

COMPENDIUM

Model Training Course on Livelihood Security of Farmwomen through Dairy, Poultry and Fish Production



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**Model Training Course
On**

**Livelihood Security of Farmwomen through Dairy, Poultry
and Fish Production**

(1-8 November, 2018)

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Livelihood Security of Farmwomen through Dairy, Poultry and Fish Production

(Compendium: Model Training Course on Livelihood Security of Farmwomen through Dairy, Poultry and Fish Production organized at ICAR-Central institute for Women in Agriculture, 1-8 November, 2018)

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FOREWORD

Agriculture is the main source of livelihood for over 80 Percent of the rural poor in India. Out of 149.8 million women workers in India, 81.3 Percent live in rural areas. 77.3 Percent of the women workers living in rural areas are engaged as cultivators and agricultural labourers. Women play a pivotal role in agriculture as agricultural labour, as farmers, co-farmers, family labour and as managers of farms and agri entrepreneurs. They have a multiple responsibility and participated in the agricultural development of the country in addition raising a healthy family by securing household nutrition. Despite being the backbone of agricultural economy in developing regions, they remain relatively, unattended group. Less access to education and technology, a host of other socio-economic factors have had an adverse impact on the lives of women farmers and they have often not been able to take advantage of opportunities from new technologies, markets, or contract farming. Rural-urban migration, growing pressure on land, water, agro-biodiversity and firewood and natural disasters associated with climate change has also affected them. The ICAR-Central Institute for Women in Agriculture (ICAR-CIWA) has been consistently working to understand the role and problems of women in agriculture, and based on research result, it has also been regularly giving inputs to researchers and policy makers for gender responsive decision making.

Livestock, poultry and fishery sectors are an integral component of Indian agriculture, where livestock production is largely in the hands of women. Most of the animal farming activities such as fodder collection, feeding, watering, and health care, management, milking and household-level processing, value addition and marketing are performed by women. Rural poultry sector contributes nearly 21 Percent 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. Despite their conspicuous involvement in fisheries activities, women's invaluable contribution is often overlooked, undervalued and undocumented. Ensuring quality participation and empowerment of women in livestock, poultry and fish production is need of the hour for sustainable development in food production for poverty alleviation, food security and promotion of gender equality. I appreciate the efforts of the course team for organising the model training course on “Livelihood Security of Farmwomen through Dairy, Poultry and Fish Production” at ICAR-Central institute for Women in Agriculture from 1-8 November, 2018 and also brining out this compendium which will be immensely useful to the participants.

S. K. Srivastava

S. K. Srivastava
Director

PREFACE

Agriculture remains a critical component of India's economy. Women in India play a predominate role in agriculture, food provisioning and subsistence agricultural activities. The share of agriculture to India's GDP is 16 Percent. The contribution of Livestock and Poultry to India's GDP is 4.11 Percent. Similarly Indian fisheries and aquaculture is also an important sector of food production, providing nutritional security and engaging about fourteen million people in different activities and contributing 1.1 Percent of the GDP. Keeping the role of animal protein in human diet with rising income, population growth and urbanization, the demand for livestock, poultry and fish based products is expanding tremendously in India. The livestock, poultry and fishery sector plays a vital role for livelihood improvement of rural people and women play an important role in it. Women are vital to food security and family well being and their need for labour saving and income generating technologies are acute. The expanding market for these products also offers an opportunity for augmenting their income to those who do not have access to land and capital resources. Ensuring quality participation and empowerment of women in livestock and poultry production is need of the hour for sustainable development in food production for poverty alleviation, food security and promotion of gender equality. While at global level, there has been a lot of concern and action on empowerment of women in agriculture, efforts in India has been slow on this front. Against this backdrop, a Model Training Course entitled "Livelihood Security of Farmwomen through Dairy, Poultry and Fish Production " is organized to orient the participants on different gender issues in agriculture, especially on livestock, poultry and fishery sector to improve the professional competence and upgrade the knowledge of participants in livestock, fishery and poultry development and to enable them understand and integrate gender perspective in their programme.

The course is designed keeping in view the requirements of the participants with different backgrounds which includes gender issues in livestock, poultry and fishery sector, food and nutritional security through animal agriculture, livelihood improvement of farmwomen through dairy, poultry and fish farming, Extension Strategies for Socio Economic Empowerment of Women, Gender Sensitive Family Farming and Doubling farmer's income of farm women through animal agriculture, Leadership and entrepreneurship development, Farm mechanization and drudgery reduction of farm women in Livestock and Fisheries, Post harvest and value addition, farmer producer's organizations (FPO's) in improving market access.

We hope, the compendium will be useful for the state agricultural, veterinary and fishery officers, extension officers, scientists of ICAR/SAUs/KVKs including agricultural R&D stakeholders. The financial support provided by the Directorate of Extension, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India is greatly acknowledged. We are grateful to Dr. S. K. Srivastava, Director, ICAR-CIWA for his guidance and support in organizing the model training course.

Course Team

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Addressing Gender Issues in Agriculture - Role of ICAR-CIWA

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Agriculture is the main source of livelihood for over 80 percent of the rural poor in India. Out of 149.8 million women workers in India, 81.3 percent live in rural areas. Around 77.3 percent of the women workers living in rural areas are engaged as cultivators and agricultural labourers. Women play a pivotal role in agriculture as agricultural labour, as farmers, co-farmers, family labour and as managers of farms and agri entrepreneurs. They have a multiple responsibility and participating in the agricultural development of the country in addition to raising a healthy family by securing household nutrition. Despite being the backbone of agricultural economy in developing regions, they remain relatively, unattended group. Less access to education and technology, a host of other socio-economic factors have had an adverse impact on the lives of farm women and they have often not been able to take advantage of opportunities from new technologies, markets, or contract farming. Rural-urban migration, growing pressure on land, water, agro-biodiversity and firewood and natural disasters associated with climate change has also affected them. Therefore, enhancing productivity and profitability of the marginal and small land holdings, where women's contribution is most profound as agricultural labour and cultivator, is of utmost importance.

Gender and Sex

Gender applies to one sex or the other, and relates to the way each behaves in a given situation. While sex is biologically determined, and cannot normally be changed, gender is a result of socialization into a male or a female role which ascribes certain behaviour according to socio-cultural norms for one's sex. Agricultural policy makers have for decades turned a biased eye to women farmers because they think of farmers as men, thus denying women's claim to participation in farming and other activities which directly affect their lives. As a result, rural women have lagged visibility behind men by most social and economic criteria. If the bias in favour of male farmers had no negative impact on agricultural production, gender issues would probably still remain unrecognized. Until an economic imperative, such as labour shortages, declining yields, or recognition of the need for the special knowledge which women have, demands a change, most agricultural policy makers see little need to address gender issues. Some startling revelations about women farmers, derived from alternative data sources are:

- Majority of women are farmers in India, although invisible because their work is uncounted.
- Women's work day is longer than men's, and most have reached the limits of endurance in stretching their day.
- Due to experience in indigenous farm implements, women harbour specialized knowledge and represent a pool of highly-skilled labour in many areas of agricultural and rural development, which men lack.

- Women increasingly head rural households, and are the chief economic providers for their families. About 18 percent of rural households in India are now female headed with small holdings. About 48 percent of India's self-employed farmers are women (NSSO, 2010).
- Women's productivity is severely constrained by the fragmentation of their time, their dual and triple responsibilities, and their lack of access to essential inputs including knowledge.
- Small farm production is increasingly unattractive to males who too frequently abandon agriculture in favour of better remunerated work in other sectors, leaving women to eke out a living on often degraded land.
- There is no biological imperative for men to maintain a stranglehold on technology, whether biotechnology or machines.
- Agricultural research and extension largely ignore the major concerns of women farmers - nutritious food crops, hardy planting materials, household food security, home storage and small-scale processing, for example.

Gender and Agriculture

Globally, farmwomen suffer from poor access to various kinds of productive resources and services, most importantly access to inputs, extension and market services, which is an important cause of their low productivity. According to a FAO (2011) study, had they enjoyed the same access to productive resources as men, women could boost yield by 20-30 percent; raising the overall agricultural output in developing countries by two and a half to four per cent. This gain in production could lessen the number of hungry people in the world by 12-17 percent, besides increasing women's income.

The results of gender researches reveal that despite the important role women play in agricultural production, they remain disadvantaged in numerous respects. On one hand, women have limited access to a wide range of agricultural inputs including seeds and fertilizers, technological resources, equipments, land and so forth. In addition, women often lack the capacity needed to deploy these resources. For example, women may have access to land but lack the capacity needed to deploy the resources as mentioned above. For example, women may have access to land but lack of access to the fertilizer needed to farm the land productively or lack of knowledge of how to properly apply fertilizer. Illiteracy, neo-literacy and lack of scientific knowledge are the major impediments in their growth. Furthermore, many non-tangible assets, such as social capital, human capital, rights and decision-making power, are more difficult for women to access and exercise due to cultural barriers and male domination.

