Gender-based constraints, needs and opportunities in livestock production

Constraints	Needs	Opportunities
Low women's participation in livestock development programmes and training	• Gender sensitization for more women's participation in formal discussions • Increased access to information, use of visual aids where there are problems of literacy • Include women in training and development programmes-very much open to innovations • Organise training programme in those periods and days when women are not involved in other duties • Organise training programme on-site (village) • Introduce leadership development and confidence building measures	• Adoption of improved technology that can suitably be integrate in traditional production system • Raise awareness of potential of livestock in increasing household food security and household economies and promotion of gender equality. • Conduct training progarmme in villages with flexibility in schedule and venue
Time constraint in livestock management during peak labour periods	• Introduction of labour-saving technologies/devices • Introduction of skills on livestock management, e.g. full hand milking, use of locally made crates, revolving stool for milking, use of long handle rack /spade for removing dung • Look at case studies where women play a leading role in livestock production for exposure visits	• Reduce livestock mortality and morbidity • Reduction in women's work drudgery • Development of other small enterprises
Low scale of production limiting access to inputs and markets	• Introduction of group approach/ women self help group /farmers' groups or associations • Facilitation of support services at village level (AI, vaccination, deworming, credit etc.) through women self help groups • Training on capacity building of women SHGs for livestock enterprise development	• Improvements in access to inputs, technical assistance and in marketing system • Women's empowerment and increasing gender equity
Lack of common pool resource (grazing, water and	• Improve access of women's to common pool resources through community participation and	• Improvement in the productivity of CPR • Enhance women's' right to

forest) for livestock production and other micro-enterprises income genration	management • Develop mechanism at village level for provision of water and fodder during scarcity period	control and manage CPR and livestock • Increasing livestock assets for the landless women
Informal and poor marketing system	• Improvements in infrastructure and transport services • Improving women's management and skills in value addition and processing	• Increase demand for livestock products and promote production

For successful livestock interventions the following factors have to be considered:

a) Livestock production system

The role of women in varies according to the different livestock production systems and types of animals; crop/livestock linkages; feeding; availability and quality of natural resources, ecological conditions and vitality of land and pastures; soil quality; natural water sources; other common property resources; availability and cost of inputs; use of manure and crop residues; technology used. While considering the gender roles in livestock production we should take into account the proportion of households with livestock and their social structure; ethnic, cultural and social relations; household activities and intra-household organisation; seasonal migration; relation between livestock and other activities; gender disaggregated seasonal occupation and sources of income.

In India livestock are generally raised in mixed farming systems, where animals very often have different functions. During earlier times they were a symbol of wealth and were vital for agricultural operations. Of late, with the mechanization of agriculture large the role of draft animals have diminished and cattle and buffalo are mainly reared for milk production. However, in areas where the mechanization of agriculture has not taken place, they are still an important source of draft power, dung and milk. The livestock activities are normally integrated into the existing farming systems: animals graze on fallow land and browse on hedges, utilise crop residues as feedstuffs and produce milk and meat, manure for biogas and power for traction.

Sheep and goats are generally kept on grazing only with little supplementation of the household leftovers. In most of the cases, women are the custodians of sheep and goats in the household and often children also actively take part in their management. Backyard poultry (BYP) is also an important activity for rural women as it generates cash income and provides employment opportunities while increasing the availability of meat and eggs that improve household nutrition. Studies conducted at DRWA in Odisha have revealed that BYP provides an income of Rs. 2000 per unit of 6-8 birds over a period of five months. The rural women mostly preferred Vanraja and CARI Devendra birds for backyard poultry rearing as both the birds as well as eggs fetch high price as compared to other birds.

b) Ownership of different livestock species

Generally, men and women tend to own different animal species. In many societies, cattle and larger animals are usually owned by men, while smaller animals, such as goats and backyard poultry which are kept near the house, are more women's domain. However, ownership

patterns of livestock are more complex and are strongly related to the livestock production system and to social and cultural factors. Ownership of larger animals is often related to ownership of the land.

c) Access to capital and knowledge

Men have easier access to government provided credit than women. Women are rarely considered creditworthy because they have no collateral. In addition, they often cannot read and write, and are not used to frequent governmental or official institutions without their husbands consent and being accompanied. In the most countries in Asia, Africa and Latin America, animal husbandry services are mainly oriented towards men. Veterinary services and extension programmes and advisory services have been mainly designed by men for men. Extension personnel are often not trained to teach technical subjects to women or to react their specific questions. Due to limited resources in time and material, attention is first given primarily to men's animals. Extension work with women often requires special didactic knowledge and communication skills because women often speak only the local language or dialect and illiteracy is high.

d) Responsibilities and division of labour

Patterns of gender division of labour are location-specific and change over time. Although the most typical pattern of gender division of labour is that women are responsible for animals kept at the homestead, there are many variations to this pattern from non-involvement in livestock to the management and herding of large stock.

If new livestock activities are introduced, it is mainly males who decide on whether or not to participate. The intra-household division of labour then depends on household labour availability, the number and type of livestock, economic development of the household and estimated income out of the new activity. But in fact, many decisions in a family are joint decisions, although they may not be formally recognised.

In Odisha women perform all the day to day activities related to caring, feeding, cleaning, health and production of livestock. These activities performed by women may appear to involve low skill levels, they are, however, most critical to the survival, health and production of the livestock. Activities performed by men are occasional in nature, involve less time, energy and labour and largely occur in the public domain, outside the confines of the household. Activities such as vaccinations, deworming, grazing, purchase of fodder and medicines, and taking animals to the dispensary are generally taken care of by men because they involve greater mobility, access to new technology and information, greater interaction with the market and the outside world. Despite this division of work, livestock production and management continues to be a household activity with flexible arrangements of work between women and men. Women's access to information and training in modern livestock management and dairying is limited and even indirect, lowering their involvement and efficiency.

e) Role of livestock in the household nutrition

One of the major reasons for keeping livestock in the household is to get direct nutrition in terms of milk and meat, but the income derived from sale of milk, and animals are also used to buy other food items. The manures produced by keeping animals improve household food production like vegetable and other food crop production. Generally, increased livestock

production can have a positive influence on the nutritional level and the well-being of household members. Increased income from livestock production changes the intra-household distribution and control over products and earnings. When higher production and marketing activities become more important, women often lose their control over products and income. The level of nutrition within the family may decrease if the animals from which the products are derived are sold and the earnings spent on personal necessities, without taking into consideration the household well-being.

f) Influence marketing of livestock products in the household economy

Women tend to have greater control on the income from sale of poultry, eggs, milk and small ruminants. They tend to spend the money they earn from livestock activities on the welfare of their families. Income from livestock activities is also invested into diversification of agriculture, to buy animals and even to buy land. In many societies, the little income derived from daily milk sales is sometimes used by men for drinking.

g) Training in livestock activities

Livestock production is generally a joint activity carried out by both men and women but, compared to women, men have easier access to technology and training, mainly due to their strong position as head of the household and greater access to off-farm mobility. The decisions in activities related to livestock sector, such as breeding, handling, feeding and health care, are largely taken by men. Livestock extension services are often controlled by men and the extension personal are primarily men hence, the extension programmes and educational materials are mainly designed by and oriented towards men. Although in most societies all household members are involved in some way or another in livestock production, the decision making processes within the family and the division of labour for activities such as feeding, milking, health care, processing and marketing differs between regions, societies and households.

Women's access to information and training in modern livestock management and dairying continues to be limited and even indirect. Successful training should be oriented towards those household members which execute these tasks. For example, in societies where sick animals are mainly treated by women, they have knowledge of the symptoms and cures for animal diseases. But if they have no access to training, progress in best practices and appropriate herding to reduce diseases is difficult. Therefore, where extension services are dominated by men and where women have little access to training due to socio-culturally defined gender roles, men need to be persuaded to see the relevance and the benefit of training women. Only through a carefully planned gender approach can livestock production goals and successful training of women and men be achieved.

h) Role of Self Help Groups

Targeting livestock development through SHGs can accelerate the process of learning and arranging the inputs like credit.

Gender analysis in livestock production

Gender analysis requires taking into consideration factors which could influence the potential impact of a project and presents opportunities or constraints to project goals and activities. It

helps in determining factors which can facilitate or constrain the project. The following factors have to be considered while making gender analysis in livestock production:

• Gender should not be an issue of mistrust and prejudice, but of creativity, inspiration and positive spirit for men and women.
• Social and cultural factors (norms and traditions which influence the behaviour of men, women and children, organisation of the daily life of the household members, specific religious rules for men and women)
• Economic factors (poverty level, inflation, infrastructure, income distribution and distribution among family members, etc.)
• Institutional structure (government, extension, education, health care, funding agencies etc., and their gender approach in theory and practice)
• Environmental factors (quantity, quality and availability of land by households and intra-household distribution, water, energy, etc.)
• Political factors (power relationship, system of decision making, legal system, etc., and their influence on the relationship of men and women)
• Demographic factors (migration, life expectancy, infant mortality, etc.)
• Legal parameters (right to ownership, law of succession, etc.)

Mapping livestock development programmes to measure outcome and impacts

There is an need to develop indicators for any livestock developmental programmes that are gender disaggregated to track outcomes and impacts. ILRI has come up a set of six outcome and impact areas for which gender disaggregated indicators have been developed.

Outcome and Impact Area	Indicators
Asset Accumulation	Domestic Assets • Household domestic asset index for male and female headed households • % of women who own different assets • Gender asset disparity Livestock (by and across species) • % of households where women own livestock • % of livestock in survey owned by women • % of total Tropical Livestock Units (TLU) under women's ownership • Average number of livestock owned by women per household
Income	• Annual farm and off farm income • % of total annual income managed by women (total and by source) • Cash income from livestock and livestock products • Contribution of livestock to total farm/household income • % of livestock income managed by women (total and by source)
Food Security	• Individual Dietary Diversity Score for female adult, male adult, female child under 5 and male child under 5 • Proportion of men, women, girls and boys consuming at least one animal source food per day • Number of months of adequate household food provisioning in

	male and female headed households
Labour Use in Livestock Systems	• Amount of labour used in livestock, by activity and gender
Access to Inputs, Services and Technologies	• % of households with access to a technology or input • % of women with access to different technologies or inputs • Women's decision-making on use of technology or inputs (% of households where women made the decision to use a specific technology or input) • % of households with savings in formal and informal savings mechanisms • % of women with savings in formal and informal savings mechanisms

The above outcome and impact areas and the indicators may be modified to suit the conditions prevalent in a particular livestock production system to measure the change.

Conclusion

Sustainable development in agriculture can only be achieved through optimum utilization of natural resources. Livestock development interventions must take into consideration the land and livestock ownership pattern. Client-oriented participatory research is needed in developing appropriate livestock technologies for women in order to identify production constraints and to develop techniques that reduce women's workloads while at the same time increasing their productivity. Such research should take into account women's roles and responsibilities, as well as their workload. The following issues should be considered in designing appropriate technologies for livestock production: (i) their implications for women's labour requirements and workloads; (ii) their suitability in terms of consumption preferences; (iii) their implications in terms of women's control over the means of production; (iv) their expansion and use of women's indigenous knowledge; (v) the participation of women in their trials; and (vi) the importance of incorporating women's physical, social and cultural assets when designing research activities.

Participation of women is essential for developing and promoting technical interventions. Women's self help groups should be encouraged to take up activities related to livestock production. This is often the only way for poor women to obtain sufficient resources (material, capital and labour) to initiate livelihood activities. The experiences suggest that there is need to focus equally on technology development and the enabling factors (availability and access to markets, credit, labour), which allows women to adopt new interventions. Providing support either in the form of funding or stock animals are good tools in starting the livelihood programme for vulnerable women, as it facilitate more effective utilization of unpaid family labour, more stable households and increased self-reliance. A favourable policy environment in terms of access to and control of productive and natural resources such as land, livestock, micro-credit, veterinary services and assured markets will have to be provided and socio-economic and technical constraints needs to be addressed in order to strengthen women's influence and social empowerment.

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IMPROVEMENT OF LIVELIHOOD SECURITY OF FARMWOMEN THROUGH DAIRY FARMING BASED INTEGRATED FARMING SYSTEM

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Dairy farming based integrated farming system (IFS) refers to integration of livestock especially dairy animals and crop production. In this system an inter-related set of enterprises is used so that the "waste" from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. IFS ensure that wastes from one form of agriculture become a resource for another form and ensure overall increase in productivity for the whole agricultural system. Livelihood security in farming system involves a range of on-farm and off-farm activities which together provide a variety of procurement strategies for food and cash. Population growth, urbanization and income growth are fuelling a substantial global increase in the demand for food while aggravating the competition between crops and livestock and influence livelihood security.

Women form the backbone of agriculture and play a significant role in agriculture and animal husbandry development. Successful dairy husbandry enterprise not only improves the socio-economic status of rural women, but also assures a sustained and assured means of income to supplement their income from the main enterprise. It does not require heavy capital investment as the farmers can start with the available non-descript cows which are hardy and can be maintained even by landless by procuring crop residues. Dairy farming based IFS does not demand heavy labour and hence the rural farm women can undertake the work without altering their present engagements. Dairy business provides good opportunity for women to develop this activity as an enterprise and ensures steady cash returns throughout the year. Apart from providing employment and income, dairy farming supply farmyard manure and biogas through utilization of agricultural by-products. Biogas reduces the dependence on wood for household fuel. Within this framework, an integrated crop-livestock farming system represents a key solution for enhancing livestock production and safeguarding the environment through prudent and efficient resource use which ensures an excellent nutrient recycling in an eco-friendly way.

Diversified versus integrated farming system

Diversified systems consist of components such as crops and livestock that coexist independently from each other. In this case, integrating crops and livestock serves primarily to minimize risk and not to recycle resources. In an integrated system, crops and livestock interact to create a synergy, with recycling allowing the maximum use of available resources. Crop residues can be used for animal feed, while livestock and livestock by-product production and processing can enhance agricultural productivity by intensifying nutrients that improve soil fertility, reducing the use of chemical fertilizers. A high integration of crops and livestock is often considered as a step forward, but small farmers need to have sufficient access to knowledge, assets and inputs to manage this system in a way that is economically and environmentally sustainable over the long term. An integrated farming system consists of a

range of resource-saving practices with integrated resource management that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment. However, technologies and management schemes that can enhance productivity need to be developed to upgrade conventional agriculture along with preserving the natural resource need to be strengthened.

Strategy to improve livelihood security of farm women through Dairy farming based Integrated farming system :

- **Animal breed:** The selection of breeds takes into account market requirements, feed availability, resistance to diseases and environmental conditions with due consideration of farm's structure & local situation.
- **Animal health: The health of dairy animals should be monitored through p**reventing the entry of diseases into the farm. Construction of boundaries/fencing, avoid direct contact of visitors with animals, taking bio security measures in place to minimise the risk of spread of disease within the farm and between other farms (transport cattle only in cleaned and disinfected vehicles, dispose fallen stock properly and contingency plan for an infectious disease outbreak etc), isolation of sick animals with contagious diseases and proper treatment with due care to avoid zoonotic diseases are some of the basic requisite for maintaining health of the herd.