It has also been observed that most of the agricultural activities undertaken by women are manual and drudgery prone. Trends in farm mechanization also reveal that women are the first ones to be replaced whenever any farm activity gets mechanized. Most of the farm machines- tractors, combines, threshers, balers, translators, etc are not gender friendly. Even small tools and implements such as sickles, hoes, clod breakers, etc until recently were made according to male anthropometric measurements. Certain other gender friendly equipments now available include-paddy transplanter, rake, shovel, chaff cutter, fertilizer broadcaster,

improved sickle, twin wheel hoe, groundnut decorticator, groundnut stripper, seed treatment drum, bhindi plucker, pedal operated cleaner-cum-grader, maize dehusker cum sheller etc.

Genesis and Progress of ICAR-CIWA

Realizing that the research information and the technologies developed in the ICAR Institutes and State Agricultural Universities rarely incorporated the farmwomen perspectives and considering that there is a gap in the technology available at the research stations and the technologies suitable for farmwomen, the Working Group on Agricultural Research and Education constituted by the Planning Commission for the formulation of the Eighth Five Year Plan (1992-97) recommended establishment of National Research Centre for Women in Agriculture (NRCWA) to undertake research relevant to the needs of farm women in agriculture and home management. Accordingly, the ICAR established the NRCWA in the year 1996 at Bhubaneswar, Odisha and subsequently upgraded it as Directorate of Research on Women in Agriculture (DRWA) from the year 2008. A Sub-centre of ICAR-CIWA had functioned at CIAE Campus, Bhopal up to 2010. After up-gradation to the level of Directorate, the operational and administrative control of All India Coordinated Research Project on Home Science is vested with it. This unique institution is expected to catalyze and facilitate R&D institutions to bring in farm women perspectives in their programmes and prepare women to take a lead role in technology development and dissemination. The Directorate has been upgraded and renamed as “**ICAR-Central Institute for Women in Agriculture**” (**ICAR-CIWA**) in the year 2014 under XIIth plan. Recently the mandate of the institute is revised and the revised mandate is as follows;

- Research on gender issues in agriculture and allied fields
- Gender equitable agricultural policies/programmes and gender-sensitive agricultural sector responses
- Coordinate research on Home science

Since its inception ICAR-CIWA has been consistently working to understand the role and problems of women in agriculture, and based on research result, it has also been regularly giving inputs to researchers and policy makers for gender responsive decision making. It has focused on participatory action research in different technology based thematic areas to test suitability of homestead and farm technologies for women and suggest measures to make these women friendly. During its 20 years of existence, some areas where ICAR-CIWA has gained competency are - methodologies for integrating gender in agricultural research; assessment of technologies in gender perspective; gender sensitization; formulation and evaluation of gender based programmes, etc.

Activities for Gender Mainstreaming in Agriculture

ICAR-CIWA recognizes ‘farmwomen’ as an important partner for sustainable development of agriculture, and hence, considers them as the pivot of its research paradigm. Therefore, it strongly advocates gender sensitive agricultural R & D strategies to address issues confronting women and agriculture. Given the critical linkage between women and agricultural growth, the ICAR vision of achieving adequate production of nutritious and safe food for feeding its ever growing population would be possible only if we could address gender issues in agriculture, and at the same time, strengthen the attitude, interest, knowledge

base and capability of women to manage the changes in agriculture. As agriculture is becoming more complex and risk-prone, achieving higher and sustainable growth would depend on how successfully we adopt scientific knowledge, modern technology and innovations on the farm. The future scenario of agriculture would depend largely on the attitude and capacity of these rural women to more effectively participate in and contribute to agriculture. ICAR-CIWA is a unique institution to catalyze and facilitate agricultural R & D institutions to integrate gender perspective in their programmes, develop women friendly technologies and policies to make women better and effective partners in the process of agricultural growth.

ICAR-CIWA carries out research programmes in various dimensions related to women in agriculture. These activities are carried out through the in-house, inter-institutional, network or collaborative and coordinated modes of research. The All India Coordinated Research Project (AICRP) on Home Science is operating at 12 centres in 11 states such as, AAU, Jorhat (Assam); PJTSAU, Hyderabad (Andhra Pradesh); CCSHAU, Hisar (Haryana); CSK HPKV, Palampur (Himachal Pradesh); GBPUAT, Pantnagar (Uttarakhand); MAU, Parbhani (Maharashtra); MPUAT, Udaipur (Rajasthan); PAU, Ludhiana (Punjab) and UAS, Dharwad (Karnataka) and UAS Bengaluru (Karnataka), Central Agricultural University, Tura and Tamil Nadu Agricultural University, Madurai. The technical plan of the project is focused on development of gender specific database and training modules for farm women, technology interventions for drudgery reduction in agriculture, nutritional security & health promotion of farm families, promotion of vocational skills among adolescent girls, value addition to under utilised natural fibre resources and empowerment of rural women for livelihood security.

The ICAR-CIWA activities are focused in following thrust areas:

- **Creating a repository of gender disaggregated data and documentation:** Gender disaggregated information in the field of agriculture and allied areas are scanty and scattered. Such information need to be collected, collated, synthesized and published in order to make it available to the users.
- **Technology assessment & refinement:** Generation and promotion of women-specific technologies is a task to be achieved for making Indian agricultural system more productive. Accordingly, appropriate technologies that will also strengthen management capability of farm women are being developed through technology assessment and refinement. ICAR-CIWA identified relevant technologies in the fields of crop production, horticulture, animal husbandry, agricultural engineering and aquaculture and tested them in women perspective, and suggests refinement to make them women friendly. Technologies were assessed through on-farm participatory research involving women.
- **Farming system approach** -In the wake of emerging problems related to sustainability, the focus has been shifted to farming system approach to produce agricultural commodities. Moreover, as farmwomen struggle to meet their diverse needs from different sources, they eventually spend a lot of time and energy in supporting their households. Therefore research on micro-level farming/agricultural systems has become urgent to develop sustainable livelihood options for women and their households.
- **Drudgery assessment and reduction**-Farmwomen face a lot of drudgery while performing farming operations and household activities. Even women suffer from

different health problems, which adversely affect their working efficiency and family welfare. But, data on the extent to which women are affected in the working environment and the effect on their work output are limited. Hence, studies were commissioned on drudgery assessment and development of reducing tools and implements suitable drudgery.

- **Natural resource management**

Degradation of natural resources such as soil and water is an important cause of stagnating or declining yields, especially in fragile and disadvantaged regions where women are major contributors to family income and food security. In recent years increasing privatization of common property resources and usurp by unscrupulous action have also reduced access of women to these resources. Since the poor women depend heavily on these natural resources for a large part of their livelihood, their loss results in declining economic activities, reduced income and more burden on women. Therefore there is a need for research with focus on gender for well informed policy making and programme development for sustainable management of natural resources.

- **Climate change**

Climate change phenomena could adversely affect prospect of agriculture, fisheries and livestock, seriously jeopardizing the availability of food on the globe. An immediate impact could be on farmers and women through loss of farm income, livelihood and employment. Depending on degree of heat stress, changing hygrothermal conditions might adversely affect farm women as they are involved in more drudgery prone activities. As a large proportion of farm women suffering from malnutrition, the impact could be more severe on women's health, working capacity and participation in agriculture. Therefore, this institute research is also focus on protecting women from such physical and physiological risks and developing adaptation and mitigation strategies with gender perspective.

- **Gender sensitive extension**-Access of farmwomen to extension/information is very limited due to various reasons. One reason is lack of required degree of gender sensitivity of our extension system and lack gender focused extension approaches and models for dissemination. Extension modules on various subject matter areas like integrated farming system, post-harvest technology, integrated pest and nutrient management, poultry and fish farming, home garden and homestead farming were be prepared for rural women.

- **Capacity building of R & D functionaries**-Scientists, both in research and extension systems, need orientation to appreciate the vital role of women in agriculture and the areas in which their efficiency of work could be enhanced either by technological intervention in agriculture and allied sectors on important problems or by improving their knowledge and skills for better job performance. In the first instance the scientists of ICAR-CIWA need to be given required training in certain identified areas so that the centre can address researchable issues on priority. Based on the research outcomes, suitable training capsules are being developed according to the need of various stakeholders like, directors, scientists, policy makers, KVK & development functionaries and women leaders.

- **Resource management** -Resources, both natural and household, provide an important base for livelihood of women and their families. The means of livelihood that women adopt depends on resource endowment of a particular region, their households and access to such resources. The resources can be common property resources such as forest, water bodies, fallow lands etc. and household resources like cultivable lands, ponds, livestock and different assets. Lack of adequate resources at household level and poor management of existing resources have made poor in general and women in particular vulnerable to livelihood insecurity. More importantly there is need to improve the resource use efficiency on one hand, and make sustainable use of resources on the other. Hence, studies taken up related to women's role in resource conservation and management; and S&T options to harness sustainable benefits assume immense significance.

Under the research projects and AICRP on Home Science, ICAR-CIWA has been working on refinement/ development of drudgery reducing tool for increasing the efficiency of the farmwomen. Many tools and equipments for farming operations and household managements were developed and modified to meet the need of women. Nineteen technologies were field validated in the operational villages such as seed bag, fertilizer trolley, manual seed drill, mat nursery, vegetable plucker, vegetable bag, water bag, face protector, dung collector, fodder chopper, fodder collector, ground nut stripper, groundnut decorticator (sitting & standing), groundnut stripping frame, long handle fork, maize sheller, mango harvester, potato picker and revolving stool. It was observed that among the technologies, mat nursery, revolving stool, groundnut decorticator was found above 70 per cent adoption where as long handle fork, water bag, face protector, mango harvester, vegetable plucker, maize sheller, ground nut decorticator (sitting type) and fertilizer trolley found 50 – 70 per cent adoption and dung collector, vegetable bag, groundnut stripper, potato picker and fodder collector found the adoption of 30-50 per cent. Besides addressing drudgery issues the ICAR-CIWA also carries out of research on various disciplines in agriculture with emphasis on improving the food and nutritional security of the farm families.

Conclusion

ICAR-CIWA is globally only institution under Indian Council of Agricultural Research (ICAR) to address gender issues in agriculture for achieving higher efficiency and productivity in agriculture. To address the issues of women in agriculture for farm mechanization and to reduce their drudgery with increased output researches are carried with the aim to frame strategies for reducing drudgery of farm women to fabricate and disseminate the available drudgery reducing farm tools and equipment to stake holders. In order to demonstrate the output and utilities of gender research, strong partnerships with ICAR institutions, KVKs, SAUs, development agencies, NGOs and international organizations would be enhanced in future. Efforts for gender mainstreaming are required to bring social, cultural and attitudinal changes which not only strive for ending the invisibility of women's contribution to agriculture, but of eliminating the drudgery that blights the lives of millions of working women in India. It is important to recognize that women's empowerment through technologies can raise their status only through a meaningful stimulation. Therefore there is, need to have the participation of women at every level in decision making, programme formulation and implementation. Which will continue to bring the country from developing to developed status globally.

Gender Issues in Livestock Production

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Livestock sector in India has been emerging on its own from being subsidiary to agriculture to being an important source of livelihood together with the agriculture in many parts of the country. It is now being seen as a tool for livelihood improvement of rural people as well as peri-urban livestock keepers. Livestock sector is an 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 livestock employs 8.8percent of the agricultural work force which varies from 3% in North-Eastern states to 40-48% in Punjab and Haryana. The livestock sector also promotes gender equity because more than three-fourth of the labour demand in livestock production is met by women. 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 3.9 percent of the Gross Value Added (GVA) in 2013-14 which is 26.1 percent of the GVA in agriculture. The milk production now stands at 146.3 million tonnes (2014-15) and it is an important secondary source of income for millions households engaged in dairying. During the 11th five year Plan (2007-08 to 2011-12), the average annual growth rate of milk production was 4.5%. The 70 percent of the workforce engaged in dairying is comprised women. The per capita availability of milk is 307 g per day (2013-14) 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 74.75 billion in 2013-14. The per capita availability of egg in India is 61 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	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 progammme in villages with flexibility in schedule and venue
Time constraint in livestock management during peak labour periods	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 forest) for livestock production and other micro-enterprises income generation	<ul style="list-style-type: none"> • Improve access of women's to common pool resources through community participation and management • Develop mechanism at village level for provision of water and fodder during scarcity period 	<ul style="list-style-type: none"> • Improvement in the productivity of CPR • Enhance women's' right to control and manage CPR and livestock • Increasing livestock assets for the landless women

Informal and poor marketing system	<ul style="list-style-type: none"> • Improvements in infrastructure and transport services • Improving women's management and skills in value addition and processing 	<ul style="list-style-type: none"> • Increase demand for livestock products and promote production
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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 personnel 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.)

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.

Overview of Indian Fisheries and Aquaculture with Gender Perspective

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Fisheries is an important sector of food production in India. India has a long coastline of 8129 Km, 2.02 million sq.km of Exclusive Economic Zone, 29000km of rivers, 3.15million Ha of reservoirs, 0.9million Ha of brackishwater and lagoons, 0.2 million Ha of floodplain wetlands and 2.41million ha of ponds. With a total fish production of more than 10 million metric tonnes, India stands 2nd in the world aquaculture fish/shell fish production, 3rd in Inland capture fish production and 7th in world marine fish production (FAO, 2016). The fish processing industry is well developed in the country. There are about 625 registered exporters (380manufacturer-exporters and 240merchant-exporters). The post-harvest infrastructure includes 215 ice plants, 481 shrimp peeling plants, 371 freezing plants, 495 cold storage units, 7 canning plants, 16 fishmeal plants, 11 surimi plants, and one agar-agar production unit. With all these resources, the fisheries sector contributes to about 1.2% of the National GDP and to 5.3% of the agricultural GDP. It has great importance in terms of employment, income generation, poverty alleviation, export promotion and foreign exchange earnings.

In world fisheries, women represent almost 50% of the total workforce. In India, of the 756,391 fisherfolk involved in fishing-related activities, 365,463 are women (approximately 48%). The exact nature of the work in which they are involved differs with culture and region and also between rural and urban areas. Despite their conspicuous involvement in fisheries activities, women's invaluable contribution is often overlooked, undervalued and undocumented. Women empowerment, according to Kieffer (1984), is an interactive process which occurs between the individual and his environment, in the course of which the sense of the self as worthless changes into an acceptance of the self as an assertive citizen with socio-political ability. Gender mainstreaming gives women a chance to reinstate their position in society, and to recognize and utilise opportunities to generate wealth. It is thus a crucial component in alleviating poverty and achieving greater food and nutrition security. Since decades women have retained their domain of activity in fisheries, ie, marketing of fresh fish, curing and processing.

Nearly 81.8% of the fisherfolks engaged in marketing and 88.1% of the fisherfolk engaged in curing and processing are women. The involvement of fisherwomen in the fisheries related activities provides additional income to their family. But the income they are getting is not always the same as compared to the wages for men for the same work (Abha et al, 2014). Women in a fishing community are subject to responsibility of household management including food, childcare, education, health and financial management including getting and repaying the debts. The off season cues an additional burden of resource management. Women-headed households are on the increase as a result of economic recession, changing labour needs, increasing urbanisation, and the break-up of extended family structures. While

all these factors add to impasse of women, realization that active fishing alone cannot support the family due to highly fluctuating earnings owing to uncertainty in marine fisheries has necessitated mainstreaming women to adopt profitable enterprises.

Role of women in fishing and pre harvest activities

Venturing out into the sea has always been considered as a male domain. This is not only because of the vigorous work involved, but also because of women's domestic responsibilities and social norms. But in several developing countries like Ghana and Uganda women also invest the proceeds from their trading in boat and gear. The fisherwomen of Cambodia, Democratic Republic of Congo, Thailand and Latin America score actively participates in boat fishing. As per the National Marine Fisheries Census, 2010 (Chakraborty *et al.*, 2013), the marine fisheries activities in India are spread in approximately 1511 fish landing centres and 3288 fishing villages among the nine maritime states and the union territories of Puducherry and Daman & Diu. In Indian coastal artisanal fishing, women mend nets and manage the smaller boats and canoes that go out fishing. The total number of active fisherfolk in India (9 coastal states, Puducherry, daman & Diu) is 9.9 lakhs. In this the number of active women fisherfolk is only to 3.65%. Tamil Nadu has the highest number (21%) of women fisherfolk in the country followed by Kerala and Andhra Pradesh. Of the total women fisherfolk population only 34.76% are involved in fishing and allied activities whereas in the case of men, the participation is 86.2%. The contribution of women in active fishing is only in fish seed collection. The highest participation of women in fish seed collection is from Odisha (50% of total number of women involved in fish seed collection). In Maharashtra, the entire fishing economy revolving around Mumbai are controlled by women. In parts of India, women net prawns from backwaters and are also actively involved in the collection of bivalves and their marketing to ornamental dealers and lime collectors. In west Bengal, it could be noted that the main occupation of women fisherfolk is net making or repairing where around 72% of the women participated. In Tamilnadu, seaweed collection is carried out by fisherwomen. Their work and incomes are rendered highly vulnerable by increasing levels of pollution, destruction of coastal habitats, reclamation of backwaters etc. Moreover, these activities are ridden with occupational health hazards like backache, headache, myalgia, anemia due to negligence about diet etc. As a result of establishment of net making plants to suit mechanisation in fishing gear, these women have been displaced from their traditional occupations. A data base on women's roles in fisheries in India can provide a holistic picture of the time women put in and the problems they face.

The inland fisheries resources provide full time vocation to 1.24 million inland fishers. The sector plays a great role in nutritional security and employment potential. As per the 17th Livestock census (DAHD,2014) the total inland fisher population is around 10.73 million. The highest number of inland fisher population is in Bihar (46.2%), followed by Jharkhand (17.99%) and Chattisgarh (17.81%). But the participation of women in fishing and allied activities were found to be the least in these states, 0.91%, 0.1% and 0.5% respectively. The women in Assam actively participate in fisheries forming the 64.5% of the total active women of the country. Around 40% of the total women fisherfolk of Assam seek full time occupation from inland fisheries and around 24% are partially involved in inland fishing activities especially trap fishing.