Vaccination schedule for cattle and buffaloes in a dairy farm

Disease	**Animal**	**Vaccine**	**Dose**	**Immunity**	**Time of vaccination**
FMD (Foot and Mouth disease)	Cattle and Buffalo	Polyvalent FMD vaccine	3ml S/C	1 year	February and December
Haemorhagic Septicaemia (HS)	Cattle and Buffalo	HS vaccine	5ml S/C	6 months and 1 year	May - June
Black Quarter (B.Q)	Cattle and Buffalo	BQ vaccine	5ml S/C	6 months and 1 year	May - June
Anthrax	Cattle and Buffalo	Anthrax spore vaccine	1ml S/C	1 year	May - June
Brucellosis	Female cattle and buffalo calf aged 4-8 months only.	Brucella vaccine	2ml S/C	1 year	-
Theileriosis	Cattle and calves above 2 months of age	Theileriosis vaccine	3ml S/C	1 year	-
Rabies post bite vaccination	Cattle and buffalo	Rabies post bite vaccination	1ml S/C	1 year	0,3,7,14,28 and 90 days

- **Milking hygiene, milk storage and milk safety**

In order to harvest good quality milk, appropriate udder preparation for milking, consistent milking techniques, separation of milk from sick or treated animals and hygiene of

milking equipments, milkers and clean environment of milking premises must be ensured. Cooling of milk to the specified temperature and/or delivery to a processing plant in a specified time should be undertaken in time.

- **Feed and fodder resource management**

1. Agronomical management

Fodder production is a major component of the integrated farming system and efforts need to be made for increasing the forage production in a holistic approach of integrated resource management based on maintaining the fragile balance between productivity and conservation practices for ecological sustainability. Some of the scientific interventions for improving the productivity of forages are detailed as follows:

Introduction of legumes/grasses: Forage legumes are important because they enrich the N content of the soil and have a high nutritive value. Legumes can be grown in mixtures with grasses in grasslands. By introduction of legumes like Siratro *(Macroptelium atropurpureum), Stylosanthes hamata, S. scabra, Glycine javanica, Dolichos auxilaris, Desmodium spp and Centrosema pubescens* etc., the quantity as well as quality of herbage production can be substantially increased. Indigenous legumes such as clovers (*Trifolium pratens*, *T. repens*), *Medicago denticulata, Melilotus alba*, white clover, red clover have proved successful apart from Lucerne and berseem.

Cutting and grazing management: The response to cutting of a forage plant depends upon its seasonal yield of carbohydrate storage, its growth habit and extent of inflorescence development. Frequency of cutting also significantly influences the yield and quality of herbage produced. The areas with high temperatures may require larger interval and low intensity of cutting to build up sufficient carbohydrate storage for regrowth.

2. Silvi-horti pastoral management

The grass rangelands exhibited enormous gain in forage production over existing situation due to multi-tier silvipasture techniques amalgamated with an adaptable complementary plant species. It involves planting of multipurpose trees in the existing pastures/grazing lands or planting such trees on wasteland/denuded lands followed by sowing /planting of grasses and or legumes in between the inter-spaces of trees.

- Under alley cropping system, *Leucaena leucocephala* and even perennial pigeon pea etc. are pruned frequently to provide leaf fodder to get better crop production. For augmenting fodder availability, emphasis needs to be given to cultivated fodder crops on large area. Foliage of fodder trees could be fed to the livestock in mixture with crop residues and hay. Mixing of tree foliage with dry roughage improves their palatability and nutritive value.
- Forage production on terrace risers or bunds
  A non- competitive land use systems for forage production in the hills is to grow forage on terrace bunds and risers. Forage grasses/legumes/fodder trees grown on terrace risers and bunds arrest the nutrient loss in run off water under high rainfall conditions of this region. In this way, forage production is easier and cheaper as it requires less weeding, sprays, fewer inputs, gives quick, regular income (Dost, 2003).

3. Feeding of balanced ration to animals

Rural farmers usually feed homemade concentrate devoid of mineral mixture imbalanced with energy, protein, mineral and vitamins which adversely affect the health and productivity of the animals and hence the economic return. Preparation of balanced ration by incorporating locally available mixed food grains ensuring optimum proportion of macro and micronutrients certainly ameliorate the malnutrition problems of animals. The concentrate and roughage ratio is usually recommended at 40: 60 for milch animals and 1kg concentrate for every 2.5 kg milk production along with 1.5-2 kg of concentrate as maintenance ration is usually followed for dairy animals. Besides concentrate mixture, provision of 30-40kg of good quality green fodder along with 2-3 kg of dry roughage (straw/hay) is normally recommended for a cow yielding 5 kg milk per day.

Farm animals derive their mineral requirements mainly from feedstuffs offered to them as use of mineral mixtures to supplement diets is almost non-existent under the field condition. Keeping aside the economic constraints, there also exists lack of awareness regarding the positive impacts of mineral supplementation in terms of enhanced productivity. Moreover, recommendation of a mineral mixture of fixed composition for all over the country is also questionable, considering its vastness and varied agro geological conditions. Hence, area specific mineral mixture (2%) is used to be supplemented along with concentrate mixture in the animal's diet which is practical as well as cost effective.

4. Conservation of fodder resource

During the rainy season, green fodder may be in excess of need which can be effectively conserved for lean period. The poor quality roughages and agro industrial byproducts are mostly left or burnt in the field which can be effectively preserved for the scarcity period. The quantitative and qualitative deterioration in common grazing lands by indiscriminate grazing pressure and the lack of adoption of fodder production technologies and its preservation further deteriorates the forage resources. Therefore, conservation of forage resources with the principle of judicious utilization of existing resources to augment productive performance of animals is the need of the hour. Green fodders of conventional source can be conserved as silage and hay making.

Silage making: Silage is the preserved green fodder in succulent form under air tight conditions where acids produced by controlled anaerobic fermentation of carbohydrates. The objectives of ensiling are achievement of anaerobic conditions and to discourage the activities of undesirable micro organisms i.e. clostridia and enterobacteria allowing proliferation of desired spp. of lactobacilli which stabilize the acidic pH (<4.2) and restricts the growth of spore forming anaerobes and clostridia producing objectionable fermentation products (amines, ammonia, CO_2, butyric acid, acetic acid etc.). Good silage is yellowish-green in colour with a pleasant vinegar smell. The technique is more or less similar to that commonly employed in the preparation of pickles in home.

All the crops are suitable for silage making. However, excellent silage may be made from maize, sorghum, bajra and barely. Among the perennial grasses, hybrid napier grass, guinea grass, para grass, sudan grass and rhode grass are commonly used for silage making. Legumes like berseem, lucerne and cowpea are not suitable for silage making. Flowering to milk stage is recommended for making silage from cereal crops. Good quality silage can be

made when the dry matter of crop is 30-35%. Silage is made by compressing the chaffed green fodder in tight pits called silos. Many types of silos i.e. pit silo, tower silo, trench silo, bunker silo and bag silo etc. are usually followed for ensiling. One cubic meter of the silo can have 650 to 700kg settled silage. A silo pit of 3.0X2.5X2.0 meter (LxWxD) dimension is a convenient size for making silage for feeding five dairy animals at the rate of 20 kg silage per head per day for three months. Before filling, the sides should be plastered with mud and line with long stalks of dried fodder to prevent fodder coming into direct contact with earth. The green fodder are chaffed into small pieces (2.5 to 4.0 cm) with a chaff cutter and filled inside the silo compactly. In case the silage is to be prepared from leguminous fodders like berseem, lucerne or cowpea or immature grass rich in protein, the addition of carbohydrate like molassess (@4-5% of weight of fresh fodder) is essential. Before ensiling, crops should be wilted to 65 to 70 % of moisture to reduce seepage and leaching losses. Good silage has higher vitamin A content and better palatability than hay and other dry roughages. Cattle prefer silage to coarse, mature and less palatable green fodder.

Hay making : Hay making is the traditional method of drying and storing of high quality forage by reducing the moisture content to the level at which plant tissues are dead or dormant. The aim in hay making is to reduce the moisture content of green crop to a level low enough to inhibit the action of plant and microbial enzymes so that it can be safely stored without any deterioration. The moisture level in well cured hay should be below 15%. In most of the crops, early flowering stage having maximum nutrient contents is considered to be the best stage to harvest crop for hay making. Thin stemmed crops like berseem, lucerne, cowpea, soybean, oat and natural grasses are suitable for hay making. Good quality hay should be leafy, green colour with typical aroma of forage from which it was prepared and should be soft, pliable, free from dust, moulds, weeds and foreign materials.

Crop residues and agro industrial byproducts : The poor quality roughages, crop residues and agro industrial byproducts are used as a staple diet for ruminants in our country. The crop residues having relevance in ruminant feeding are jowar, bajra, maize stovers, wheat and paddy straw. These are highly fibrous in nature with low crude protein content. Most of the crop residues have more than 60% of DM in the form of cellulose and hemicellulose which are good source of energy (Jakhmola and Misra, 2000) for ruminants. But, their association with lignin form lingo cellulose complex which is more resistant for action by hydrolytic enzymes and rumen microbial enzymes and reduce the bioavailability of energy source (cellulose and hemicellulose) to animals. The products of digestion from such roughages are also considered to be poorly balanced for all productive purposes. Several methods have been developed in form of physical (chaffing, chopping, soaking, grinding, pelleting etc.), alkali treatment (sodium hydroxide, calcium hydroxide, urea etc.) and supplementation of trace minerals which improve the rumen fermentation pattern, digestibility and nutritive value of crop residues to enhance animal productive performance. Urea (4% level) is generally the most practical and often cheapest chemical available for treating crop residues which changes its physical nature and improve digestibility (ICAR, 1985).

Most of the agro industrial by products are invariably moderate source of energy and protein with high levels of acid insoluble ash, erratic levels of minerals. The presence of toxic

principles may not show apparent toxicity but may cause cumulative toxicity over a period of time and may adversely affect the health and production of animals. Therefore, suitable treatments are needed for removal of anti nutritional factors for efficient utilization of feed. Besides physical and chemical treatment, biotechnological tools through use of white rot and brown rot fungi also improve the nutritive value of crop residues and agro industrial byproducts (Sharma and Walli, 1992). They solubilize the lignocellulosic complex by secreting enzymes and synthesize amino acids resulting improvement in quality.

Compact feed block : The feeding value of crop residues and agro industrial byproducts can be improved if they are blended into complete feeds. Complete feeds with desired ratio of roughages, concentrate, molasses and other agro forest based non-conventional feeds including top feeds improve the feed palatability, voluntary DM intake, avoids refusal of unpalatable portion, reduces wastage, increase bulk density thereby reducing transportation cost. This feeding system not only ensures improved utilization of nutrient from non-conventional feed stuffs but also helps in developing low cost balanced feeds for ruminants especially the dairy animals suffering from scarcity of conventional feed and fodder. Compact feed blocks are found to be very nutritious, easily digestible, handy to transport and require comparatively lesser space for storage and are considered as readymade balanced ration for ruminants for the benefit of landless labourers, small and marginal farmers. The common formulation of standard compact feed block is wheat straw / cellulosic waste/ tree leaves – 55-60 %, concentrate mixture - 30-35 %, molasses - 10%, mineral mixture - 1% and salt - 0.5% (Singh and Singh, 2007).

- **Community-based extension approach : Need of the hour**

The government controlled extension system is unable to provide adequate technical support to livestock raisers. Hence livestock owners need to create a horizontal networking to have a platform to share their ideas and strategies for their overall upliftment. In order to provide green forage, year-round alternate landuse (Agroforestry) systems need to be developed on private or community lands in the vicinity of villages. The community lands, civil and panchayat lands, serve as potent source for grazing and hay production but do suffer from lack of management. "Every body's property is no one's responsibility", applies well to these areas. In the absence of any effective and efficient management organization to enforce mutual agreements, it is difficult to control the livestock population, encroachment for various purposes and indiscriminate grazing. The active participation of inhabitants can only achieve the desired goals. Appropriate production technology, availability of quality seeds of high yielding local and improved species is invariably a limiting factor. Therefore, after the selection of grass, legume and fodder tree/ shrub species, priority should be given to seed production and distribution programmes. Management of natural forest by the community could be improved substantially, ensuring ecological stability and reducing biotic pressure on existing resources.

- **Role of government/NGOs for feminization of dairy sector**

It is hightime for the feminization of dairy. The solution lays in the formation of village level women self help groups. United efforts of these SHGs, Govt and NGOs are required to fight against the constraints in each aspect of dairy farming practices. Government and milk federation must take corrective action for formation of village level cooperative societies, so

that farmers get proper market for their milk with reasonable cost. In addition to this dairy development department must conduct skill-oriented long term training programs for production of value added milk products, so that they get more prices, from their raw material (milk). In addition to this, dairy development department must conduct skilled oriented long term training for production of value added milk products, so that they get more prices from their raw material (milk). Bank of local area should encourage the rural women for dairy business by easily availability of loans with reasonable interest or providing subsidies to dairy farmers by the dairy development department for promoting dairy business. The animal husbandry department should conduct vaccination/ deworming/ health care programme with the help of scientists to improve knowledge among farmers about importance of schedule vaccination, deforming and health care of dairy animals and also conduct training programme for milk producers of study area about better management of milch animals coupled with importance and techniques of clean milk production. Government should take proper action for controlling the high charges taken by particularly government veterinary doctor/staff for performing medical assistance. It is necessary that government as well as NGOs must take initiative for proper functioning of AI centres. Veterinary and animal husbandry officers, district dairy development officers and scientists must aware the farmers regarding scientific feeding practices to dairy animals through conducting training. Keeping in view of above facts, there is need from government or other dairy development agencies to make available all essential infrastructures along with proper supply of technical inputs and services at the same time. If all suggestive measures taken up by government then only the study area will get momentum in feminization of dairy sector.

Conclusion

Livestock development especially dairying is most likely to be effective as 'a pathway out of poverty for rural women and enable them to compete with commercial producers provided: a) organisations planning and implementing livestock development programmes are sensitive towards the needs, resources, production systems and perceptions of the families; b) livestock development is a part of 'integrated development programme' that incorporates natural resource management and development of producers organisations to provide credit and services and help to improve efficiency and quality of livestock produce; c) technologies, recommendations and services are developed on the basis of 'needs assessment' and are pre-tested for being beneficial to the resource poor farmer; d) livestock extension is strengthened and targeted to the underprivileged families particularly the women.

There is a vast scope to improve the household profitability by judiciously utilizing family labour using innovative practices and ensuring multiple uses of various household resources. This is possible through women's empowerment through location specific trainings and critical need based support. Addition of organic residues in the form of animal and plant wastes could also help in improving the soil-health and thereby productivity over a longer period of time with lesser environmental hazards. Integrated farming systems offer unique opportunities for maintaining and extending biodiversity. The emphasis in such systems is on optimizing resource utilization rather than maximization of individual elements in the system. The well being of poor farmers can be improved by bringing together the experiences and efforts of

farmers, scientists, researchers, and students in different countries with similar eco-sociological circumstances i.e. through Integrated Farming System. The highly productive, economically profitable, environment friendly and sustainable successful models of farming systems can pave way to attract the farm women to work in rural areas even from urban areas having links to the rural system. This can reverse the process of trans-migration and also may promote agro-eco tourism.

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FAMILY POULTRY: A VIABLE OPTION FOR POVERTY ALLEVIATION & GENDER EQUITY IN INDIA

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India is home to the fourth largest agriculture sector in the world with an estimated 180 million hectares of farmland. In India traditional agriculture is still dominant as many farmers depend on livestock in crop production, for manure as fertilizers, and the use animal powered ploughs. According to 2011 statistics, the average farm in India is about 1.5 acres, minuscule when compared the average of 50 hectares in France and or 178 hectares in United States and 273 hectares in Canada. In rural India, the percentage of women who depend on agriculture for their livelihood is as high as 84%. Women make up about 33% of cultivators and about 47% percent of agricultural labourers. These statistics do not account for work in livestock, fisheries and various other ancillary forms of food production in the country. India still faces a big challenge in job creation and maintenance of food security and women's role in farming is still inadequately acknowledged. It is estimated that 78% of India's economically active women are involved in agriculture. Across the poor farming communities care of animals is the women's domain, but not in the rich families. Rural poultry sector contributes nearly 21% of the national egg production in India and is the most neglected one. Poultry production in rural/backyard areas is one promising strategy to enhance the nutritional and economic conditions of population in these areas and women empowerment. In order to meet the rural demand for poultry eggs and meat it is imperative that production for the masses should catered by the mass scale adoption of poultry farming in rural areas using low input cost technologies.