Role of women in fish processing and marketing activities

Since decades, women of fishing communities of India have been playing important roles in marketing of fresh fish, and processing surplus catch. Nearly 81.8% of the fisherfolks engaged in marketing and 88.1% of the fisherfolk engaged in curing and processing are women. Around 90-95% of coastal fisherwomen of Odisha are active dry fish producers and vendors. One of the major constraints the women fish vendors in India face is the fact that they are not allowed to travel in the buses as they are considered unclean. Secondly, there are no adequate transport services that link women to landing centers and markets at the right time. Hence women lose their access on good quality fish, prices and consumers. Moreover, the modernization of the fisheries sector has resulted in concentration of fish landings in harbours and hence displacement of women from fish vending.

Women involved in post harvest fisheries activities lack access to resources like institutional credit or technological innovations like ice boxes and proper storage mechanisms. Low level of literacy, restricted mobility, limited access to training programmes and information, lack of organized women groups, social and cultural issues, lack of partnership in decision making and ignorance on modern processing techniques like hygienic curing, good practices in handling and preparation of diversified and value added fish products are some other factors that impedes their progress.

In order to provide useful information for policy initiatives, it is necessary to understand the role women play in fish marketing, value chains and the drudgery involved in the process, problems they face in transport, in accessing market facilities, credit, etc.

Role of women as workers in processing plants

The displacement of women from fish vending have landed them as wage earners in fish processing plants in peeling and grading of prawns, processing of squid and scuttle fish, clams and mussels, filleting and packing of fish and related activities. About 89.6% of the fisherfolk engaged in peeling of prawns are women. But there is a huge disparity in terms of wages paid to them (almost 30% less than that paid to men). It is usually migrant women between the age group of 18-25 who are preferred as laborers in these units. These women have to stay away from their homes for longer periods, which makes it more difficult for them to fulfill their domestic roles and they experience poorer working conditions. They are usually housed under very unhealthy conditions and made to work 12-15 hours. Their employment is seasonal and carries with it a large number of health hazards. Workers of pre processing plants usually does not wear personal protective devices like gloves, gumboots or respiratory masks as they are not provided with these devices by the plant owners (Nag and Nag 2007). Some of the health risks associated with working in fish processing plants, are safety risks (mechanical and electrical accidents), excessive noise levels, low temperatures, bacterial and parasitic infections and the presence of bioaerosols (which contain seafood allergens, microorganisms and toxins). These commonly result in fatal or non-fatal injuries and occupational diseases such as frostbite, noise induced hearing loss, skin infection and sepsis, allergic respiratory diseases, musculoskeletal cumulative trauma disorders, and stress related health problems. An in depth study on the working conditions of women in the sector, wages and the disparity in wages, the changing nature of employment, the impact of changes

in technology on the occupation of women and markets etc is needed in order to advocate welfare measures for women employed in this sector.

Role of women in aquaculture

Women have assumed a leading role in the rapid growth of aquaculture around the world with their participation along the aquaculture value chains. The scope and magnitude of women's participation in aquaculture production in Asia are influenced to a large extent by the level of advancement in aquaculture technology in a particular country and more importantly, the role and status of women in that society. For example, in China, Thailand, and the Philippines, there exists a large pool of trained and skilled women fish farmers, technicians, extension workers, and professionals who are directly or indirectly involved in various capacities in fish production through aquaculture. This can be attributed to their higher literacy rates and liberal legal systems. But it takes a different picture when it comes to India. In India, Women of Manipur, Assam & West Bengal in participate in sustainable aquaculture in pond fertilization, nursery rearing, fish feeding & harvesting. It is reported that in northern India only 13% of women are involved in aquaculture activities. Their role is negligible in states like Andhra Pradesh and Punjab where carp culture has made rapid progress and has achieved a higher level of production compared to the other states. Reasons for nonparticipation are mostly traditional beliefs, lack of knowledge and priorities for household chores. But in north eastern states and West Bengal. the participation is much high at around 55%. In these states, aquaculture still remains largely a subsistence activity and the higher involvement could be attributed to a higher number of fish eating population than the North Indian states. Although Andhrapradesh occupies the first position in fish production, the average monthly percapita consumption is only around 0.13 kg. In Punjab also the fish consumption is very negligible to the tune of 0.001kg/ month/per capita. But the average monthly per capita fish consumption in West Bengal, Assam and Tripura are 0.92 kg, 0.72 kg and 1.27 kg respectively indicating a much higher demand and potential for fish production in these states. The most important reason as told by around 45% women for non participation in aquaculture is their lack of time to spare from the household chores especially when the ponds lie at farther off places from their home with the second reason (26%) being lack of technical knowledge. The common constraints identified for women participation in aquaculture are illiteracy, cultural and religious norms, restricted mobility, lack of land ownership, lack of access to credit, low participation in decision making, limited access to training, lack of women's organization, low gender sensitivity etc. the strategies that could be adopted to improve the participation of women in aquaculture are to improve their access to information and credit and input, family approach training, development of women friendly technologies, involving gender sensitive extension staff in dissemination of the technologies etc.

In freshwater aquaculture, culture of ornamental fish in the backyards of households, carp seed production, carp culture, murrel culture, magur culture and integrated fish farming are some of the technologies which could be adopted by rural women because of the low capital investment required and for maximum utilization of natural resources available in the proximity of their households. Rural women inhabiting brackish water areas could indulge in aquaculture activities like shrimp farming, crab fattening, milk fish culture, bhukti culture etc. Mariculture technologies that possess potential for women's participation include mussel

farming edible oyster farming, pearl oyster farming and pearl production, clam culture, lobster farming and fattening, sea cucumber culture, marine finfish culture, ornamental fish culture, seaweed culture, open sea cage farming etc. In order to improve the participation of women in aquaculture, location specific and need based training programmes need to be organized by adopting flexible timings and approaches. Improving their access to credit, developing women-friendly aquaculture technologies, involving women trainer/ extension worker and organising women's aquaculture clubs can give better result in technology transfer. The gender-disaggregated data and information on women in aquaculture need to be strengthened to understand the exact roles they play in aquaculture and to promote equity and women's rights.

Livelihood Options in Mariculture for Empowering Coastal Women

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Introduction

Aquaculture is one of the fastest growing food-producing sectors globally, having the greatest potential to meet the ever growing demand of aquatic food around the world. The contribution of aquaculture to global supplies of fish, crustaceans, molluscs and other aquatic animals for human consumption continues to grow every year, and has reached 80.0 million tonnes in 2016 (FAO, 2018). Presently, aquaculture is practised in freshwater, coastal areas and the freshwater aquaculture contributing the major portion of total aquaculture production (FAO, 2014). The contribution of inland and marine aquaculture production is 51.4 & 28.7 million tonnes, respectively (FAO, 2018). Marine aquaculture, also known as mariculture, is practiced in the sea, in a marine water environment, while coastal aquaculture is practiced in completely or partially human-made structures in areas adjacent to the sea, such as coastal ponds and gated lagoons. The different culture practices available in marine and coastal waters are fish culture in cage or pond, shrimp culture, seaweed culture, oyster and molluscan culture and depending on the resource availability different countries are leading in different areas of operation with higher production. In total mariculture production, the contribution by finfish, crustacean, and molluscan is 22.89%, 17.7% and 58.7%, respectively in 2016. The top 15 major producers of mariculture are China, India, Viet Nam, Indonesia, Bangladesh, Norway, Thailand, Chile, Egypt, Myanmar, Philippines, Brazil, Japan, Republic of Korea & the United States of America (FAO, 2014). Among these, the Norwegian aquaculture is exclusively of finfish mariculture, mainly the cage culture of Atlantic salmon. Chilean aquaculture is similar to that of Norway but it also has a significant production of molluscs (mostly mussels). In case of Japan and the Republic of Korea, half of their food fish production is of marine molluscs, and their farmed finfish production depends more on marine cage culture. Half of Thailand's production is crustaceans, consisting mostly of internationally traded marine shrimp species. Indonesia has a relatively large proportion of finfish production from mariculture, which depends primarily on coastal brackish-water ponds. In the Philippines, finfish production is comparatively more than that of crustaceans and molluscs especially that of milkfish culture in marine cages and brackish water ponds. In China, the finfish mariculture sector is comparatively weaker than the freshwater finfish sector, where the contribution from mariculture is around 4.4% of the total finfish cultured. The major categories of mariculture species are seaweeds, molluscs (clams, oysters, abalone, scallops, and mussels), crustaceans (shrimp, crabs, lobsters, and crayfish), and finfish (FAO, 2014).

India is bestowed with the vast resources for mariculture including 8129 km of coastline, 2.2 million km² of Exclusive Economic Zone (EEZ) with 0.5 million km² of continental shelf, 1.2 million ha of brackishwater area, 8.5 million ha of inland saline area and 20 million ha for sea farming, etc (Modayil *et al.*, 2008). In spite of having huge mariculture resources, India is

still at the initial stage in mariculture production when compared to the global scenario. At present, in India only 13% of total available potential area is under coastal aquaculture operation, producing around 4 lakh tonnes of shrimp annually. Most of the potential mariculture areas in India are underutilized and there is scope to improve the production by involving rural women through small scale operation.

Coastal women in mariculture

It is estimated that in 2016, a total of 59.6 million people were engaged in fisheries and aquaculture operation, among which women accounted for nearly 14% of all people directly engaged in the fisheries and aquaculture as a primary sector. Women are strongly associated with the post-harvest sector e.g. processing, sales, distribution and marketing; however, women also involved in fishing in some of the regions in different countries. Moreover women are most often involved in fishing when the water body is close to the household. Coastal women obtain independent income and empowered through these activities. Though the a considerable women population involved in fisheries related activities, the comprehensive information is lacking on women in fisheries, it appears that much of women's catch is of small highly nutritious fish and other aquatic animals and is consumed by their households. In India as a whole, it has been estimated that women account for 25% of the workforce in fishing and fish farming, for 60% of the workforce in export oriented fish and shellfish processing and for 40% of the workforce in domestic fish marketing. About half a million women are involved in harvest and post-harvest operations in the Indian fisheries sector, and they have better option as other livelihood option in sector related to mariculture. It has been reported that in most of the coastal states women have been involved in different fisheries related activities as an alternative livelihood option. The important area, in which coastal women could actively participate includes.

- Cage culture
- Bivalve farming: Mussel culture, oyster farming, pearl culture
- Clam culture/Collection
- Ornamental fish culture
- Mud crab fattening/culture
- Lobster fattening/culture
- Seaweed based enterprises

1. Cage culture

Cage culture is one of the production methods for raising aquatic species using enclosures made of wire or netting around rigid frames which are placed in water. In India, open sea cage culture technology is a new and relatively recent activity. Understanding the importance of cage culture, the Central Marine Fisheries Research Institute has initiated cage culture as a research and development activity to identify appropriate design and suitability of cages under Indian context in the year 2006-07. Cage culture could be performed in open sea and brackish water environment and the cage design is varies according to the culture

environment. To make successful farming, selection of appropriate site and design is important.

Site for cage culture:

A suitable place for cage culture should meet the following criteria: water temperature of 26°-32°C, depth of up to 10 to 15 m, close to the shore and away from polluted waters. Bays, straits and inland seas protected from strong winds and rough weather are ideal sites for cage culture. The sites should have adequate circulation of water, with wind and wave action within moderate limits. Flowing waters with a slow current of 1.0 to 9.0 m per second are considered ideal for cage operation.

Species selection

Species selected for culture should meet the following criteria: 1) Availability of seed and seed production technology 2) Good consumer demand and high market value 3) Hardy and tolerant to crowded conditions 4) Should be able to accept external source of food and 5) Fast growth rate. Fish species fulfilling above mentioned criteria will perform better in cages, and bring good returns to the farmers. Some of the important potential candidate species available in India for open sea cage culture are groupers, snappers, sea breams, Cobia, pompano and Asian seabass and pearl spot

Cage design

Presently, the floating HDPE (high-density polyethylene) cages are identified as most suitable in East and West coast of India for sea. These cages have a buoyant frame or collar that support the bag; they are less limited than most other types of cages in terms of site requirements and can be made in a variety of designs, and are the most widely used in rough sea conditions. The floating HDPE cages are having following components:

Cage frame: It provides appropriate shape/structure to the cage. In addition, it also provides buoyancy and holds the system at a suitable level in the surface of the water. Ideal size for grow out cage is 6 m due to its easy operation.

Mooring system: This holds the cage in the suitable position according to the direction and depth decided in the design, and sometimes helps to maintain the shape of the cage. The mooring joins the cage at the anchor system. The materials used in the mooring systems are steel lines, chains, reinforced plastic ropes and mechanical connectors. Presently, in India 14 mm alloy steel link chains with C hook or U shackles are used in cages. In mooring system, 2-3 barrels (1 m length with 220 cm dia) filled with PUF is used for floatation

Anchor system: It holds the cage and all other components in a particular site in the seabed and is connected to the cage by the mooring system. In India, dead weight anchors are commonly used. These are usually concrete blocks and the major advantage with this type is that they are fairly consistent in holding. The anchor system is formed by a system of concrete blocks of minimum 3 tonnes joined together by chains to provide appropriate strength and connected to a buoy by a braided rope.

Net cage: The function of the net bag is to contain and protect the fish. The nets are kept stretched vertically with weights (ballast) at the bottom. Nets of varying dimensions and materials were tested for suitability of net cage in India. CMFRI has identified and used

braided and twisted HDPE nets for grow out purpose. It can last for two or more seasons. Nylon net also can be used economically, but it is light weight, requiring high load in the ballast to keep its shape intact. The depth of net ranges from 2 to 4 m for nursery rearing and 5 to 6 m for grow out

Demonstration of sea cage culture in India

Successful demonstration of open sea cage culture for finfish and shellfish was carried out by CMFRI in the coastal states of Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. Lobster culture was successful at Kanyakumari, Vizhinjam and Mandapam. Asian seabass culture has shown highly encouraging result at Karwar, Balasore and Chennai. Mullet, Asian seabass and Pearl spot were also successfully harvested from backwater cages at Cochin and Mangalore. Cobia was successfully demonstrated and harvested in Mandapam and Karwar. Malabar grouper was successfully harvested in Palk Bay. Apart from grow-out culture, presently marine fish brood stocks are also being developed in cages with successful gonad development. At present, Visakhapatnam Regional Centre of CMFRI is maintaining brood stocks of orange spotted grouper, Indian pompano and golden trevally in cages and all have shown good growth and maturation.

Brackish water cages

Apart from sea, cage culture technology is used in other water bodies such as estuaries, creeks, backwaters and lagoons. Cage culture of different fishes suitable for these water bodies has been demonstrated by CMFRI in different places such as Kochi (Kerala), Mangalore (Karnataka), Nagayalanka & Rajulanka (Andhra Pradesh). A study in different places has showed that the cage culture technology can be used effectively in these systems similar to the sea cages. Unlike sea cages, cost involved for installation of cages in these water bodies is comparatively less because of cage material & mooring systems. The cages suitable for the system are HDPE cages, GI cages and wooden cages, however use of the cages made by different material is depending on the water current and wave action in the selected sites. The commonly used mooring is pole mooring in calm water areas, and chain or rope mooring where water current is more. Fishes suitable for these systems are mullet, milk fish, sea bass and pearl spot

2. Bivalve farming: Mussel Culture, Oyster Farming, Pearl culture

The world production of bivalves (oysters, mussels, clams and scallops) has been steadily increasing since the last decade with recording 16.1 million metric tonnes in 2014. The global bivalve production mainly consists of clams (33.3 %) including cockles and ark shells, oysters (29.4 %) and scallops / pectens (14.7%) and mussels (11.8 %) during 2005-2014. The bivalve resources of India comprise of the pearl producing pearl oyster (*Pinctada* sp), the protein rich edible oyster (*Crasostrea* sp) and mussel (*Perna* sp) and clams (*Villorita* sp, *Meretrix* sp, *Paphia malabarica* and *Marcia opima*). These resources have been important source of income to the coastal population dependent on fishing these resources from the coastal waters, (pearl estuaries and backwaters). Bivalve production through harvest from the estuaries of Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra was estimated at 89897 t in 2012 and 92513 t in 2015, with an mean annual production of 86100 t (CMFRI Annual Reports 2012-2015).

Traditionally, in India, bivalves have always been considered as subsistence food of the poor, save for pockets of high consumption like the Malabar and Goa coasts. But, taking into account the status of bivalves in international aquaculture production (a third of the total by weight) and trade, focus was placed on developing technologies for its farming and hatchery production of seeds. Through this focused attention, techniques for farming mussels, oysters and pearl oysters were developed by the CMFRI in the nineteen eighties. The concentrated effort on technology by CMFRI on mussels and oysters from the nineties helped to achieve the combined production of 20,000 tonnes making India one of the top-ten countries in Asia in bivalve mariculture production. In marine pearl culture too India has made significant achievements in developing a pearl production technology, besides a protocol for hatchery production of pearl spats.

Farming methods: Mussel and Oyster

Rack method: This method is especially suited for estuaries and shallow seas. Bamboo or Casuarina poles are driven into the bottom spaced 1-2 m apart. These stakes are connected horizontally with poles. The horizontal poles should be above the level of water high tide. Seeded rope can be suspended into the water for farming from these poles. Three seeded ropes can be suspended from one square meter area of the rack.

Long-line method: This method is considered ideal for unprotected open sea condition. Synthetic rope of 16-20 mm diameter is used for the long-line (main line). The main line is supported with 220 litre barrels tied to it, spaced at 5 m. The long-line and barrels are anchored in position at either ends using concrete blocks and nylon ropes. Seeded ropes are suspended from the long-line.

Raft method: Ideal for open sea conditions which are not rough. Square or rectangular rafts are made with sturdy bamboo or Casuarina poles. Buoyancy for the raft is given by tying 5 barrels of 200 litre capacity (metal oil barrel painted with anticorrosive paint or synthetic barrel). Ideal size of the raft is 5 x 5 m. the rafts are to be positioned at suitable site in the sea using anchors (grapnel, granite, concrete). Three seeded ropes can be suspended from one square metre area of the raft.

Marine mussels are the most commonly farmed species globally. In India, there are two species of marine mussels, *Perna Viridis* (green mussel) and *Perna indica* (brown mussel) which are distributed in the rocky coastal areas and they support a sustenance fishery. For culture either these mussels are collected or seeds produced from hatchery are directly used for the culture. The muscle culture has been commercially culture in west coast especially Kerala and Karnataka and some of the pockets in Tamil Nadu and Andhra coast.