Current scenario

Poultry industry has witnessed a phenomenal growth and transformed itself from the traditional backyard venture to a dynamic commercial agri-based industry during the last 3 decades. The development is not only in size but also in productivity, sophistication and quality. The constant efforts in up-gradation, modification and application of new technologies paved the way for the multifold and multifaceted growth in poultry and allied sectors. The development of high yielding layer (>320 eggs) and broiler (2.4-2.6 kg at 6 wks) varieties together with standardized package of practices on nutrition, housing, management and disease control have contributed to spectacular growth rates in egg (4-6% per annum) and poultry meat production (8-12% per annum) in India. The annual per capita availability also increased to 58 eggs and 3.2kg of meat, consistently with increase in productivity. However, it is far below the recommended level of consumption of 180 eggs and 10.8 kg poultry meat per person per annum by Nutritional advisory committee.

Non-availability of poultry products and low purchasing power of the rural people devoid them of access to the highly nutritious products like egg and meat, thereby, resulting in malnutrition. Free range and small scale semi-commercial back-yard poultry production can be advantageously promoted in rural areas, as the large commercial poultry production continues

to be concentrated in urban and peri - urban locations. It can be used as a powerful tool for alleviation of rural poverty, eradication of malnutrition and creation of gainful employment in vast rural areas. Adopting small scale poultry farming in backyards of rural households will enhance the nutritional and economic conditions of these people.

Why family poultry production?

Spectacular growth has been achieved in commercial poultry sectors but the rural poultry sector remained unchanged. Chicken population in rural areas increased marginally from 63 million to 75 million during the past 40 years. The contribution of rural poultry to egg basket of India is about 21%. India has nearly 70% of its population living in rural areas. However, in the present scenario most of the commercial poultry production is concentrated in urban and peri - urban areas. Just 25% population living in urban areas consumes about 75-80 % of eggs and poultry meat. The incidence of protein deficiency among the susceptible groups like children, women, pregnant mothers and aged people can be alleviated by adopting small scale poultry farming in back yards of rural households. It has been reported that 75% of eggs and meat produced in Africa and 50% in south Asian countries is derived from traditional backyard poultry production. About 70% of the total eggs in China come from rural poultry production. Rural poultry keeping can be used to reduce poverty among women and children in rural areas. By increasing women's income, poultry farming also enhances women's social status and decision making power in the household. Therefore, the need of the hour is to promote free range and backyard poultry farming in rural, tribal and underdeveloped areas of the country.

Gender equity through poultry production

Livestock and Poultry production in the rural areas is generally considered a key asset for rural livelihoods. It offers advantages over other agricultural sectors and is an entry point for promoting gender balance in rural areas. This is because all household members have access to livestock and poultry and are involved in production, processing and marketing of these products. Rural women traditionally play an important role in poultry sector and are often in control of the whole process from feeding to marketing, which is not the case in production systems for other livestock species. Poultry is easy to manage, requires few external inputs, and enjoys good market demand and prices. Rural poultry keeping can be used to reduce poverty among women and children in rural areas. By increasing women's income, poultry farming also enhances women's social status and decision making power in the household.

The role of family poultry in poverty alleviation, food security and the promotion of gender equality in developing countries are well documented. Family poultry production represents an appropriate system to contribute to feeding the fast growing human populations and to provide income to poor small farmers, especially women. It makes good use of locally available resources, requiring low inputs. Though generally considered secondary to other agricultural activities by smallholder farmers, poultry production makes an important contribution to supplying local populations with additional income and high quality protein. Poultry products can be sold or bartered to meet essential family needs such as medicine, clothes and school fees. Village chickens are active in pest control, provide manure, are required for special festivals and are essential for many traditional ceremonies

Prospects of Family Poultry Farming

- Family poultry is easy to manage and handle.
- It needs minimal use of land, labor and capital. It involves less & there is higher demand and higher price for eggs and birds of native fowl
- Family poultry plays a significant role in the cultural life of rural people as a gift to visitors and relatives, as starting capital to youths and newly married maidens, as sacrificial offerings in traditional worship, as a potential source of employment and easy source of income for small scale farmers.
- Family poultry requires little intervention in rearing, the major intervention is in the areas of feed and water supplementation, over night housing and to a much lesser degree in health management.
- It can easily integrate with other agriculture, aquaculture and livestock farming.
- It can contribute to the village economy.
- The most important is women in rural areas can operate family poultry with maximum involvement.

Chicken varieties suitable for family poultry farming

Having realized the importance of rural poultry farming in India, several research institutes across the country have developed different varieties (Table 1). These are the varieties are now effectively raised in different parts of the country by the rural farmers. These birds were selected based on growth rate, immune-competence egg production and plumage colour. These birds are able to thrive in adverse climatic conditions under free range/ semi-intensive farming in India.

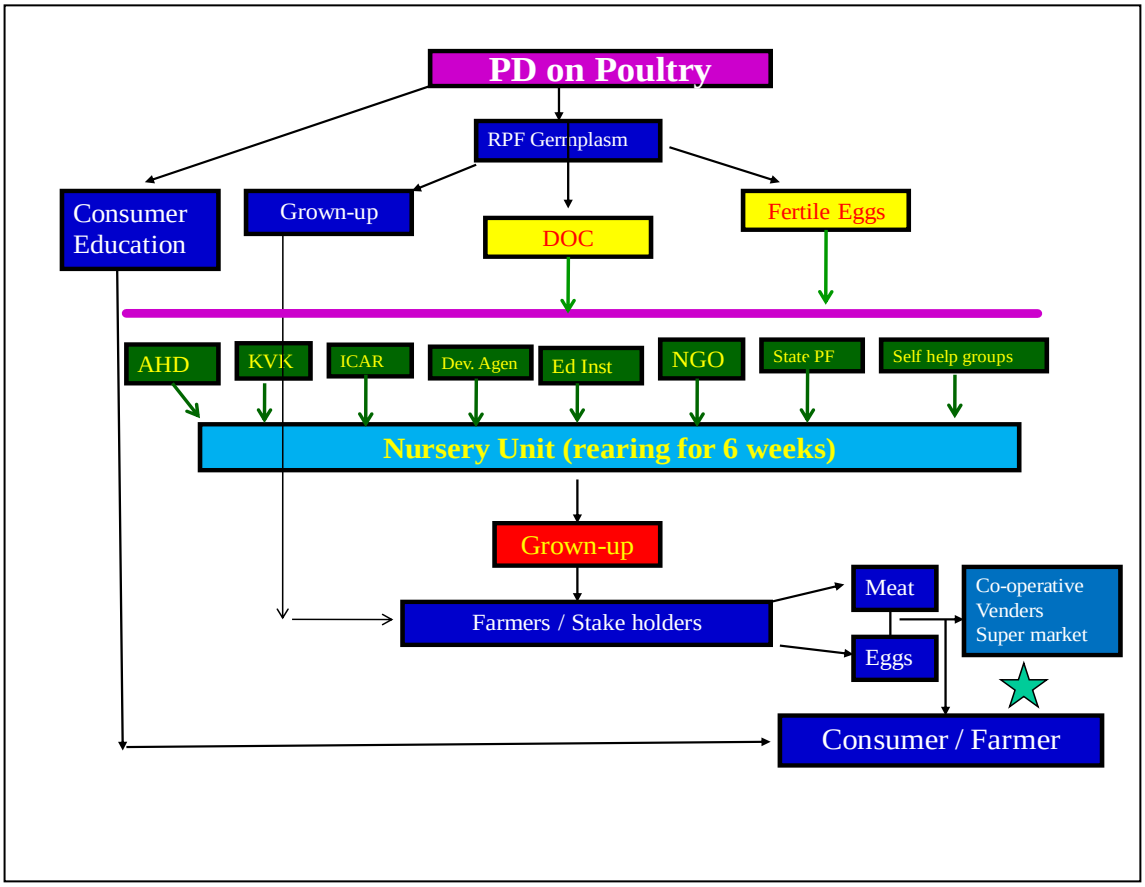
Table 1 Birds developed for Rural Poultry Production

Variety	Type	Developing agency
Vanaraja	Dual	DPR, Hyderabad
Gramapriya	Egg	DPR, Hyderabad
Nitishree	Dual	DPR, Hyderabad
Giriraja	Dual	KVAFSU, Bangalore
Girirani	Egg	KVAFSU, Bangalore
Krishna J	Egg	JNKVV, Jabalpur
Nandanam 99	Egg	TANUVAS, Chennai
Gramalakshmi	Egg	KAU, Kerala
Kalinga Brown	Egg	CPDO, Bhubaneswar
CARI Nirbeek	Egg	CARI, Izatnagar
CARI Shama	Egg	CARI, Izatnagar
Upcari	Dual	CARI, Izatnagar
Hitcari	Dual	CARI, Izatnagar

While going for rural poultry production, it is essential to understand the local production system, their limitations and opportunity, the circumstances under which such traditional system came into existence and how they can be improved further. The focal points for family / rural poultry production is adoption of appropriate technology, proper utilization of locally

available resources, proper health management, training of farmers and organized marketing system.

The ICAR- Directorate of Poultry Research, Hyderabad where the author had an experience of working 18 long years is one of the pioneer institutes under government sector for supply of poultry birds (fertile eggs, both parents and day old chicks) for rural poultry farming. The institute has developed three promising crosses for rural poultry farming which is mentioned in Table1. The commercial day old chicks are being supplied to farmers through governmental and non governmental agencies which rear the chicks' upto 4 weeks of age under standard management conditions and then they distributed to the farmers. The supply chain model for propagation of germplasm is one of the successful models and depicted here under.



Based on the experience of the author an economic analysis is carried out for Vanaraja birds based on the quantity of natural food base available, body weight and health of the bird for input and on the basis of productivity and body weight of bird for output. The analysis is for 12 weeks for male birds of Vanaraja and the layers are kept for complete laying cycle of 72 weeks of age. The input cost includes price of the chick, feed health etc, upto 4-6 weeks of age there

after the recommended mode of rearing is free range without any feed supplementation. Additional feed supplementation is optional which may increase the performance of the birds. The input cost growers and layers include medication and additional feed supplementation (optional) under the free range conditions. The farmer can earn a net profit of about Rs. 100 /bird on males and 500/bird on female birds in by rearing improved chicken varieties. A unit of 20 birds with 15 females and 5 males is ideal and viable for providing additional income for the family which will improve the livelihood status of the farmer.

Table 2. **Economics of Vanaraja bird under free range conditions per bird**

Input			Out-put		
Sex	Age of the bird	Cost (Rs)*	Particulars/details of the bird	Receipt (Rs)	Profit (Rs)
Male	12wk	100	Bird at 12wks (1.5-1.8 kg) @ Rs. 120/kg	180-240	80-140
Female	72wk	225	Eggs: 100-110 @ Rs. 3/egg Birds: 3.0 kg @ Rs. 80 kg Total	300-330 240 540-570	315-355
Total profit from a pair of birds		325		720-810	395-485

*Includes cost of day old chick, feed, medicines and healthcare etc.

Conclusions

The poultry production in India continues to exhibit spectacular growth in spite of several challenges encountered over the years. Adoption of small scale poultry farming in backyards of rural households will enhance the nutritional and economic status of the rural people. The role that women play in poultry production and in rural development needs to be supported by adequate policies and be addressed by policy makers and planners. The authors feel that if properly implemented, family poultry production will definitely alleviate poverty and ensure women empowerment in this country.

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DUCK REARING IN VARIOUS IFS MODELS: A POTENTIAL OPTION FOR WOMEN EMPOWERMENT AND LIVELIHOOD SECURITY

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The importance of water for the mankind in 21st century, is beyond ordinary debate, for a multitude of reasons. It is increasingly being essential to conserve every drop of ground water for sustaining the survival of humanity, as threat of its wastage/loss could portend a disaster for everybody. Therefore, scientific community has a responsibility to ensure judicious use of all non-saline available water, so that: unit food-production per unit- water consumption is enhanced and optimized. Accordingly, all scientific-agricultural technologies employing water should invariably employ novelties, aimed at enhancing output of crops and animal husbandry and fishes.

Fitting to the above theme, come the integrated Duck-fish or the Duck-fish-horticulture; Duck-fish-agriculture concepts, which have become very popular across many parts of world. Especially, in the Asian and South east Asian nations, the Duck cum Fish integration is catching up with most farmers, who are increasingly convinced now that these systems not only offer efficient usage of water, but also enhanced productivity in terms of quality and quantity. The latter system: Duck-Fish-horticulture system, is even more appropriate for adoption in Indian conditions, particularly in the coastal states like Orissa, West Bengal, Kerala, Andhrapradesh etc.. Its rationale is simple, which shows how from unit land, unit use of water, and from unit investment the output gets significantly larger in size. Let us then look at the merit of all the available models of integrated farming which can be offered for adoption to fish and duck entrepreneurs. As such, the public also needs to be educated, how from the same traditional water body, more output can be harvested with a simple scientific intervention, by using the Ducks as an efficient layer poultry, so that the productivity of the pond could be near double interms of profit and quality protein output.

Why consider Ducks in an water based integrated agricultural system?

The Ducks (*Anas platyrhynchos*) which constitute nearly 4 to 5% of the total domesticated poultry of India (Animal Husbandry Census, 2012) are endowed with equal or better in production abilities compared to chickens. In our country, in many ways, duck production emerges as a better alternate to chicken production which can contribute substantially to food, income, employment and livelihood security of the masses. However, duck production in India, is still in unorganized form which is carried out in limited scale. Marshy lands and adverse climatic conditions of coastal areas which are not suitable for chicken production and animal husbandry, as a whole, can be effectively utilized for duck production. Ducks usually grow well with locally-available feedstuff and less manpower is needed to raise them using meagrely-equipped facilities. In rural areas, the women folk (including elderly women) and aged people (in age group of 50 to 70 too) can easily be persuaded to manage production of ducks. Small-

scale farms remain enormously important because of large number of rural households they support. They also make a useful contribution to food-supply chain of urban populations using recycled resources effectively. While the global Duck population is around 1242 million (1185.74), India's duck population is just 26 million in number (FAOSTAT, 2013). With this germplasm-base, India produces around 38 million tonnes of duck meat and 1.5 billion numbers of duck-eggs annually. In India, ducks are concentrated in coastal regions, especially southern and north-eastern states.

Duck production systems suiting to various farming communities

There are many prevalent Duck farming systems which can be adopted in our country, whose merits can be briefly discussed below.

A. Foraging or free range System

It is a one of the oldest known system for duck-rearing which utilizes the natural resources through foraging mainly in paddy or crop (grain)-fields after harvest. This system of management, however, is a low input technology. As such, foraging the ducks in various possible ecosystems e.g. ponds, rivers, reservoirs, canals, lakes, back-water, miscellanious water-bodies and post-harvest paddy fields is advantageous in many ways.

B. Backyard Rearing System

This backyard duck husbandry system is primarily meant for small and rural farmers. Here, the ducks get mingled with chickens and other avian species, throughout the area. They are mainly confined to the farm premises, but may roam around the village. Under this, Duck needs little care and small supplementary feedings, where they are usually kept enclosed near to farmer's house, at night. Flock-size under this system could range from 5 to 20 ducks. While, during day-time, the ducks are free to roam outside in search of feed, they are brought inside at night, by putting some extra feed in the night-shelters and nests (usually of earthen pots or wooded partitions) for laying eggs. An advantage of this system is that: ducks go out to harvest their feed themselves. Although the performance under this backyard-system is generally lower than that of intensive systems, its hallmark of low or no-cost feed can compensate the disadvantage of lower performances.