Oysters occur in shallow waters attached to rocks and form subsistence fisheries along the Indian coast of the six species of oysters in India, the *Crassostrea madrasensis*, the India backwater oyster is most widely distributed. The annual production of oysters from wild was less than 4000 t but has increased significantly due to farming in the estuaries. The edible oyster is highly euryhaline and has fast growth rates. Being filter feeders, it gives high production per unit area without additional feed inputs. For culture, rack and ren and rack and tray methods developed by CMFRI found to be suitable method for culture. The development of hatchery technology for oyster seed production paved the way for the expansion of oyster culture into new cultivable areas where no natural stocks were available or natural spat fall

was poor. Initially the set larvae (spat) on cultch were transported from hatchery to culture site. Now scientists of CMFRI have been able to develop a remote setting method by which eyed or pediveliger larvae are transported without water, in moist condition to distant places where they are set on the cultch material.

Pearl culture:

The pearl has a history more ancient, more fascinating and more regal than any other gem and India has a wealth of marine pearl producing oysters: the *Pinctada fucata* distributed in the Gulf of Mannar, Palk Bay and Gulf of Kutch and the blacklip pearl oyster, *P. margaritifera* in the Andaman and Nicobar Islands. In India, the marine pearls are obtained from the pearl oyster, *Pinctada fucata*. Success in the production of culture achieved for the first time in India in 1973 by CMFRI raft culture and rack culture in near shore areas are the two methods commonly adopted for rearing pearl oyster and recently attempts have been made to develop onshore culture methods. Recently maybe pearl production was standardised for production of base images with ten different types of moulds. Technology for production of jewelry from maybe pearl was also standardised.

3. Clam culture:

Clams burrow into the substratum with the help of a well developed foot. In India, a clams form subsistence fishery all along the coast. Clam meat is nutritious and is a cheap source of protein. Clam culture is practiced in several countries such as Taiwan, Thailand, Malaysia, Indonesia, Singapore, UK, and Australia. In Clam culture, the seed is generally collected from the natural grounds and replanted in areas with a suitable substratum and allowed to grow to market size and hence, it is also known as relaying. Calms are cultured on the bottom and therefore site selection depends on the substrate. Clam farms are located in estuaries, bays and other sheltered areas close to the shore. About 1-2 hrs exposure at low tide is desirable as it is easy to remove the predators. The Central Marine Fisheries Research Institute has developed the technology for culture of *Anadara granosa*, *Meretrix mertrix*, *Paphia malabarica* and *M. casta*. The culture of the blood clam *Anadara granosa* in the Kakinada Bay is popular in Andhra Pradesh. Two important culture methods are used for the clam culture such as bottom and suspended culture, in which Suspended culture gives a higher production per unit area compared to bottom culture even though the stocking densities were twice that of bottom culture. The production varies from 15-45 tonnes/ha in 4-6 months time according to culture methods. Recently short neck clam Governing Council of Ashtamudi Lake in Kerala for becoming the first Marine Stewardship Council certified fishery in India. The clam fishery in Ashtamudi dates back to 1981 and supports the livelihoods of around 3000 fisherpersons involved in collection, cleaning processing and trading clams.

4. Ornamental Fish culture

Ornamental fish business has been recognised as an avenue of employment for women in various countries. In India many women have taken up ornamental fish breeding or farming as a backyard activity especially in rural areas. Ornamental fish farming is considered a good avenue for women as the culture practice involves relatively simple techniques and small capital investment. The ornamental animals are the highest valued products that are mostly harvested from coral reef environments. The global marine ornamental trade is estimated at

US\$ 200-330 million. The trade is operated throughout the tropics. Philippines, Indonesia, Solomon Islands, Sri Lanka, Australia, Fiji, Maldives and Palau supplied more than 98% of the total number of marine ornamental fish exported in recent years. There are wide varieties of ornamental fishes in the vast water bodies and coral reef ecosystems along Indian coast, if it is used carefully, a sizeable foreign exchange could be earned. Apart from collection, a long term sustainable trade of the marine ornamental fishes could be developed only through hatchery produced fish. In the recent years CMFRI achieved breakthrough in developing methods for breeding, larval rearing and culture of more than 20 species of marine ornamental fishes, which includes clown fish, damsels, dotty backs and some shrimp species. Adoption of marine ornamental fishes by several selfhelp groups in Kerala and Tamil Nadu has been initiated by technical support by CMFRI has been recorded. Thus, culture of ornamental fishes could be one of the alternative livelihood options for the coastal women.

5. Crab farming and fattening

There are four species of mud crab, *Scylla serrata*, *S. tranquebarica*, *S. paramamosain* and *S. olivacea* that are the focus of both commercial fisheries and aquaculture production throughout their distribution. They are among the most valuable crab species in the world, with the bulk of their commercial production sent live to market. Compared with other types of aquaculture, mud crab culture still has a large number of variants, including: the use of seed stock collected from the wild, as well as produced from a hatchery; farming systems that range from very extensive to intensive, monoculture to polyculture; and farm sites that vary from mangrove forests to well-constructed aquaculture ponds or fattening cages. As such, there is no one way to farm mud crabs, but techniques, technologies and principles have been developed that can be adapted to meet the specific needs of farmers. In fattening, the water crab collected is maintained in polythene sheet wrapped pond, bamboo cages and in net wrapped ponds and 1/m² stocking density and sold after 3-4 weeks. For culture, the crab seeds collected from natural collection site especially Mangroove areas or seed produced from hatcheries are used. The seeds are maintained in pond directly either by monoculture or with milk fish as polyculture. Recently box method is also gaining importance for culture of crabs. The price of mud crab varies from 500-1500/kg depending on the size and demand. Crab farming and fattening can progress the rural women's empowerment and alter the livelihood option within household and can provide a better opportunity to them that ultimately could bring change in their decision making empowerment.

6. Lobster farming and fattening

The spiny or rock lobsters (*Panulirus* spp.) are marine crustaceans (shellfishes) commonly found in rocky shores and grow up to a body length of 60 cm. The dominant and most widespread species of the Pacific is the golden rock lobster. Other common species are the painted lobster, the striped leg lobster, and the ornate lobster. Eight species of spiny lobsters, six shallow water species and two deep-sea species and the sand lobster contribute to lobster fishery of India. The shallow water species are: *P. homarus*, *P. ornatus*, *P. polyphagus*, *P. pencillatus*, *P. versicolor* and *P. longipes*). On-growing of wild-caught seed lobsters is widely practiced in several places. Like crab lobster also sold as live in the market. The wild collected lobster is collected and maintained for two to three months until it reached market size (180-200 g) and it can be stocked at the stocking density of 10-15 young ones/m². The

culture can be either cage or pond. The market price for lobster goes maximum up to RS 2500 depending on size.

7. Seaweed culture:

Seaweeds or marine macro algae constitute one of the commercially important renewable marine living resources. They are primary producers, shelter, nursery grounds and food sources for marine organisms. Seaweeds are not only of high ecological, but also of great economic importance. Extracted seaweed substances are used as stabilizers and stiffeners in food industry, cosmetics, pharmaceutical industry, and biotechnology. They are the only source for the production of phytochemicals such as agar, carrageenan and sodium alginate which are widely used as gelling, stabilizing and thickening agents in food, confectionary, pharmaceutical, and dairy, textile, paper, paint and varnish industries. As many as 1000 varieties of seaweed are in existence in India and the important seaweed species of *Ulva fasciata*, *Enteromorpha compressa*, *Chaetomorpha antennina*, *Sargassum species*, *Padina sp*, *Gracilaria corticata*, *Gelidium sp.*, etc. Seaweeds either collected from wild or cultured using different methods like raft, rope or net bag depending of sea condition. Culture duration is around 45 days and it is sold in the fresh @Rs 5/kg and dried is around 40-50/kg. In India, cultivation of *Kappaphycus alvarezii* was initiated at Mandapam during 1995-1997 and the cultivation was popularized by PepsiCo during 2002 since then the commercial production the species started in different states (Tamil Nadu, Gujarat) and production varies from 120 – 1500 MT/year in dry weight basis. Though the demand for the species in India is more than 5000 MT/Year (Dry weight), but production is always less than 2000 MT/year through culture. Thus, the demand for the species is existing in India. Seaweed culture envisaged as one of the important areas for empowering coastal women and several studies has been conducted by research institutions like CMFRI and CSMCRI (Central Salt and Marine Chemical Research Institutes. Several demonstration trails with several women self-help grouper has been experimented in states like Tamil Nadu, Gujarat and Andhra Pradesh and the observed results are encouraging.

Apart from, above mentioned area, there are several other areas are available coastal women as livelihood option to empower the coastal women, which includes shrimp culture in small areas, sea cucumber culture, fish seed collection in mangroves. Package of practises have been developed all these activities by several fisheries research institutions and also demonstrated in some states. If these technologies adopted by different group with some modifications according to area of activity, then it will be helpful for sustainable women empowerment in all coastal states.