Figure: *Ducks besides a fish pond in traditional Duck-fish integration system.*

As such, the native ducks propagated by CARI, RC are considered best for such a system, as these are hardy in nature and can manage their own nutritional needs, with minimal supplemental feeding.

C. Duck-Rice Integrated System

The duck-rice integrated system has been practised in our country since long. Although this duck-raising method accounts for a relatively limited volume of the duck industry, it has attracted more attention in recent years, owing to its connection to organic farming. The rice-duck system provides a measure to benefit both the paddy fields and ducks. Insects, snails, tadpoles, earthworms and weeds constitute the major food sources for ducks, and in turn, the duck's excreta become the manure for the rice/paddy. Water stirring caused by the ducks' activities inhibits the growth of weeds through photosynthesis reduction when the water becomes turbid. Their activities also enhance the rice root, stalk and leaf development, thereby accelerating rice's growth. In addition, duck's active grazing in such a system can directly lead to reduced need for pesticides and fertilizers, thereby benefitting the ecological system. In usual practice, an optimum population of 200-300 ducks/ hectare of paddy field can be recommended to obtain a good rice and duck harvest, in combination. This number can be adjusted based on the input feed-sources (weeds, insect and snails) which are available in paddy fields. The other points that need consideration in this practice could be as follows. (a). Ducklings at 3-4 weeks of age are introduced into the field after transplanted seedlings become rooted, and before introduction they must be trained to get into the habit of flocking and oiling their feathers. (b) A protective fence is however, required to protect ducks from predators such as dogs, wild-cats and foxes and also to prevent them from escaping. (c) Water, by planning, should be kept at a level in which ducks can both swim and walk.

Figure: *Ducks in growing-paddy field in Duck-rice integration system.*

Along with laying ducks, the table ducks (ducks for meat) can be reared in the rice fields post-harvest. Generally farmers purchase ducklings from the hatcheries, 3 to 4 weeks before the rice harvest. The ducks usually selected for this system, are of native meat type, local meat type and or crossbred local x exotic varieties. After 3 weeks of age when the ducklings can consume whole rice grains, they are permitted to enter the newly harvested rice fields. Here, they forage

the whole day on leftover or fallen rice grains, insects, shellfishes, small-frog, fish, and water plants. In the late afternoon, they can be moved back to pens or sheds near the household until next morning. The ducks raised in this system, are usually finished at 2.5-3 months of age, when they achieve live weights of 1.6-2.0kg, especially for crossbred varieties. Now-a-days, since mainly high yielding varieties of rice are planted and harvested within a short period, only a limited time can be available for the duck-flocks to scavenge. As the result, this traditional system of post-harvest duck rearing has limited feasibility and is less in vogue.

D. Duck-Fish Integrated System

This system of duck rearing is rather straight-forward system of mixed farming, which happens to be the most popular of the integration systems.

Benefits of fish- cum- duck farming

The duck-fish integration system is usually employed by many farmers, in such areas, where the underground water-table is usually good and standing water is available in the water-body, during most parts of the year. In this, the ducks have access to water for drinking and heat-stress alleviation. Ducks, in this system, only need shelter for resting. Generally speaking, a minimum area of 0.5 square meter per duck is required. Ducks can be housed in a variety of ways. A pen can either be built which floats on the water, or resting on stilts above the water or even can be fixed on bank of the pond.

Regarding the advantages of this system, unlike other domesticated poultry, ducks can alone be considered for this system as an active entity, since the ducks are basically waterfowls, which can enter into water-bodies and utilize the system symbiotically. Here, introduction of layer or dual-type Ducks are usually made into the water surface, say a fish-pond in a multi-carping project, for using it as a duck- grazing area. Ducks can then ensure a full utilization of the pond's water in complimentary terms to the fish production. Fish ponds then work as an excellent environment where ducks help prevent them from parasitic infection. Ducks can feed on predators and can help fingerlings to grow better. As a result, it can reduce the demand for protein to 2 - 3% in duck feeds. Duck droppings go directly into water providing essential nutrients to increase the biomass of natural food organisms. The daily waste of duck feed (~ 20 - 30 gm/duck) serves as fish feed in ponds or as manure, resulting in higher fish yield.

Manuring from the ducks get homogeneously distributed without any heaping of duck droppings. Further, by virtue of the digging action of ducks in search of benthos, the nutritional elements of soil get diffused in water and promote plankton production. Ducks also serve as bio aerators, as they swim, play and chase in the pond. This manoeuvring of the surface of pond greatly facilitates aeration. The feed efficiency and body weight of ducks too increase and the spilt feeds could be effectively utilised by fishes. As such, the survival of ducks raised in fish ponds increases by 3.5 % due to clean and healthier environments of fish ponds. As a conservative estimate, duck droppings and left over feeds of each duck can increase the output of fish to 37.5 Kg/ha. Ducks aid to keep aquatic plants in check. As a major advantage of this system, no additional land is required for duckery activities. So, from such a combined

Endeavour, It results in high production of fish, duck eggs and duck meat per unit time and water area. It ensures high profit through less unit investment.

In order to ensure that manure supply remains constant, it is best to keep different (duck) age groups at the same time. Once the fish has been harvested the pond will be empty of fish. When one can think of growing a batch of small fish before the old stock is harvested. As a long term policy, after 4 to 5 years of rearing, the ponds need cleaning. The manure remaining in the pond can be taken out and be used for crops or added to compost. Alternatively, the manure in the pond can be utilized by growing some crops in the dry ponds. From the fish production angles, it is however, difficult to prescribe the exact numbers of fish and ducks because the numbers are dependent on many other factors. Most fish species under this system take about 6 months to reach market weight. In such system, the stocking rates could vary from 6000 fingerlings/ha and a species ratio of 40 % surface feeders, 20% of column feeders, 30% bottom feeders and 10-20% weedy feeders are preferred for high fish yields. Mixed culture of only Indian major carps can be taken up with a species ratio of 40% surface, 30% column and 30% bottom feeders.

Figure: Ducks in the most popular Fish based integration system
Left: A Duck-Fish-horticulture integration system.(Courtesy, ICAR-CIFA, Bhubaneswar).
Right: Duck cum fish integration system in backwater of Kerala (Alappuzha)

As a major advantage of the Integrated Duck - fish farming, not only it increases fish production but also cuts down the cost of fish culture operations considerably. Where average cost of production in conventional poly-culture with supplemental feeding and inorganic fertilization was Rs. 2.93/kg in Eastern India (Anon, 1976), researchers have recorded the cost of production nearing Rs. 1.61/kg from a duck-fish integrated farming system.

Conclusion

The 21st century's agriculture has got to be a high-tech and resource efficient venture, for the sustenance of the mankind. Envisaging the increasing scarcity of water, in the coming decades, the input-output auditing of water based agriculture vis a vis the efficiency and importance of every agri output has to be ascertained. In this backdrop, the Duck cum Fish and Duck cum water-based enterprises are considered important. This system not only is investment efficient but also, ensures maximum agricultural output per unit water investment. In this system, inter alia, many benefits accruable from raising of ducks on fish ponds, it promotes fish growth, increases fish yields and eliminates pollution problems that might otherwise be caused from excreta, in a duck pen. Fish-duck integration also promotes the recycling of nutrients in the pond ecosystem. In shallow pond areas, a duck usually dips its head to the pond bottom and turns the silt to search for benthos. Due to this digging action, nutritional elements deposited in the pond humus gets released. Further, the ducks also act as pond aerators through their swimming, playing and chasing by disturbing the surface of pond and thereby contribute to the natural oxygenation of water bodies, and making them conducive for higher fish production. Therefore, in summary, the duck-fish integration system has great potential for water-efficient animal husbandry and agriculture/pisciculture.

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FRESHWATER AQUACULTURE FOR FOOD AND NUTRITION SECURITY

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Fish forms an important component of the animal protein supplement of Indian food. Being the cheapest and the safest animal protein source, popularity of fish has increased in the country. Fish is consumed by 55-60% of Indians. Increase in popularity of fish has prompted enormous growth of the aquaculture Industry in the country. As per the available data of 2013-14. India produced 6.58 MMT of fish of which the inland sector produced around 6.14 MMT. While inland production includes both inland capture and aquaculture production, the later contributes 80-85%. Over the years, the changes have been brought in the methods of fish farming. Species spectrum in the culture system has been increased. Culture of fast growing native fish species has been promoted. The aquaculture industry has come up with varied fish farming methods suiting to the need of industrial aquaculture as well as rural fish farming. Today, aquaculture has also been recognised as an important avenue for rural food and nutritional security.

Freshwater aquaculture in India mostly involves polyculture of three Indian major carps, viz., catla (*Catla catla* Hamilton), rohu (*Labeo rohita* Hamilton) and mrigal (*Cirrhinus mrigala* Hamilton), or sometimes with the three exotic carps, viz., silver carp (*Hypophthalmichthys molitrix*), grass carp, (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*). More than 83% of the total freshwater aquaculture production (≈ 5.1 million tonnes/yr) in the country is contributed by the carp groups for which carp culture is considered almost synonymous with the freshwater aquaculture. Of late, the necessity to include more species of promise into the freshwater aquaculture systems in the country has been emphasized time and again. Fortunately, our country is blessed with wide species diversity including many promising cultivable species. Attempts on species diversification in recent years have shown enough possibilities for incorporation of some medium and minor carps *viz*., *Labeo calbasu*, *L. fimbriatus, L. gonius, L. bata, Puntius gonionotus, P. sarana* etc. in the major carp based polyculture systems due to their reasonable growth, consumer preference and price they command in the market. The country also has a rich resource of many small indigenous fish species (SIFS) which are available in almost all types of water bodies and are important for nutritional security. The SIFS are popular among the fish eaters because of their taste and richness in the nutrients. Culture of such species in carp ponds and rice fields has proven its potential in contributing to the nutritional security of the poor people in Bangladesh. Such species are gradually becoming popular among the fish farmers of India. Besides carps, there are many other species such as freshwater prawn (*Macrobrachium rosenbergii* and *M. malcolmsonii*), air-breathing catfishes (*Clarias batrachus, Heteropneustes fossilis, Pangasionodon hypophthalmus, Pangasius pangasius, Ompok spp.*), snakeheads or murrels (Channa striatus, Channa marulius) and freshwater pearls mussel (*Lamellidens marginalis*) have also attracted considerable attention of the aquaculturist, offering scope for diversifying their culture system into more rewarding farming systems.

Freshwater aquaculture in general offers three types of opportunities:- (i) Induced breeding and seed production of important species, (ii) Seed rearing activity and (iii) Grow-out fish farming, with sub-division of each activity as per species and different life stages of the fish. Unlike earlier years, each of the activity has been able to provide scope of round the year activity which has ensured adopting each specialised activity as full time profession. For example, successful off season breeding and extension of breeding season has stretched the hatchery activity throughout the year. Similarly demand for fish seed throughout the year has helped in making seed rearing a full time profession. Further, the wide range of input dependent fish production (2-15 t/ha) through fish farming offers scope to adopt the activity by marginal to commercial farmers depending on their investment capacity as well the kind of water body.

In the following pages, information has been provided on the above activities for carps, since this group form the mainstay of aquaculture in the country. For other species like catfish, prawn and murrel, though pond management and broodstock management and feeding etc, are more or less similar, certain species specific activities are essential for induced breeding and seed production. However, discussed here the details of activity for carps and barbs.

1. Induced breeding and seed production of carps in hatchery

The technology of induced breeding aimed at producing quality seed starts with the broodstock management till the production of spawn in the hatchery. For performing these activities, a hatchery should have the facilities of broodstock raising pond and the hatchery proper with its components like spawning pool, hatching pool, overhead tank, and water supply and drainage systems.

The induced breeding activity for the Indian major carps, minor carps and barbs is almost similar with certain modification for the barb species which are also discussed. Two to three years of healthy fishes are collected and maintained in the broodstock ponds at least 3-4 months before breeding season at the density 1500-2000 kg/ha. They are provided with balanced diet @ 1-2% of the body weight daily. Water replenishment of 20-25% is advisable in the pond in every month. The matured males at oozing condition and females with buldged abdomen and protruding vent are collected from the broodstock pond for breeding. The males and females are kept in the breeding pool under shower separately in two previously fixed breeding hapas, at male and female ratio of 1:1 by number and approximately 1:1 by weight. When pituitary extract is used as inducing agent, females are given two injections, first dose @ 3-6 mg/kg followed by the second @ 8-12 mg/kg at 6 hours intervals, while males are given single injection of 3-6 mg/kg at the time of second injection to the female. However, in case of using synthetic hormones like Ovaprim, Ovatide or Wova-FH, the injection is given only once to both males (0.2-0.3 ml/kg) and females (0.3-0.5 ml/kg). The injected brooders are released in the pool for spawning. In case of breeding *Puntius gonionotus* (silver barb) in eco-hatchery condition, since the hatchlings are extremely small measuring only 3 mm in length, a finer mesh cloth is required for the central screen of the incubation tank to prevent escape of hatchling. Similarly, *P. sarana* was observed to be a batch spawner releasing eggs in weed mass. While provision of aquatic weed in bunches in the breeding tank facilitates its spawning, the strands

and leaf surface of weed such as *Hydrilla* acts as a substratum for attaching the typical egg of the species which is provided with a stalk for attachment.

The broods are kept in the pool under shower before and after hormone injection. Water current is allowed in the pool before one hour of estimated spawning time, which triggers the spawning activity. The response time in all these species varies between 8-11 hours at water temperature 27-28°C. Once spawning starts, effective spawning occurs within 1-1.5 hours from the spawning initiation. Fertilised eggs collected from the breeding tank are incubated in the circular incubation tank. Larvae hatch out after an incubation period of 15 hours at 27-30°C temperature. The hatched larva called hatchlings are kept in the incubation tank for another 60-62 hours during which yolk absorption completes and the larvae develop to the tiny fish called spawn. The spawn from the incubation chamber can be collected by cotton hapa or through the outlet of the pool on a water cushion in the spawn collection chamber. The pool is cleaned with 5 ppm $KMnO_4$ for the next operation.

The carp spawn can be transported to long distance in oxygen filled polythene bags. The density of spawn depends on the duration of transport which generally range between 25,000-50,000/bag with 6 litre of water. Short distance transfer, however, may be done by aluminium containers.

2. Seed rearing of carps

Seed of carp generally refers to two life stages such as fry and fingerling. The spawn collected from hatchery are further reared in well prepared nursery pond for 15-20 days to raise them to 1 inch size which is called fry. The fry is further reared in the rearing pond for a period of two and half to three months when it reached about 4 inch size which is called fingerlings. The details of the procedures are discussed below.

2.1 Production of carp fry

Generally small ponds of 0.01-0.1 ha size were considered ideal for spawn rearing of carp fry. However, higher growth and survival of the fry have been observed in relatively bigger ponds up to 0.4 ha size. Rearing of spawn of carps is carried out mostly with monoculture. Availability of suitable natural feed in the nursery pond is the most critical factor for the delicate transition phase of yolk nourishment to commencement of natural feeding. Suitable ecological conditions also play a great role for the survival of these spawn. Such environmental condition is ensured following a series of activities of pre-stocking pond preparation prior to seed stocking that includes aquatic weed clearance, Eradication of predatory and weed fishes, manure application, liming, inorganic fertilisation, aquatic insect control, etc.