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Livelihood Improvement of Farmwomen through Family Poultry Production

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Worldwide poultry production has increased significantly over the past fifty years to accommodate increased demand for poultry products. Today poultry production for egg and meat is one of India's most innovative industries. Having evolved from the backyard to a vertically integrated and organized sector it has achieved unprecedented growth during the last four decades. 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. Today, the development of poultry sector is not only been in size but also in productivity, sophistication and quality. Availability of high yielding layer (320-330 eggs) and broiler (2.4-2.6 kg at 6 wks) varieties together with standardized package of practices on nutrition, housing and management, and disease control have contributed to spectacular growth rates in egg (6-8% per annum) and broiler production (10-12% per annum) in India. Though considerable growth has taken place in poultry sector, the consumption of egg and meat is far below the recommended (Nutritional Advisory Committee) consumption of 180 eggs and 10.8 kg poultry meat per person per year. 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 per capita consumption of egg is 100 and poultry meat is 2.2 kg per person per annum in urban areas. However, in rural areas it is restricted to only 15 eggs and 0.15 kg poultry meat. 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. Poultry production in rural/backyard areas can enhance the nutritional and economic conditions of population in rural / tribal 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.

The rural people are practicing backyard poultry keeping since time immemorial in India and other Asian and African countries. Small and landless farmers as well as those belonging to weaker sections, including tribal and scheduled castes people traditionally keep local breeds for their subsistence. These birds forage and scavenge for their food in the back yards of human dwellings and provide eggs and meat at insignificant cost. They provide rich nutritional food and regular source of income for the rural / tribal poor. 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.

Why Poultry is the choice?

- Poultry farming is an essential activity of the typical rural/tribal household system in India, touching their social, cultural and economic lives (Kumtakar and Kumtakar, 1999).
- According to a Survey by Anthropology Survey of India, majority of Indian population is non-vegetarian. Moreover poultry has no religious sentiments, as it is acceptable to all sections of society irrespective of cast, creeds and colour. Presently poultry meat is accounting for about 27% of the total meat consumed and is the most popular meat from any single livestock species (FAOSTAT, 2006).
- Poultry is the choice of species because it needs minimal use of land, labor and capital. Also it gives quickly turnover as, the growth cycle is very fast, only 42 days (broiler chickens). So it generates fast cash.
- It also easy to handle and does not require special attention.
- The poultry products like egg and meat is nutritious and the biological value of egg protein is very high (Table 1). Poultry meat is low in fat and cholesterol and hence choice of health conscious people. By going for poultry production in rural area it not only assures the availability of eggs and meat to cater the food need besides providing additional income. Thus has a potential to fight poverty and malnutrition and provide scope for high employment generation and solving gender issues in employment.

Table 1. Comparative nutritive value of eggs and other food stuffs

Foodstuffs	Biological value	Protein efficiency ratio	Net Protein utilization	Chemical Score	Digestibility%
Egg	96	4.5	93	100	97
Milk	85	3.0	81	65	94
Meat	80	2.8	76	70	82
Chicken	82	2.9	78	71	85
Fish	85	3.0	72	70	85
Soybeans	64	2.0	54	57	73
Peas	56	1.6	45	42	72
Potato	60	1.8	49	48	82
Rice	64	2.0	57	60	90
Wheat	58	1.7	47	42	90
Maize	45	1.3	34	35	85
Bajra	62	1.8	52	52	88

Advantages of Family Poultry Farming

- It is easy to manage and handle.
- It needs minimal use of land, labor and capital.
- There is higher demand and higher price for eggs and birds of native fowl.
- It 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.
- Rural 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.
- The poultry products such as egg and meat are highly nutritious and the biological value of egg is very high. Poultry meat is low in fat and cholesterol and hence choice of health conscious people.
- Poultry farming in rural area not only assures the availability of eggs and meat to cater the food need but also provides additional income. Thus has a potential to fight poverty and malnutrition and provide scope for high employment generation and solving gender issues in employment

Poultry Production and Poverty Alleviation

The United Nations Food and Agriculture Organization (FAO, 2014) estimates that about 805 million people of the 7.3 billion people in the world, or one in nine, were suffering from chronic hunger or undernourishment, of which 791 million people are from the developing countries, representing 13.5 percent, or one in eight, of the population of developing countries. Poultry represent an important system to feed the fast growing human population of developing countries of South Asia and to provide income to poor small farmers, especially women. Increased production of poultry, both commercial and rural, is a vital contribution to food security at both the household and community levels. Rural poultry production continues to make a significant contribution to poverty alleviation and household food security in many developing countries (Alders and Pym, 2009; Guèye, 2012). Village poultry production is ideally suited to rural areas where the conditions for a successful commercial poultry sector are rarely met. Indigenous poultry breeds are excellent scavengers, transforming feed resources considered unsuitable for human consumption into high quality products such as poultry meat and eggs. The ability of indigenous breeds to scavenge, to flee predators, to lay and hatch their own eggs and to contribute to pest control results in a production system that complements other farm activities without directly competing with humans for cereal crops. Village poultry are generally owned and managed by women and children and are often essential elements of female-headed households.

Gender and Poultry

Gender is defined by FAO as ‘the relations between men and women, both perceptual and material. Gender is not determined biologically, as a result of sexual characteristics of either women or men, but is constructed socially. It is a central organizing principle of societies, and often governs the processes of production and reproduction, consumption and distribution’ (FAO, 1997). Despite this definition, gender is often misunderstood as being the promotion of women only. However, as we see from the FAO definition, gender issues focus on women and on the relationship between men and women, their roles, access to and control over resources, division of labour, interests and needs. Gender relations affect household security, family well-being, planning, production and many other aspects of life (Bravo-Baumann, 2000). The role of family poultry in poverty alleviation, food security and the promotion of gender equality in developing countries is 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.

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.

Chicken rearing has a history of over 5000 years in India. Red jungle fowl, the wild native chicken is believed to be the basic source of all the modern breeds reared throughout the World. Poultry farming was confined to rearing of few chickens and ducks in the back yards till early 1960s and egg and chicken meat production was insignificant. The per capita availability of eggs in 1960 was only 0.3 kg (FAOSTAT, 2006). Realizing the importance of eggs and chicken meat in human nutrition and the increasing requirements of growing human population, efforts were initiated for increasing poultry production in the country. The fruits of commercial poultry production in India have been limited to the urban and semi-urban areas and the rural poultry sector remained unchanged. Egg production from native chicken contributes only 21% of total egg production of the country. In rural areas, the poultry products are sold at 10-40% higher price than the prices at urban and semi urban areas. Further, the incidence of protein deficiency is prevalent among the susceptible groups like children, pregnant women, nourishing mothers and aged people in rural areas, which can be alleviated by adopting small scale poultry farming in backyards of rural households. Besides, the backyard poultry production relies on minimal cost inputs in the form of kitchen waste, locally available grains, tender leaves, worms, insects and other material available for scavenging. The production potential of the native chicken breeds is very low. Realizing the importance of backyard poultry farming in India and the need for high yielding varieties, research efforts were initiated in the recent past at ICAR Institutes and SAUs for developing new strains suitable for rural farming. Crosses like Vanaraja, Giriraja, Gramapriya, Girirani,

Krishna J, Gramalakshmi, CARI Gold, Niocbari etc. have been evolved and being raised in different parts of the country.

The role of family poultry in poverty alleviation, food security and the promotion of gender equality in developing countries is well documented (Guèye, 2000). 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 (Gujit, 1994; Alders, 1996; Kitalyi and Mayer, 1998). 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 (Alders, *et al.*, 2003). Studies in neighbouring countries like China, Bangladesh and Sri Lanka have shown that Family poultry farming has a useful role and is worth studying to take up appropriate steps to improve the productivity (Dattarya and Sangeetha, 1996).

Important Aspects of Family Poultry Production

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 rural / backyard poultry production is

- Adoption of appropriate technology
- Utilization of locally available resources
- Training of farmers
- Proper health management
- Organized marketing system

Development and adoption of appropriate technology

There is a need to develop suitable germplasm for rural / backyard production with improvements in the economic traits in the existing native breeds or the development of new stock with infusion of native blood. The productivity of these stocks should be 120-150 eggs per annum and around 1kg meat in 10-12 weeks of age. Upgrading and cross breeding are the most easy and quickest method for improvement of indigenous germplasm for traits of economic importance. Genetic characterization and breed description of indigenous fowl breeds like Kadaknath, Assel Naked neck and Frizzle have received priority in research conducted so far. Some important genes, already proved for their special utility in the tropics are naked neck and Dwarf gene. Introduction of naked neck gene into broiler genome is receiving considerable attention in recent years for tropical broiler production because of its superior heat tolerance, adaptability and protein conversion efficiency. Many institutions are working hard to develop varieties of chicken suitable for rural poultry farming and some of them are given in the Table 2 below.