Ponds that dry up in summer or could be easily and economically drained present least problems. But perennial ponds if not managed properly, often gets infested with several types of aquatic weeds, which are floating, submerged, emergent and marginal in nature. These aquatic weeds poses several problems as they absorb nutrients arresting pond productivity, harbouring predatory and weed fishes/insects, hindering free movement of fish and netting operations. Although a wide range of manual, mechanical, chemical and biological methods available for control of these weeds, generally the manual method is commonly advocated for

weed clearance because of their smaller size and no time requirement for detoxification as in herbicide use.

Presence of predatory and weed-fishes in the ponds severely affect the seed survival through devouring on the stocked seed as well as competing with them for space and oxygen. While the commonly found predatory fishes in fish ponds are murrels, gobi, magur, singhi, pabda, *Wallago*, etc., the weed-fishes include *Puntius*, *Barbus, Oxygaster, Anabas, Amblypharyngodon, Colisa*, etc. Dewatering followed by sun drying the pond is the most effective methods adopted for eradication of these fishes. Other methods used includes

(i) application of mahua oil cake @ 2,500 kg/ha-m three weeks before seed stocking: besides acting as pesticide, it also serves as organic manure after decomposition.
(ii) application of commercial bleaching powder (30% chlorine) @350 kg/ha-m of water (approximately 10 mg/l chlorine)
(iii) Alternatively, application of urea @100 kg/ha-m followed by commercial bleaching powder @175 kg/ha-m after 18-24 hours is also effectively controls these fishes.

Generally soil with slightly acidic to neutral pH (6.5-7.0) is considered productive, while low pH is always associated with low productivity. Therefore, amendment of pond bottom soil is a prime requirement for fish culture. Acidic soils are treated with lime for increasing the soil pH. High dose of organic manures are sometimes used for amending slightly alkaline soil, while alums are used for pH correction in alkaline soil. The characteristic soil pH in most part of the country falls in the acidic range and is amended through application of different types of lime. Lime also helps as a disinfecting agent in pond with a neutral soil pH, corrects water pH and controls of turbidity in subsequent period of culture operation.

Over the years, several phased manuring practices advocated for nursery rearing have shown encouraging results. However, most of these could not be adopted in large scale due to their complex application schedule. Phased manuring with a mixture of groundnut oil cake at 750 kg, cow dung 200 kg and single super phosphate 50 kg/ha have shown to be effective in production of desired plankton. A thick paste of half of the above amounts are prepared by addition of sufficient water and applied as basal dose 2-3 days prior to stocking and the remaining amount is applied later in 2-3 split doses depending on the plankton levels of the ponds.

Varied stocking densities 1.0-10.0 million spawn/ha have been tried in earthen nursery ponds for rearing of carp spawn to fry with application of manures and fertilizers alone and along with other inputs such as supplementary feed, aeration etc. Study conducted at CIFA has shown density of 5.0 million/ha to be ideal for such earthen nursery pond. Use of bigger concrete tanks for seed rearing of carps at high density has also proven to be effective. Nursery rearing of carp spawn at 10-20 million densities (1000-2000/m^2) in the concrete tanks (10 m x 5 m x 1.2 m) system developed at CIFA has shown higher fry survival to the tune of 40-50%. Use of aeration and water exchange in such system has further proven to enhance the seed survival up to 60%. Use of such concrete seed rearing system has made it possible for a farmer to use high density seed rearing in smaller area and harvest 3-4 crops of fry with higher survival level in a season i.e., during June-September.

The spawn are transferred from the hatchery and stocked in nurseries during cool hours, preferably in morning, after due acclimatization to the new environment. The stocked seeds are provided with mixture of finely powdered groundnut oil cake and rice bran at equal proportion by weight as supplementary feed @ 600 g/lakh for the first 5 days and 1200 g/lakh spawn per day for the subsequent days in two equal instalments during morning and evening hours. During 15 days of rearing period the fry attain the size of about 25 mm which is the ideal size for transferring to rearing pond. Harvesting is done by repeated netting with dragnet of 1/8" mesh. Survival levels of 40-50% are normally achieved in well-managed ponds. During a season from June to September at least 2-3 crops of fry can be raised in earthen ponds and 4-5 crops in cements tanks.

2.2 Production of carp fingerlings

Fry are raised for two to three months to fingerling size in a relatively larger rearing ponds of 0.05-0.1 ha area with 1.2 to 1.5 m water depth. Like nursery ponds, the rearing ones also need specialized management for good survival and production of healthy fingerlings. However, some of the basic operation such as clearance of aquatic weeds, soil correction, and control of predatory and weed fishes are similar to the ones discussed for the nursery pond. The aspect of aquatic insect control in this case is not required. Further, the aspects of management involved in manuring, fertilization and water quality management of the rearing ponds are discussed below.

Pond fertilisation includes application of raw cowdung at the rate of 5-10 tonnes/ha depending on the organic carbon load of the soil. While one third of the above amount is applied 8-10 days before stocking, the remaining amount is applied in equal split doses at fortnightly intervals. Application of biogas slurry at 30-45 tonnes/ha in bimonthly split doses is also found to be effective as improvement over raw cowdung application. In case of use of poultry droppings, the dose may be reduced to one third to half of the amount of cowdung. In addition to the organic manures, inorganic fertilisers such as urea and single super phosphate are applied depending on the nutrient status.

While single species culture is practiced in nursery ponds, rearing pond involve culture of mixed species of carp due to their divergent feeding habit and food preference. Usually fry are stocked at 2-3 lakh/ha density. In ponds with facilities for water circulation/exchange or aeration, the density can be further increased to a considerably high level.

Feed requirements of the growing fingerlings are met through the available natural fish food and provision of supplementary feed commonly in the form of mixture of groundnut/mustard oil cake and rice bran/wheat bran at 1.1 ratio by weight. Other ingredients such as fish meal, soybean flour, vitamin-mineral mixture, etc. are also suggested to be incorporated for improving the feed quality. Periodical samplings of the fry at fortnightly interval are done to assess the growth and biomass. Feed is provided at the rate of 8-10% of biomass of fry stocked per day during the first month, which are reduced to 6-8% of the standing biomass during the subsequent two months. Feeding is usually done in moist dough form in equal installments

during morning and evening hours. Crumbled pellets may be used for reducing the feed wastage.

Harvesting of fingerlings is done when they attain 80-100 mm length. Fingerlings are effectively harvested by using a closed-meshed drag net. Rearing period can be further extended when bigger size fingerlings or stunted fingerlings are required.

If the fingerlings are to be transported, feeding is usually stopped one day prior to harvesting so as to improve their conditioning. Morning hours with low water temperature is the most preferred time for harvesting. Long distance transportation of fry and fingerlings can be done in polythene bags filled with oxygen. The number of seeds to be packed in each bag would depend on the size of fry/fingerling, duration of transport, quality of water and environmental temperature.

3. Grow-out carp production

Usually ponds of 0.1 to 1 ha size with an average water depth of 1-5-2.5 m is preferred for polyculture of the major and minor carps. However, seasonal ponds with 5 to 6 months holding of 1-1.5 m water depth can also suitably used for culture of the minor carps and the barbs. Essentially, the management practices in carp polyculture involve environmental and biological manipulations for obtaining higher levels of fish production, which can be broadly classified as pre-stocking, stocking and post-stocking operations.

3.1 Pre-stocking pond preparation

The details of the pre-stocking pond preparation have been discussed in seed rearing section. Manipulation of the species ratio in grow-out pond is important for minimizing the inter-specific and intra-specific competition for food available at various trophic levels and zones in a pond. Either single species or more than one species occupying different niches could be utilized in a pond for exploiting the food available at various zones. A proportion of 30-40% surface feeders, 30-35% coloumn feeders and 30-40% bottom feeders is commonly adopted depending on the productivity of the pond. Accordingly, suitable species combination of major and minor carps/barbs may be adopted.

3.2 Stocking density

Decision on the stocking density is an important aspect in the management which depends on pond productivity and the type of rearing protocol to be used. Generally in major carp polyculture, a density of 6000-8000 fingerlings is followed as standard stocking rate per ha for a production target of 4-5 tonnes/ha/yr. In seasonal ponds or where water level becomes limiting during summers it is reduced to 3000 fingerlings/ha to obtain higher growth rate. Stocking densities of 8000-10000 fingerlings/ha has been used for production levels of 5-8 tonnes/ha/yr. Although the major carps are expected to reach an average of a kilogram in the first year, the growth rate is invariably reduced in higher stocking densities. Higher targeted levels of fish production levels of 10-15 tonnes/ha/yr are achieved by resorting to stocking the ponds at a density of 15,000-25,000/ha.

Ponds are stocked with seed after proper acclimatization. If mohua oil cake or bleaching powder is used as piscicide during pond preparation, it must be ensured that toxicity is reduced and oxygen balance is established in the pond prior to seed release. Fingerlings of 10-15 cm size are considered as suitable stocking material of the major carps while size of the fingerlings in minor carps may vary from 4 to 6 cm.

In the single stocking–single harvest cropping pattern, when fingerlings of major carp are used for stocking the grow-out ponds, there remains a large gap between the carrying capacity and standing crop of the pond during the initial months leading to underutilization of the pond productivity. Pond productivity can be effectively utilized with use of the single stocking-multi-harvest cropping pattern where the stocking density can be increased 1.5-2.0 times. In this method, almost one third to half of crop is harvested at the end of six culture months and the leftover stock is reared further with periodic planned harvesting. However, the initial growth of the species hampers in such culture method due to the increase in the intra-specific competition apart from the crowding effect. Therefore, .instead of increasing the number of individuals of the same species (catla, rohu and mrigal) in the pond, different species of minor carps can suitably be incorporated considering their habitat preference and food habit, which would not only reduce the intra-specific competition, but also would increase the utilization of micro niches in the pond. Considering this fact, the concept of intercropping of the minor carps has been advocated in the conventional major carp polyculture system to increase the fish yield. In the intercropping methods, while major carps are stocked at the recommended density (8000-10000 fingerlings/ha), an equal density of minor carps/barbs are released in the pond as additional stock. These minor carps are harvested from the pond after approximately six months of culture letting the major carp to grow further. As mentioned earlier, such intercropping has proven a 30% increase in the fish yield.

3.3 Post-stocking pond management

The post-stocking pond management primarily involves the aspects of intermittent liming and fertilisation, supplementary feeding, water management and health care. In an average productive pond, the post-stocking fertilization measures includes fortnightly application of cowdung @ 0.5 tonne/ha, urea @10 kg/ha and SSP @15 kg/ha. The organic manure and inorganic fertilizers are applied in alternative weeks to maintain the natural productivity status. However, the time of application and dosage can be deferred depending on the water quality and plankton content of the pond. Poultry dropping may suitably be applied in place of cowdung, but at one third of its dose. n intensive carp culture pond, application of *Azolla* as a biofertilizer @ 40 t/ha/yr, supplied at weekly split doses, has proven to supply the full complement of nutrients i.e. 100 kg nitrogen, 25 kg phosphorus, 90 kg potassium and 1,500 kg organic matter. Use of biogas slurry @ 30-45 t/ha/yr or 80-100 litre/day/ha) is advantageous due to its lower oxygen consumption and faster rate of nutrient liberation.

3.4 Supplementary feeding

Supplementary feeding enhances fish production, permitting higher stocking density. While several ingredients of both plant and animal origin have been evaluated on Indian major carps and exotic carp species, the supplementary feed in Indian carp polyculture is mostly restricted to mixture of groundnut/mustard oil cake and rice bran at 1:1 by weight. This combination is

often fortified with vitamins and minerals and are used by some fish farmers. Carps require at least 50% natural food, which normally take care of the vitamins and minerals requirements. But in situations where they have to be brought up on artificial diet alone or where supplementary feeding forms a major part, such fortification becomes necessary. With the shift towards intensive fish culture, a qualitative change has been effected by incorporation of different plant and animal protein sources. Further, the formulations of balanced feed have received considerable attention in recent years for making up the deficient essential amino acids and incorporating vitamins and minerals. To hold these components in the feed together, pelletization has been done and their merits in terms of water stability, consumption and utilization by fish have been proven. Extruded floating pellets are now available for carps.

Feed is usually provided at 5% of the stocked biomass in the first month of culture and gradually reduced to 1% within 6 to seven months of culture. The biomass of fish is estimated through monthly sampling and the daily feed ration is calculated as follows:

Feed requirement/day = Estimated fish biomass in the pond x % feeding rate
where, biomass = Average weight of fish X total number of fish stocked x %survival

Survival percentage of 80% is usually considered for estimation of biomass. The daily ration may be divided into two splits and provided in dough form preferably in feed trays or gunny bags hung at uniform distance inside the pond.

Feed intake of fish often reduces following cloudy weather and also in the winter months. Therefore, the daily ration should be modified as per the consumption pattern of the previous meal. In terms of dispensation of the dough feed, the feed mixture is to be provided in the form to dough in trays or gunny bags hung at different places in the pond. Quantitative requirements of feed is important since underfeeding depresses growth while overfeeding results in wastage of feed, the costliest input, leading to deterioration of water quality.

3.5 Aeration and water exchange

Dissolved oxygen is probably the most important single variable regulating production of fish in intensive culture. Aeration may be used mechanically to increase the concentration of dissolved oxygen in ponds. There are several types of aeration. Emergency aeration is employed to prevent fish death during periods of oxygen depletion. Oxygen depletion may occur during prolonged period of cloudy weather. Aeration is also sometimes applied to prevent thermal and oxygen stratification in ponds. Of the three major types of pond aerators available viz., the paddle wheel aerators, the aspirator aerators and the submersible pond aerators, while the first one is a surface aerator which may be ideal for water depth of 1.0 to 1.5 m, the other two type of aerators is considered to be more effective in fish ponds due to their high injection capacity of air into the water, even in deeper ponds.

Water exchange is another important activity, considered to be crucial in aquaculture operations. Due to continuous accumulation of metabolites and decayed unutilized feed, besides heavy organic manuring, the water environments get deteriorated, leading to slow

growth of fish species and often leading to outbreak of diseases. Thus, it is necessary to replace certain amount of water at regular intervals, especially during later part of the culture period in case of intensive culture practices.

3.6 Health management

It is said that prevention is better than cure. So prior to stocking, the fish seed should be given a bath of 3-5% potassium permanganate for 15 seconds. Incidence of disease is quite common in high stocking densities. Though mortality is rearely observed in well-managed ponds fish growth is severely affected due to parasitic infection to some extent. Repeated infection is effectively controlled by applying a dose of 0.1 ppm at monthly intervals.

3.7 Harvesting and marketing

Harvesting of fishes is usually done after a culture period of 12 months to one year. However, fishes attaining the marketable size can be harvested periodically to reduce the pressure of density on the pond and thereby providing sufficient space for the growth of other fishes. Replenishment of the harvested species ensures maintenance of ecological balance that the particular species exhibit. Such periodic harvesting with and without replenishment, facilitating stock manipulation, are biological means of increasing fish production.

Usually fresh fish fetches about one and half times higher market price in the local market than those of iced-fish transported from long distance. Further, fishes sold in live condition commands around 30% higher market price than the fresh ones. Thus, the marketing strategy forms an important aspect for higher profit realisation that the fish growers should take advantage.

4. Conclusion

Freshwater aquaculture has been identified as the key areas for meeting the growing demand for fish in the country. Carp culture being the principal component of the sector has tremendous potential for growth in coming years. Higher fish production from this sector can be realised through bringing more area under culture and increasing the production per unit area. Further, carp culture involves easily adaptable technology and offers greater flexibility in use of local resources, which makes it farmers' friendly. The availability of a host of carp culture technologies with varied production levels further provides enough option to the farmers as per their investment capacity.

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TECHNOLOGICAL EMPOWERMENT AND DRUDGERY REDUCTION OF FARM WOMEN

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According to Dr. M.S Swaminatthan, the famous agricultural scientist, some historians believe that it was woman who first domesticated crop plants and thereby initiated that the art and science of farming. While men went out hunting in search of food, women started gathering seeds from the native flora and began cultivating those of interest from the point of food, feed, fodder, fiber and fuel. Women played a major role in decision making process in traditional agriculture, but they are virtually not recognized as producer within their right. Due to socio-cultural traditions, the rural women have subordinate role in the society. They have inaccessibility to modern technology, credit, training and other facilities available to male workers and farmers. Their role has passive due to ignorance of modern inputs and methods of cultivation. Their regain energy is spent in procuring fuel, fodder, food and has little time to improve their skills. In the process they have lagged behind their male colleagues in using of improved crop production and processing tools and machinery. Besides hand tools and improved bullock drawn implements, more 240,000 tractors and 700,000 irrigation pumps are introduced every year for mechanization of Indian agriculture. But these improved implements are exclusively handled by male workers. The rural women are usually employed in most arduous field operations like sowing behind and plough, transplanting, weeding, intercultural, harvesting, threshing and agro-processing. It may be seen that women are largely employed in those operations most of which have not been mechanized.

In addition to crop production, women are also employed in other field operations in horticulture, agro-forestry, animal husbandry, dairying and fisheries. These sectors are least mechanized in India. Almost entire post harvest and agro-processing activities are performed by women. Which is socially accepted, irrespective of economic status of the women, fortunately mechanically powered simple equipment and gadgets are available in rural areas on custom for many of these operations and therefore women's drudgery has been reduced to a great extent. The custom services of rice milling, flour grinding and oil expelling are quite common in rural areas. This equipment reduce drudgery, facilitate utilization efficiency of inputs, ensure timeliness in field operations and reduce turnaround time for next crop, increase productivity of man-machine-power system, conserve energy, improve quality of work and also quality of produce.

Technology and Gender Issues

The improved technology package has been developed in the country for agriculture and agro-processing but these have selectively been adopted mainly by male farmers. The female farmers remained passive spectator and continued to adopt traditional practices. The reasons may vary from technological to marketing and social barriers. These issues may be grouped into:

1. Technological
2. Training and skill
3. Passive attitude towards modernization
4. Credit facilities
5. Marketing system
6. Social barrier

1. Technological barriers

The equipment for agriculture production processing and value addition are developed keeping ergonomic design factors of male operators. For women these are scaled down in size but their physiological responses under long duration of work are hardly investigated her physical strength, working posture and environment under which female workers are employed varies from region to region, which influences the adoption of technology. The research institutions have hardly appointed female researchers and technicians for evaluation of specific technology.

2. Training and skill

The training facilities available for women, in selected trades, are largely located in cities and rural women can hardly avail these opportunities. Agriculture production related training facilities (agricultural machinery and equipment) are no where available to cater to the rural women needs. The programme confine mainly to demonstration of machinery and women hardly get chance to handle these machines. This does not improve the skill of women but creates awareness and therefore, modern machinery does not generate interest among women worker.

3. Passive attitude towards modernization

In traditional agriculture women farmers were equally involved in decision making process. In the absence of knowledge of modern agriculture technology, men alone take the decision for modernization of agriculture and the female members are left behind as passive spectators. They give their share of labour through traditional tools and equipment. The attitude of women towards accepting modern machinery can be changed only through proper training and demonstration.

4. Credit facilities

The modern agriculture, including improved machinery, requires higher capital investment, which is not adequate from farmer's savings alone. The women farmers are not conversant with Banking system and procedure for availing loan and thus, are deprived of credit facilities for purchase of machinery and other agricultural inputs.

5. Marketing system

Purchase of improved machinery or sale of agro-produce requires knowledge of industries dealing in machinery and organized marketing network system for agro-produce. The women workers seldom handle such issues outside their village or local bazaars. Since marketing requires movement away from their villages, it will be appropriate to organize, group societies,

to look after such issues. Network can be established like 'Contact farming', 'Franchise trading' supply to organized cooperatives for value added products for assured marketing.

6. Social barrier

Women are equally competent to operate any mechanical device as seen in urban areas. In Asian countries such as in Japan, Korea, China, Philippines, Thailand and Malaysia, women equally participate in operation of field machinery. But the rural women workers in India, Pakistan, Bangladesh and Nepal have confined to using hand tools and there is social reservation in handling machinery. This may take sometimes and there is no short cut. Only persuasion, motivation, patience and social recognition to their field work with use machinery will encourage them to adopt mechanical devices.

Drudgery by female workers

Farmwomen perform hard physical work in plantation of crops, care and management, harvesting, threshing / processing, marketing bartering of produce, child bearing and rearing simultaneously. The farmwomen undergo hard physical drudgery especially while transplanting rice in mud with bending position for a long time in rains and scorching sun, harvesting by bending with traditional sickle, weeding by hand in sun, rain and cold for a long hours, drying of produce, standing in scorching sun, winnowing in dust and sun for a long time, parboiling of rice by traditional arduous methods with hard physical labour, dehusking / shelling, pounding, grinding of cereals, pulses by hand as well as hand operated chakki. Women also perform multifarious tasks such as milking of cattle, fodder cutting, collecting and bringing fodder from the field and chaffing of fodder, bathing and cleaning cattle, cleaning cattle shed, collection of dung, preparation and storage of dung cakes, preparation, storage and marketing of dairying products. In addition, they also perform various unspecified and miscellaneous tasks related to home management such as collecting and carrying fuel over long distance, fetching water for cooking and drinking from distance place. It is quite clear that farmwomen experience a lot of drudgery while performing all these household and farming activities. As a whole farmwomen undergo drudgery and health hazards while carrying out these farm and household activities, which affects their work efficiency and physical wellbeing

A number of farm tools and implements have been designed and developed by research organizations and state agriculture university but mostly suits to male subjects though women play an important role in Indian agriculture apart from their traditional concerns which are associated with specific domestic tasks such as fuel collection, drinking water supplies and cattle care. The share of women labour force in agriculture is 39.0 per cent in year 2001 as per census. Their share would be about 5.5 per cent by year 2025. Ergonomical characteristics (capacity of a person including their anthropometric data, muscular strength and aerobic capacity) of men and women are different. Hence, the existing equipment available for various operations under NARS that could be operated by farm women needs to be evaluated ergonomically. Brief write up is given about such equipment that can be operated by farm women.

1. Hand operated maize dehusker-sheller is used for dehusking and shelling maize from whole cob. Its capacity is 60 kg/h. Two persons are required to operate this machine.

Benefits
- About 15% saving in cardiac cost of workers per unit of output in comparison to the traditional practice.
- The productivity of workers increased 1.6 times than traditional practice i.e. shelling with the help of sickle.
- The chances of injury to fingers are eliminated thus making the operation safer for workers.

2. Seed treatment drum is used for safe and uniform mixing of chemicals with seeds for seed treatment before sowing. Its capacity is 200 kg/h. One person can operate this machine.
Benefits:
- Equipment provides safety to worker as direct contact of body parts with chemicals is avoided.
- Uniform mixing of chemicals with seed is done.
- It also avoids bending/squatting posture as done in traditional method of treating the seed.

3. Hand ridger is for making ridges in field to sow vegetables on ridges. The equipment can also be used for making furrows in field for irrigation. Its capacity is 330 m^2/h. Two persons are required to operate this machine.
Benefits:
- About 67% saving in cardiac cost of worker per unit output with the ridger in comparison to the traditional method of making ridges.
- It avoids bending posture, which is generally adopted in traditional method with short handled tools for making ridges.
- Productivity of worker doubles with the equipment than traditional practice.

4. Fertilizer broadcaster is used for uniform application of granular fertilizer in the field. Its capacity is 1.15 ha/h. One person can operate it.
Benefits:
- About 6% saving in cardiac cost of worker per ha with refined broadcaster in comparison to traditional practice was found.
- Uniform application of fertilizer is done.
- It saves workers from dust of urea at the time of application thereby enhancing safety of workers.
- Productivity of worker increased more than thrice with the equipment than traditional method.

5. Sitting type groundnut decorticator is used for separating kernels from groundnut pods. Its capacity is 30 kg/h. One person can operate it.
Benefits:
- About 79% saving in cardiac cost of workers per unit of output with the groundnut decorticator as compared to traditional practice.
- The productivity of workers increased tremendously than traditional practice apart from safety of workers.
- The reduction of drudgery with the equipment per kg of pods decorticated is to the tune of 74 and 79% in case of standing and sitting type decorticator respectively.

6. Standing type groundnut decorticator is used for separating kernels from groundnut pods. Its capacity is 45 kg/h. One person can operate it.
Benefits:

- About 79% saving in cardiac cost of workers per unit of output with the groundnut decorticator as compared to traditional practice.
- The productivity of workers increased tremendously than traditional practice apart from safety of workers.
- The reduction of drudgery with the equipment per kg of pods decorticated is to the tune of 74 and 79% in case of standing and sitting type decorticator respectively.

7. Hanging type grain cleaner is used for separating impurities like stubbles, chaff, dirt and broken received with grain after threshing. Its capacity is 225 kg/h. One person can operate it.
Benefits

- Saving in cardiac cost of worker per unit of output is about 63%.
- Productivity of the worker increased more than four times as compared to traditional thereby reducing drudgery.

8. Seed drill is used for row sowing of seeds like wheat, soybean, maize, gram, pigeon pea etc. Its capacity is 430 m^2/h. Two persons are required to operate this machine.
Benefits

- Output is 18 times than traditional practice.
- 87% saving in cardiac cost of workers per unit of output.
- By the use of seed drill, bending posture which is generally adopted in traditional method can be avoided.
- Line sowing is done with the equipment that promotes use of mechanical weeders for weeding thereby reducing cost and drudgery during weeding operation.
- Seed saving is also achieved.

9. Improved sickle is used for the harvesting of wheat, rice, soybean, chickpea, grasses and thin stalked crops. Its capacity is 150 m^2/h. One person can operate it.
Benefits

- About 15% saving in cardiac cost of workers per unit of output with improved sickle as compared to local sickle.
- Serrated sickles do not require the sharpening of cutting edge frequently.
- It also provides safety to the workers due to its better construction.

10. Tubular maize sheller is used for shelling maize from dehusked cob. Its capacity is 27 kg/h. One person can operate it.
Benefits

- About 15% saving in cardiac cost of workers per unit of output in comparison to the traditional practice.

The productivity of workers increased 1.6 times than traditional practice i.e. shelling with the help of sickle.

- The chances of injury to fingers are eliminated thus making the operation safer for workers.

11. Cono weeder is used for uprooting and burying of weeds in between standing rows of rice crop in wetlands. Its capacity is 120 m^2/h. One person can operate it.
Benefits:

- Bending posture is avoided thus reducing drudgery of workers in weeding operation in wetlands.
- Output is increased significantly

Conclusion & SuggestionS

Farm women can operate the above mentioned manually operated improved equipment by providing one day training. Which will not only reduce the drudgery but also enhance the productivity and work efficiency. In India they play a crucial role for the well being a of moral families and work for 14-16 hours a day using the convenient tools and small farm implements. Inspite of the intensive involvement in most arduous agriculture and allied activities, her work is not recognised in monetary terms, her achievement are not mechanised and work related tools and equipments are not made as per her anthropometric and reach measurements. The drudgery prone activities performed by them should be needed immediate attention so that the physiological and muscular stresses of the said activities for farm women are reduced and the efficiency of the work is ensured and the safety and health status of women are promoted.

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ERGONOMIC RISK ASSESSMENT TECHNIQUES AND PARTICIPATORY EVALUATION OF STRESS INDEX

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Introduction

The quality of work life of women in agriculture is characterized by long hours of work, awkward postures and drudgery experiences at work due to work load and unsuitable farming equipments. They adopt very awkward static posture squatting, bending, sitting and performed task repetitively which was responsible for musculoskeletal disorders and leads to occupational health hazards. There is lack of awareness about different improved tools and agricultural implements. These are some of the factors lead to drudgery and stress among the farm women in the field.Human power plays a great importance in agriculture system since agrarian and they are involved in various farm operations. Hence in the design of farm tools and equipment, everything known about operator is very important, as they have to work with the designed/developed equipment. It is reported that many agricultural projects aimed at men with the assumption that they will somehow automatically benefit women though the ergonomical characteristics of women are different than men workers. The contribution of women is very high in the farm sector as they are involved in majority of farm operations and are therefore subjected to extra harsh conditions of work that leads to drudgery. Therefore introducing women friendly ergonomically designed farm tools or implements is required to reduce drudgery and health hazards as well as increasing working efficiency of farm women. Thus ergonomics plays a major role in such aspects.

ERGONOMICS

Ergonomics is the scientific study of relationship between human and his/her working environment. The term environment includes his/her tools and materials, his/her method of work, ambient conditions and physical environment of work, and also the organization of the work. The scope of ergonomics application includes the following:

i) Fitting the demands of work to the efficiency of human in order to reduce stress.
ii) Designing machines, equipment and installations so that they can be operated with great efficiency, accuracy and safety.
iii) Working out proportions and conditions of work place to ensure correct body posture.
iv) Adopting visual and thermal and acoustic environment to suit human's physical requirements.

It can be easily defined as the study of the interrelationship between people, the work they do and their work environment. It is about adapting the workplace and work tasks to fit the worker.

Importance of Ergonomics to:

- Identify risk factors that can lead to discomfort and pain, and make adaptations to improve work situations.
- Change the way people do their work
- Change the physical environment
- Modify work tasks, tools, equipment

These above will help to increase working efficiency of the working with saving energy, time and limiting occupational health hazards.

Ergonomics Risk Factors

Ergonomic risk factors are the aspects of a job or task that impose a biomechanical stress on the worker. Ergonomic risk factors are the synergistic elements of MSD hazards. Exposure to ergonomic risk factors in the workplace can cause or contribute to the risk of developing an MSD. The ergonomic risk factors are most likely to cause or contribute drudgery, occupational health hazards and MSD are give following

- Awkward postures
- Contact stress
- Force
- Repetition
- Static postures
- Vibration
- Unsuitable work station, tools and equipment
- Extreme environmental conditions

Of these risk factors, evidence in the Health Effects chapter shows that force (forceful exertions), repetition, and awkward postures, especially when occurring at high levels or in combination, are most often associated with the occurrence of MSDs. Exposure to one ergonomic risk factor may be enough to cause or contribute to a covered MSD.

Physical work activities and conditions

The following table shows the physical work activities and workplace conditions that are associated with those physical aspects:

PHYSICAL ASPECTS OF JOBS AND WORKSTATIONS	**EXAMPLES OF PHYSICAL WORK ACTIVITIES AND CONDITIONS ASSOCIATED WITH THE PHYSICAL ASPECT**
Physical demands of work	Exerting considerable physical effort to complete a motion Doing the same motion over and over again Performing motions constantly without short pauses or breaks in between Maintaining same position or posture while performing tasks Sitting for a long time Using hand as a hammer Using hands or body as a clamp to hold object while performing tasks

PHYSICAL ASPECTS OF JOBS AND WORKSTATIONS	EXAMPLES OF PHYSICAL WORK ACTIVITIES AND CONDITIONS ASSOCIATED WITH THE PHYSICAL ASPECT
	Objects or people are moved significant distances
Layout and condition of the workplace or workstation	Performing tasks that involve long reaches Working surfaces too high or too low Vibrating working surfaces, machinery or vehicles Workstation edges or objects press hard into muscles or tendons Horizontal reach is long Vertical reach is below knees or above the shoulders Floor surfaces are uneven, slippery or sloped
Characteristics of the object(s) handled	Using hand and power tools Gloves bulky, too large or too small Objects or people moved are heavy Object is slippery or has no handles
Environmental Conditions	Extreme temperatures, noise, vibration, illumination level

Exerting considerable force to complete a motion (forceful exertions)
Performing forceful exertions requires an application of considerable contraction forces by the muscles, which causes them to fatigue rapidly. The more force that must be applied in the exertion, the more quickly the muscles will fatigue or become strained. Excessive or prolonged exposure to forceful exertions also leads to overuse of muscles and may result in muscle strain, soreness and damage.

Doing the same motions over and over again (repetitive motions)
Many jobs that involve repetition of the same job again and again are apparent even upon cursory observation: assembly line jobs where motions are repeated every few seconds, data processing jobs, directory assistant operators, court reporting, letter and package sorting. Repetitive motion jobs include performance of identical motions again and again, but also include repeating multiple tasks where the motions of each task are very similar and involve the same muscles and tissues. The joints are most susceptible to repetitive motion injuries, especially the wrists, fingers, shoulders, and elbows. Repetitive work that is done with the foot (operating foot activated controls) or knees (climbing ladders or using a carpet kicker) may also result in an MSD.

Performing motions constantly without short pauses or breaks in between (inadequate recovery time)
Jobs that do not provide short pauses or breaks between motions or task cycles are often a problem because there may not be adequate time for muscles to recover from the effects of the exertion before the motion must be repeated. If there are no pauses between motions or the

pauses are too short, the muscles cannot recover to the rested condition. Thus, the effect of the forces on the muscles accumulates and the muscles become fatigued and strained. The lack of adequate recovery time often occurs in jobs involving highly repetitive tasks. The longer motions or job tasks are performed, the less likely that there will be adequate recovery time. The accumulation of exposure leads to muscle fatigue or overuse. In addition, where the intensity of exposure is greater, for example, in repetitive motion jobs that involve exposure to additional risk factors (force, awkward postures, or static postures), the increased forces required for the exertion also increase the amount of recovery time that is needed. Any part of the musculoskeletal system involved in moving the body is subject to injury where there is inadequate recovery time, and the recovery times needed vary by body part.

Awkward postures, static postures, contact stress, vibration

The presence of any or all of these risk factors in a job, particularly jobs involving repetitive motion or forceful exertion, increases the force already required to perform job tasks and, therefore, increases the amount of time muscles need to recover from the exertions the task requires. If the recovery time is not adequate, the presence of these risk factors hastens the onset of fatigue and the effects associated with overuse of muscles, joints and tendons.

Performing tasks that involve long reaches

Many job tasks involve long reaches: working overhead, putting items on a high shelf, reaching across a conveyor to put in a part or grasp an object, or bending over to reach a part in the bottom of a big supply box. These tasks expose employees to extreme awkward postures. Where long reaches are momentary and/or infrequent and the forces are low, these tasks are not a problem because there is likely to be adequate time for the body to recover between reaches. However, when long reaches are done frequently, force is involved and/or a long reach lasts more than a few seconds, the risk of harm increases.

Working surfaces are too high or too low

Working surfaces that are too high or too low are another way in which employees are exposed to awkward postures. Where employees must work on such surfaces for a long period, the risk of tissue damage and other MSD problems increases. Working surfaces can be too high or too low for many employees because most working surfaces are not adjustable.

Maintaining same work positions or posture for a long period

Static postures increase the amount of force required to do a task because, in addition to the force required to perform the task, contraction forces must be applied to hold the body in position throughout the work shift. Maintaining the same position or posture includes a variety of things. It includes holding the arms and shoulders in a non-neutral posture without moving. The effects of maintaining the same work positions can occur in almost any joint of the body and vary depending on body location.

Using hand and power tools

"Using hand and power tools" to perform physical work activities does not in itself mean that employees are exposed to ergonomic risk factors that put them at risk of injury. Rather, it is a

shorthand way of alerting employers that there are aspects of tool design and use that need to be checked out to see whether ergonomic risk factors may be present. These include:

- Weight and size of tool
- Tool handles and/or grips
- Tool activation (repetitively, one finger)
- Tool kickback, vibration and maintenance

Manual handling (lifting/lowering, pushing/pulling and carrying)

Forceful manual handling activities are a leading cause of workplace injury and illness. Lower back MSDs from lifting account for a large percentage of all workers' compensation cases. Studies discussed in the Health Effects section indicate that employees performing manual handling tasks have a significantly higher risk of back injury where they are exposed to force, repetition and/or awkward postures in the job. The physical work activities and conditions included on the manual handling list in the proposal are ones that are likely to be a significant problem because they are ones in which the major ergonomic risk factors associated with manual handling tasks are present: force and awkward postures/static postures. This discussion about physical work activities and conditions in manual handling tasks is organized by task (lifting, pulling). Manual handling tasks are discussed only where the physical work activities and conditions and ergonomic risk factors are likely to be a significant problem.

Ergonomics Risk Assessment of work place

Ergonomics is an applied science that deals with the adaptation of work and workplace to the characteristics and capabilities of worker so that he or she may perform the duty of job effectively and safely. It addresses the worker's physical capabilities in relation to the physical requirement of the job (eg. strength, endurance, flexibility, ability to tolerate postures and positions, visual and auditory acuity etc.) as well as his and her mental and emotional status in relation to the way the work is organized (eg. Work schedules, workload and work related stresses). Ideally adaptations are made to the work place, equipment, furniture and tools used by the worker and to the working environment to enable the worker to perform adequately without risk to him/her, co-workers and public. Thus, it is the field of study that examines human behaviourial, physiological and psychological capabilities and limitations. By understanding these, the professionals in this field can design new work environments to maximize productivity, worker's comfort and overall efficiency. In order to reduce the worker's drudgery in performing household, farm and allied activities, there is a need to collect the relevant ergonomical data such as anthropometrics measurement of body parts, heart rate, physiological cost of work, cardiac cost of work, energy expenditure etc. related to farm women for designing women friendly tools and equipment. These components aim at identifying the maximum drudgery prone activities performed by the women workers in household, farm and allied fields and their impact on women's health and efficiency. This also aims for designing women friendly technologies.

Importance of ergonomics is very much relevant in agriculture and related activities. In most of the developing countries human work constitute as one of the important sources of farm power. In developed countries also human workers operate various tractor operated/self propelled/power operated machines. Therefore in agriculture also, the application of

ergonomics can help in increasing the efficiency and thereby productivity of the worker without jeopardizing his/her health.

The ergonomical issues that affect farm women in using the already existing farm tools and equipment are grouped under the followings:

A. Anthropometry
B. Muscular strength
C. Aerobic capacity
D. Physiological cost of operation
E. Posture
F. Load carrying capabilities

A. Anthropometry

Anthropometry is the technology of measuring various human physical traits as size, mobility and strength. It is an attempt to apply such data in designing farm equipment, workplace and clothing to enhance efficiency, safety and comfort of the worker as human-machine interface decides the ultimate performance of the equipment/work system. Anthropometric measures vary considerably with factors such as gender, race and age that play dominant role in this variability. Due to variability, generally equipment is designed in such a way that it will satisfy 90 per cent of the users which can be achieved by using 5^{th} and 95^{th} percentile values/ limits. The anthropometric criteria deal with issues of clearance (95^{th} percentile limit), reach (5^{th} percentile limit), posture (as per job requirement) and strength (5^{th} percentile limit). Based on 5^{th} percentile selected body dimensions of Indian farm workers, it is observed that the dimensions of women farm workers were about 6 to 21 per cent lower as compared to men workers. Hence, farm equipment developed for men workers may not be suitable for operating by women workers.

B. Muscular strength

In the agricultural activities, human beings are used as a source of power or a controller and data on muscular strength of various parameters are necessary for optimal design of equipment as muscular strength is the maximal force which muscles can exert isometrically in a single voluntary effort. It is generally considered that the strength is positively correlated to body weight. Strength also varies with age, its maximum value being in the age group of 25-35 years. Older workers aged between 50 and 60 years can produce muscular power of only about 75-85% of that of the younger group. Astrand & Rodahl (1986) reported that women's maximal strength of leg muscles is roughly 65-75% of that of men.

C. Aerobic capacity

VO_2 max (also maximal oxygen consumption, maximal oxygen uptake, peak oxygen uptake or aerobic capacity) is the maximum capacity of an individual's body to transport and use oxygen during incremental exercise, which reflects the physical fitness of the individual. It is considered as an International Reference Standard of cardio-respiratory fitness and depends on age, race, sex, body built-up, training etc. Astrand et al. (1973) reported that the women's power is on an average, 65 to 75% of that of man. Gite and Singh (1997) reported that the aerobic capacity of

Indian men workers are about 2.0 l/min while for western workers value comes out to be about 3.0 l/min.

D. Physiological cost of operation

Physiological cast of any operation is expressed in terms of heart rate and oxygen consumption rate. For an 8 hour work period for male workers a work load requiring oxygen at a rate of 0.7 l/min is considered as the maximum limit for acceptable work load. The heart rate for such a workload will be about 110 beats/min. For female workers the corresponding values will be 0.6 l/min and 105 beats/min. The heart rate levels of 120 beats per min or work pulse of 40 beats per min may also be considered as optimal criteria, for the quick appraisal of the state of activity that may be continued for longer period with proper rest pauses.

E. Posture

A good working posture is one which can sustain a minimum of static muscular effort and in which it is possible to perform the given task more effectively and with least muscular discomfort. Any operation in squatting or bending posture involves drudgery and it is reflected in terms of discomfort experienced by the workers. Therefore, as far as possible, such postures should be avoided and only sitting or standing posture should be used during work. Also for long duration work, a sitting posture may be better than the standing posture. In many cases, though the work may be well within the physiological limits, the body discomfort may restrict the duration of work depending upon the static load component involved in it and this is the case for most of the agricultural activities.

F. Load carrying capabilities

Load carrying and transportation is one of the important activities in agriculture for example carrying tools & equipment, manure, FYM, seeds, fertilizer, lifting & transportation of harvested produce and grain etc. It is generally considered that the load to be carried by a worker should not exceed 40 per cent of their body weight. As per the anthropometric data of Indian farm workers, the body weight of women was about 21 per cent less as compared to men worker. Therefore, the equipment/ material designed for men workers would again not be suitable for women workers.

Ergonomical implications for farm women

The principle of ergonomics plays a major role in reducing drudgery and increasing working efficiency of farm women. Farm women use various traditional tools for different farming, household and animal rearing activities. It is observed that these tools and equipments are not women friendly. They face difficulty while handling and it induce drudgery. By considering ergonomical parameters, data on anthropometry, physiological and physical parameters, muscular strength etc. tools and equipments can be modified or refined suitable to the workplace and to help the farm women in maximizing their activities. Safety aspects can be considered while providing improved tools and equipments. Materials and information handling are also the important aspects for the worker at their workplaces. By assessing the workplace, type & nature of work various means can be provided to check manual material handling which is considered as most drudgery prone activity at work places. Lifting, shifting or transferring the heavy object is a kind of tough job, which can be performed in team work and improved tools

and equipments and with various automatic machines. Providing important information about different tasks, tools, hazards and safety issues at different workplace of farm women is very much required to reduce accidents, hazards and improve the health and safety of farm women.Working environment parameters such as temperature, humidity, light, noise, good quality indoor air can be controlled or provided according to the need of farm women at different work place. Besides these enough space should be provided for free movement without any accidents and also in avoiding in the adoption of awkward posture by farm women during working hours. All the parameters can be measures carefully and provide various means to avail enough space, lighting, ventilation, good quality air, less noise, vibration etc at their work place. These can also increase the working efficiency of farm women without any hazards or accidents. While performing daily tasks, do not exert more force than is really necessary. Good posture maintains the natural curve of the spine and includes relaxed shoulders that are held slightly back and level, ears in line with the shoulders, chin tucked slightly inward, and pelvis shifted forward to allow the hips to align with the ankles. Sit close to work and keep frequently used materials within reach. It is important to maintain neutral wrist/arm postures as much as possible and also to avoid twisting and bending motions.. Avoid extended periods of continuous work by taking short breaks or performing other tasks intermittently between periods spent on harder work. This helps in bringing natural variation in posture. Always make sure to have enough light to comfortably and safely perform job duties, avoid direct or overly-bright lighting.

Tools used for work place assessment:
Some of the tools used for the are following:

A. Measuring tape
It is available in variety of material namely, metal, cloth, and plastic. The length of tape also varied. It is graduated in millimeters. In the present study metallic tape measuring 200 cm of length and plastic non stretchable 152 cm length can be used. Both were graduated in millimeters.

B. Wet Bulb and dry bulb thermometer
It is used for measuring indoor temperature and humidity. The upper display shows indoor temperature while the lower display shows the humidity level. The user can view maximum and minimum temperature or humidity records by processing maximum/minimum keys.

C. Sound level meter
It is used for measuring the level of sound in the working area. It is small in size and its light weight design allows for easy operation.

D. Lux meter It is used to measure the intensity of light available in the working area. It has LCD display, and is of pocket size, easy to carry and operate.

E. Multiple gas detector
It is used to measure the presence of various gases in the working area. It has also a LCD display, and is of pocket size, easy to carry and operate.

F. Anthropometry

It is used to measure the various body dimensions of the worker working at their respective workstations.

G. Checklists

Various standards checklists are available from various organization to analyze the workplace such as NIOSH Checklists, OSHA checklists etc**.**

Stress Index

Stress can be defined as a reaction to a short-lived situation, such as working in un-ventilated kitchen under smoky, hot environment and less illumination. Or it can last a long time if respondents/workers are dealing with dangerous machine, a spouse's death or other serious situations. Stress becomes dangerous when it interferes with respondent's/ worker's ability to live a normal life over an extended period. Respondent's/worker may feel tired, unable to concentrate or irritable. Stress can also damage respondent's physical health.

Stress index (Annexure-I) is developed for the farm woman involved in household, farm and animal rearing activities by assigning numerical ratings 1 through 5 against structured sentence. These sentences may cause the stress which further resulted into problem/ incident/ accident/ health problems of farm women. The scoring key, given below, will guide in assessing extent of stress.

40-60 : Virtually free from stress
61-100 : Somewhat stressed
101-140 : Stressed- need to watch
> 141 : Super stressed –Need to reduce all pressures in her life or try getting counseling.

Conclusion

The quality of work life of women in agriculture is characterized by long hours of work, awkward postures and drudgery experiences at work due to work load and unsuitable farming equipments. These all are responsible for drudgery which creates hurdles while performing various activities. Ergonomics provides a wide horizon to modify the work station, tools & equipment, work place and working environments according to the need and suitability of the worker such as in case of farm worker and farm women. During the performance of workers simultaneously postures adopted by them can be assessed with standardized tools and improved method can be advised in order to reduce awkward postures and repetitive motions. It will also help in the increasing the working efficiency of the farm women and improving their work productivity. It decreases the work place stress of a worker at his/ her work place. It will also reduce the chances of occupational health hazards, accidents and musculoskeletal disorders. Ergonomically modified workplace will be helpful in solving the health and safety issues of the farmer/farmwomen/ worker. If the workplace will be modified ergonomically then drudgery, health and safety issues of the farmer/farmwomen/ worker can be solved ultimately.

This also leads in the direction of technological empowerment of rural women involved various agriculture, household and allied activities

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Annexure I

The structured statements that may cause some stress are given below in tabular form.

S. No.	Statements	Ratings				
1	I don't have any problem for food preparation work. [Light, sorting grain, peeling, cutting, chopping, pounding, dough making, milling of pulses & wheat]	1	2	3	4	5
2	I don't have any problem for cooking food for my family alone. [Indoor, out door, temperature, Smoke, light, fuel, water, within the reach of all materials related to cooking, tiredness]	1	2	3	4	5
3	I don't have any problem in cleaning the dishes/utensils. [use of ash, detergent, water availability, rubbing of vessel, proper place for cleaning]	1	2	3	4	5
4	I always find difficulty in getting the items related to cooking due to non-availability of storing space.	1	2	3	4	5
5	I do not tire in fetching water from a well outside of my home.	1	2	3	4	5
6	Management of fuel wood for cooking is a heavy task for me.	1	2	3	4	5
7	Management of dung cake for cooking is not burden to me.	1	2	3	4	5
8	I do not have any problem in cleaning of house daily.	1	2	3	4	5

9	I do not find any difficulty in washing cloth.	1	2	3	4	5
10	I always cover my face while doing all household work at the presence of elders.	1	2	3	4	5
11	I am not comfortable in keeping veil while cooking.	1	2	3	4	5
12	I am experiencing reciprocator related problem while cooking in un-ventilated kitchen	1	2	3	4	5
13	I always come in problem when I am in tension or pre-occupied in some of tasks/worries.	1	2	3	4	5
14	I always get tired physically after completing the household tasks.	1	2	3	4	5
15	I am always under fear while cooking as some of my friend burnt her face partially/ fire caught to saree while preparing food.	1	2	3	4	5
16	Milling of pulse with hand stone mill is a tough job for me	1	2	3	4	5
17	Milling of wheat with hand stone mill is also difficult task for me	1	2	3	4	5
18	I comfortably perform field preparatory work in every season. [Squatting/ sitting/ bending posture, scorchy heat, taking out the foreign material from field and its disposal, clod breaking]	1	2	3	4	5
19	I do not have any difficulty in bringing food items for husband to the field.	1	2	3	4	5
20	I do not indulge in to any problem while carrying FYM/ fertilizer/ seed etc.	1	2	3	4	5
21	I do not feel any un-easiness with dust.	1	2	3	4	5
22	I use to prepare chemicals in bare hand.	1	2	3	4	5
23	I am having skin problems after chemical preparation, fertilizer application, working in summer, rouging, weeding, harvesting, threshing, vegetable plucking, winnowing, cleaning and storage.	1	2	3	4	5
24	I frequently find scratches on body due to use of sickle.	1	2	3	4	5
25	I find less irritation while using some protective wear during rouging, inter-culture, plucking, harvesting, threshing, winnowing and storage.	1	2	3	4	5
26	I feel inferiority while working with thresher, winnower, tractor, etc due to no knowledge of the operational tips.	1	2	3	4	5
27	I met with accident while working with thresher, winnower, grader etc.	1	2	3	4	5
28	I came to understand that pre-occupied mind set and hurry always fear me to meet with any accident/ problem.	1	2	3	4	5
29	Once I was hospitalized due to carrying/loading the materials.	1	2	3	4	5

30	While working in scorchy heat, I was suffering from dehydration and sunstroke.	1	2	3	4	5
31	I feel depressed when I get less wage to counterparts for same work.	1	2	3	4	5
32	I deprive of using improved farm tools and equipment for the operations which are being performed by me.	1	2	3	4	5
33	I find my self fully tensed during peak season of farm work. [All household work, rearing of children, guest and farm work]	1	2	3	4	5
34	I occasionally tired after completing the field work.	1	2	3	4	5
35	I always feel insecure in farm work regarding livelihood.	1	2	3	4	5
36	I always become disturb due to family tension and faced with some incident/ accident/ health problems. [Father in law, mother-in-law, husband, husband's brother, husband's sister, children, my parents and family members]	1	2	3	4	5
37	I do not find any problem while feeding to animal, cleaning shed and disposing the cow dung. [Sneezing, skin problem, infection to self & children, irritation, vomiting, headache]	1	2	3	4	5
38	I sometime get injured while chaffing fodder. [Minor cut, major cut, damage to any body part]	1	2	3	4	5
39	I sometime hit by animal while feeding, cleaning and milking.	1	2	3	4	5
40	I upset for not getting the price of produce. [Vegetable, grains, milk, fruit etc]	1	2	3	4	5

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IMPACT ASSESSMENT OF IFS MODELS THROUGH PARTICIPATORY APPROACH

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Impact Monitoring/Impact Assessment

Despite the increasing number and sophistication of management tools and methodologies, monitoring the impacts of development efforts continues to be a complex and neglected task. Management focus is generally concentrated more on planning than on other aspects of project administration. Results are usually measured in terms of outputs…….. and sometimes in terms of outcomes. But almost never in terms of impacts

Impacts are often difficult to measure for several reasons…..

- They do not have always happen as per plans and schedules
- Impacts that are intangible or qualitative are difficult to measure and document credibly and comprehensively
- Unintended, unplanned, unexpected impacts get overlooked unless they are somehow discovered and captured
- The extent to which project activities alone are responsible for impacts is not always clear since there may also be other external factors influencing impacts
- Practical methodologies to assess and document impacts are inadequate

On the other than, development agencies are increasingly exposed to public pressure and are expected to justify how and to what extent expenditures have benefited the intended populations. They are called upon to demonstrate that their projects are creating the expected benefits for their target groups.

Participatory Impact Monitoring/Assessment refers to

A process in which development interveners and local communities jointly observe, document and critically reflect on the effects and changes caused by project interventions

The objectives of PIM/A are threefold

Participatory Impact Monitoring/Assessment
Promoting Learning Process
Improving Communication between stakeholders
Improving Project Steering

PIM/A is not simply a methodology but even more, it represents a philosophy. It is not a one-time event, it has to be periodically undertaken so that programmes and intervention strategies are constantly reviewed and improved.

Indicators for Impact Monitoring and Assessment

Indicators are quantitative or qualitative variables that can be measured or described and, when observed periodically, demonstrate trends; they help to communicate complex phenomena. They represent the abstraction of a phenomenon or a variable. In other words, an indicator is just an indicator. It is not the same as the phenomenon of interest, but only an indicator of that phenomenon (Patton, 1999).

Classification of Indicators

Scientific indicators tend to be measurable in quantitative terms; they are global within a given discipline and are meant to be comparable across space and time.

Grassroots (indigenous/local) indicators are signals used by local people (individuals, groups, communities) based on their own observations, perceptions and local knowledge, applied within specific cultural, ecological and spiritual contexts; they tend to be more descriptive.

Another, classification of indicators says that, they can be broadly classified into two categories, namely; ***final and intermediate***.

Final indicator: when an indicator measures the effect of an intervention on individuals' say ` well-being', we call it a "final" indicator.
For example, literacy may be considered one of the dimensions of `wellbeing', so an indicator measuring it—say, the proportion of people of a certain age who can read a simple text and write their name—would be a final indicator. Sometimes final indicators are divided into ***"outcome"*** and ***"impact"*** indicators.

Impact indicators measure key dimensions of `well-being' such as freedom from hunger, literacy, good health, empowerment, and security.

Outcome indicators capture access to, use of, and satisfaction with public services, such as use of health clinics and satisfaction with the services received; access to credit; representation in political institutions and so on. These are not dimensions of
`well-being 'in themselves, but are closely related. They may be contextual.
Thus, both the ***impact*** and ***outcome*** indicators should constitute the final indicators of impact assessment and monitoring impact.

Intermediate indicator: when an indicator measures a factor that determines an outcome or contributes to the process of achieving an outcome, we call it an ***"input"*** or "***output"*** indicator, depending on the stage of the process—in other words, an "intermediate" indicator.

For example, many things may be needed to raise literacy levels: more schools and teachers, better textbooks, and so on. A measure of public expenditures on classrooms and teachers would be" input" indicators, while measures of classrooms built and teachers trained would be "output" indicators. What is important is that inputs and outputs are not goals in themselves; rather, they help to achieve the chosen goals.

Features of Good Indicators

A good indicator:

• Is a direct and unambiguous measure of progress/change—more (or less) it is unmistakably better.

• Is relevant— it measures factors that reflect the objectives.

• Varies across areas, groups, over time, and is sensitive to changes in policies, programs, institutions.

• Is not easily blown off course by unrelated developments and cannot be easily manipulated to show achievement where none exists.

• Can be tracked (better if already available), is available frequently, and is not too costly to track.

Identification and Selection of Indicators for Impact Monitoring and Assessment

Once a set of goals/objectives of the project have been agreed upon through a participatory analysis processes, the next step is to identify indicators—also in a participatory way—to measure progress toward those goals as a result of an intervention or a development project. The impact monitoring and assessment depend critically on the choice of appropriate indicators. Preferably, they should be derived from the identification and descriptions of relevant variables being given by the clients, with appropriate indicators of them being based on discussion of all the stakeholders.

Basis for Indicators of Impact Assessment

Indicators should comprise comprehensive information about the program outcomes:

- Indicators of the program impact based on the program objectives are needed to guide policies and decisions at all levels of society- village, town, city, district, state, region, nation, continent and world.
- These indicators must represent all important concerns of all the stakeholders in the program: An ad- hoc collection of indicators that just seem relevant is not adequate. A more systematic approach must look at the interaction of the program components with the environment.
- The number of indicators should be as small as possible, but not smaller than necessary. That is, the indicator set must be comprehensive and compact, covering all relevant aspects.

- The process of finding an indicator set must be participatory to ensure that the set encompasses the visions and values of the community or region for which it is developed.
- Indicators must be clearly defined, reproducible, unambiguous, understandable and practical. They must reflect the interests and views of different stakeholders.
- From a look at these indicators, it must be possible to deduce the viability and sustainability of change due to a project program and current developments, and to compare with alternative change/development paths.
- A framework, a process and criteria for finding an adequate set of indicators to assess all aspects of the impact of the program are needed.

These facts must be borne in mind when defining indicator sets.

Appropriate Tools

Participatory Rural Appraisal (PRA) tools are often only seen as appropriate for gathering information at the beginning of an intervention, as part of a process of appraisal and planning. Development workers may talk about having 'done' a PRA, sometimes seeing it as just a step towards getting funding. However, PRA tools have a much wider range of potential uses, and can often be readily adapted and used for participatory monitoring, and for participatory evaluation.

PME methods and examples

The examples documented here are not selected as models to be followed, but as cases of real situations, described by participants as learning experiences worth sharing. To stimulate further thought, particular points of note are given in comment boxes. For each case example, a small information box provides an introduction to the NGO concerned, and indicates the communities with whom they are working.

The examples described are as follows:

Transect walk: is a means of involving the community in both monitoring and evaluating soil conservation changes that have taken place over the period of programme intervention. This method entails direct observation whilst incorporating the views of community members. The case example comes from the Nilgiri hills of Tamil Nadu, where the Keystone NGO is working with tribal communities.

Spider web diagram: in this case is used as a means for participants to monitor and evaluate key areas of a programme. The spider web is a simple diagrammatic tool for use in discussions; it does not entail any direct field observations. The case example comes from the Jawadhu hills of Tamil Nadu, where the SCOPE NGO is working with tribal communities.

Participatory mapping: is perhaps the most easy and popular of participatory tools, used here to evaluate project interventions. The example is taken from Chikmagalur district, Karnataka, where the Vikasana NGO is working with generally poor and marginalised communities.

Photographic comparisons: is another easy visual tool, here used to stimulate community discussions in evaluating programme interventions. In this case, the RWT NGO is working with marginalised communities in Belgaum district, Karnataka.

Matrix ranking: in this case used to evaluate the impact of skills training to women belonging to a shepherd community. The example is taken from Belgaum district, Karnataka, where the RES NGO is working with the shepherd community.

Time line: a tool used to elaborate historical change. In this example, only a simple time line is given, comparing two points in time (usually there would be more). The case is a second one from the Keystone NGO, working in the Nilgiri hills of Tamil Nadu.

Well-being ranking: is described in the final example, being used to differentiate the benefits that different community members have gained from the renovation of a community pond. This example comes from the Prakruthi NGO in Kolar district of Karnataka.

H-form: a simple monitoring and evaluation tool, used in this case to evaluate tank silt application to farm land. The Grama Vikas NGO is working with marginalised farming communities in Kolar district, Karnataka.

The H-form: the method

This method is particularly designed for monitoring and evaluation of programmes. It was developed in Somalia for assisting local people to monitor and evaluate local environmental management. The method can be used for developing indicators, evaluating activities, and to facilitate and record interviews with individuals tank silt application.

Steps in using an H-form

1. Take a large paper and fold it in half length-wise and then fold it in half width-wise, and then half again width-wise. Unfold the paper and darken the 'H' lines with a pen. Exclude the centre vertical line.
2. Write the question in the top centre of the H-form. This should be simple and lucid. If you have a complicated issue, break it up into many small questions. On the left of the horizontal line of 'H' write 0 representing 'not well' and at the right side 10 representing 'extremely well'.
3. If you are working with a group, ask each individual to place their score along the line between 0–10. Give them each many cards or 'post its' (pieces of paper with a sticky backing) and ask them to write/draw out as many reasons for their score. Only one reason should be written on one card.
4. The participants have to write both positive and negative reasons for their score, which are then collected and pasted on to the respective side, as shown in the figure.
5. The participants are then encouraged to read each other's comments or each participant is made to read out the comments they have written. This is a process of sharing and also to encourage discussion.

6. The next step can be to encourage the group to come out with a consensus group score. Once this is achieved, the group discussion can focus on 'steps ahead', ideas of how to make things better, etc.
7. The results of the exercise can be recorded and analysed further as a step towards monitoring and evaluation and documented in a report.

PME as an integral part of all community-based interventions

However interesting a participatory evaluation at the end of a programme might be, without it having been based on a sound system of participatory monitoring throughout the project intervention, the evaluation in itself is limited. Thus, the first conclusion to draw is that monitoring and evaluation should be made a systematic feature of all interventions, seeking community participation from the outset in defining what should be monitored (indicators); how often and by whom the monitoring should be conducted; how this information will be used, etc.

Document unexpected or negative outcomes carefully

In a number of the examples documented, participants voiced only positive outcomes of the intervention. This may be partly due to a wish not to cause offence, but it may also be a genuine inability at the end of an intervention to identify more negative aspects, given a general feeling that the activities were successful. Yet, often the greatest opportunities to learn arise from unexpected findings. Thus, for example, whilst Keystone was surprised to find that dietary habits had changed less than they expected over the course of project interventions, they could use this finding to stimulate further community discussions and learning.

Be flexible in the use of participatory tools

In a number of the examples given, the partner staff had a certain idea on how to approach an exercise, and when they came to the field, they found that they had to adjust their plans because more people had come than expected, or for other reasons. It is best to conduct participatory exercises in a spirit of flexibility, whilst keeping sight of the information that is required for effective monitoring and/or evaluation.

Gender

In most of the exercises documented, a deliberate effort was made to seek out the views of women and men separately. Generally, however, the outcomes were quite similar, so the overall findings were pooled as one. Sometimes differences of perspective can appear relatively minor, but it is nevertheless important that they are discussed to ensure that any underlying differences are fully explored.

Capacity building

A participatory approach to monitoring and evaluation requires not only knowledge of tools, but an overall understanding of community dynamics, and aspects such as facilitating the

representation of all groups in discussions and decision-making. It also requires, of course, a clear conceptual understanding of what monitoring and evaluation entail. For both NGO staff and community members alike, regular capacity building through trainings, field exposures and learning 'on the job' are thus an essential aspect of promoting PME in particular interventions, and as a part of organisational culture.

A technology is said to be successful, only when majority of the clientele groups implements it without any inhibition and gets satisfied with the result. Of course, all research innovations cannot be adopted in the field, as they have varied attributes. Hence, location-specific technology generation and target-based technology transfer efforts have to be followed for wider adoption and popularization. There should be sufficient pre-project diagnosis or situational analysis to better characterize research problems. Paradigm shifts in technology development process such as the shift from mono-disciplinary to multi-disciplinary, supply-driven to demand-driven, general to location-specific etc. are the need of the hour.

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