Table 2. Chicken varieties developed for rural poultry production

Variety	Type	Developing agency
Giriraja	Dual	KVAFSU, Bangalore
Girirani	Egg	KVAFSU, Bangalore
Swarnadhara	Egg	KVAFSU, Bangalore
Vanaraja	Dual	ICAR-DPR, Hyderabad
Gramapriya	Egg	ICAR-DPR, Hyderabad
Krishibro	Meat	ICAR-DPR, Hyderabad
Srinidhi	Dual	ICAR-DPR, Hyderabad
CARI Debendra	Dual	ICAR-CARI, Izatnagar
CARIBRO Dhanraja	Meat	ICAR-CARI, Izatnagar
CARI Nirbheek	Egg	ICAR-CARI, Izatnagar
CARI Shyama	Egg	ICAR-CARI, Izatnagar
Krishna J	Egg	JNKVV, Jabalpur
Narmadanidhi	Dual	JNKVV, Jabalpur
Nandanam IV	Dual	TANUVAS, Chennai
Gramalakshmi	Egg	KAU, Kerala
Kalinga Brown	Egg	CPDO, Bhubaneswar
Rajasree	Egg	SVVU, Hyderabad
Nicrorock	Dual	ICAR-CIARI, Portblair
Nishibari	Dual	ICAR-CIARI, Portblair
Jharsim	Dual	BAU, Ranchi
Himsamridhi	Egg	CSKHPKV Palampur

Utilization of locally available resources

In the backyard poultry keeping, it is difficult to know the activity of the birds for their picking up habits and availability of feed ingredients. It is therefore suggested to provide some diets to satisfy their nutrient requirements for optimum production for egg and meat. The availability of common feed ingredients for poultry is becoming a scarce as sizable human population depends on grains like maize, sorghum and other coarse millets for their sustenance. It has become necessary to identify the alternative feed resources available locally and evaluate their nutritional value for poultry. This will not only help in reducing the cost of production but also proper utilization of the local produce.

Disease control

Constant outbreak of poultry diseases in the recent past is one of the havocs for rural poultry production. The single most important disease concerning to rural poultry production has been reported to be Ranikhet Disease (RD) which is accountable for 60-80 per cent mortality. Hence vaccination against most common poultry disease (Marek's disease and Infectious bursal disease) in general and Ranikhet disease in particular is very essential for success of rural poultry. Also there is a need for reliable diagnostic tests and facilities to differentiate various poultry diseases and also efficient vaccines must be made available at reasonable cost. Training on proper management and Bio-Security should be imparted to prevent spread of diseases. More women should receive training in husbandry practices and gain access to poultry health services for successful poultry activities. The vaccination schedule for rural poultry is given in Table 3.

Table 3. Vaccination schedule for rural poultry

Age	Vaccine	Dose	Route
1 st day	Marek's disease	0.2 ml	Subcutaneous (S/C)
7 th day	Newcastle disease	1 drop	Ocular or nasal
14 th day	Infectious bursal disease	1 drop	Ocular or oral
24 th day	Infectious Bursal disease	1 drop	Ocular or oral
28 th day	Newcastle disease	1 drop	Ocular or nasal
6 th week	Fowl pox	0.2 ml	Intramuscular (I/M)
8 th week	Newcastle disease	0.5ml	I/M
18-20 weeks	ND+IBD killed	0.5ml	I/M or S/C
40 th week	ND+IBD killed	0.5ml	I/M or S/C

Marketing system

This sector is neglected so far. Most of the birds in rural areas are sold live. Sometimes the birds are slaughtered and displayed for sale in the open air without any concern for hygiene. Therefore, there is a need for development of reliable and stable market chain round the year for proper marketing of the poultry products. Also facilities for hygienic slaughter and preservation of eggs should be made available at market places in rural areas. Formation of producer co-operatives/ Associations and Rural market yards will help in proper marketing. A well-organized marketing system, accessible to women, is the key to guaranteeing a better price for their poultry products is the need of the hour.

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Doubling the Income of Farmwomen through Animal Agriculture

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Introduction

Aiming to boost Indian agriculture, the Government has set a goal to double the farmers' income level by the year 2022. It is possible by formulating suitable action plan for development of location specific technologies, and timely transfer of such technologies to the farmers' fields. To fulfil the aim, a range of approaches and strategies need to be adopted starting from transformation of production-driven as well as market-driven factors and an enabling environment, which support farmers in all their endeavours. Current level of average income of an Indian farmer is about Rs. 6,430 per month (NSSO, 2012-13) with huge disparity among different regions, like farmers of Punjab earned highest income (Rs. 18,060) followed by those in Haryana (Rs. 14,440), Jammu & Kashmir (Rs. 12,685) and Kerala (Rs. 11,890), whereas farmers of Bihar earn the least (Rs. 3,560) per month. Hence, instead of 'one solution fit for all', a mix of strategies will need to be embraced which not only enhance the income to double or nearly double but discourage the level of disparity among different regions of India.

The Livestock Sector

Livestock production has grown faster than agricultural production in most developing countries, and this trend is likely to continue with growth rates over the next 20 years estimated at 4.5 percent per annum. Historically, growth has come primarily from the expansion of livestock numbers rather than an increase in productivity. If this trend continues, it will put tremendous pressure on the available feed resources - even assuming substantial progress in feed conversion efficiency - and this probably will be the major challenge facing livestock planners.

The development of livestock in many developing countries is constrained by minimal public-sector investment and inefficient and poorly coordinated support services, however. This situation can, in part, be attributed to a lack of any consistent strategy for livestock development, which is exacerbated by inadequate analytical tools and a lack of information on which to base decision-making.

Clearly, increased livestock production will depend ultimately on the adoption of appropriate technology, improved support services, market access and infrastructural development to stimulate increased productivity. However, there must be a framework of coherent policies and development strategies that facilitate such development and ensure that the full potential of livestock in developing countries is exploited.

Role of Women in Livestock Management

Management of livestock is one of the important allied agricultural activity in which rural women contribute significantly. Dairy related task such as fodder cutting, care of animals,

grazing, milking of animals, cleaning of sheds are performed mainly by women. Despite of dual responsibility of home and farm sector, women have to perform all the activities of dairy sector also. Dairy farming involved back-breaking tasks, as all the activities are carried out in arduous posture. Heavy load in these activities can cause musculo skeletal disorders (MSD) and disability. Tools to perform dairy activities are rarely designed as per the needs of women.

In the animal husbandry sector, men and women work hand in hand. Feeding the animals, milking of animals etc. mostly performed by women. However, role of both men and women are complementary in the field of animal husbandry and it is not possible to segregate the functions into specific grouping. Women have been at the fore-front of dairy cooperative movement, which was initially carried under the Operation Flood Programme and later also under the Integrated Dairy Development Programme implemented by the Government. In the poultry sector, the rural backyard poultry is an income supplementing scheme mostly implemented by women, priority in training should be given to women. Similarly, in the scheme for conservation of breeds, the conservation of sheep, goat and small ruminants are oriented in such a way that women are being identified to take up such schemes.

Options for Improving Farmers' Income

Farmers' income can be improved when productivity goes up, cost of production comes down, risk is reduced, post-harvest loss is minimized and commodities produced get a remunerative price. It should also improve income from allied activities to agriculture. The strategy should integrate these all. The following options are available for increasing farmers' income in rice-based systems (ICAR-NRRI, 2017).

A. Improving productivity and quality

1. Providing quality seed and enhancing seed replacement ratio
2. Promoting high-yielding varieties and hybrids
3. Growing nutrient rich (CR Dhan 310 and 311) and aromatic rice (Basmati)
4. Increasing cropping intensity in rice-fallow areas

B. Increasing input use efficiency

1. Crop planning to identify areas where the crop can be grown with least input
2. Promoting water harvesting and micro-irrigation to achieve per drop-more crop
3. Using soil health card and site-specific crop management
4. Promoting farm mechanization and solar energy

C. Reducing crop loss

1. Adopting plant protection measures
2. Promoting resistant varieties and e-surveillance
3. Crop insurance to mitigate risks at affordable cost
4. Weather services and forecasting system

D. Diversification

1. Dairy husbandry for small farmers
2. Promotion of intensive vegetable production
3. Promotion of ancillary activities like poultry, goatery, beekeeping and fisheries
4. Strengthening Organic Food Program

E. Market price realization and value addition

1. Community/co-operative farming with crop-value chain
2. Use of the crop biomass to make products through small industry
3. Creation of a national farm market with information system for export and online selling
4. Agribusiness Incubation Centres to promote agri-preneurship

Challenges in Doubling Income

- Avoiding food losses and food waste at the production and post-harvest phases
- Climate change, temperature, precipitation, and sea level
- Shrinking per capita land and water resources
- Feeding for high yield without ecological cost
- Shift from low value to high value crops – Eg. basmati rice
- Expanding biotic and abiotic stresses
- Adverse cost-risk-return structure of farming
- Monsoon and market volatility
- Credit and Insurance
- Reluctance of youth to take to farming
- International trade and import – export policies

(Courtesy: M S Swaminathan (2017) Road Map for ‘Doubling Farmers’ Income, MSSRF).

Doubling Farm Income: Role of Mahila Kisans

- In 2004-05, women accounted for 34% principal and 89% of subsidiary workers in agriculture.
- Women suffer from a multiple burden on their time
- The NREGP should enlarge the concept of work in the case of women by including activities like running creches and child care centres, preparing noon meals in schools, undertaking immunisation of children and providing family planning services
- A Gram Panchayat Mahila Fund should be established to meet gender-specific needs
- Credit including the issue of Kisan Credit Card, insurance, technology delivery and marketing should be engendered
- Strengthen the role of women in the National Horticulture Mission.

(Courtesy: M S Swaminathan (2017) Road Map for ‘Doubling Farmers’ Income, MSSRF).

Most common agricultural practices including AH, Dairy, Hort & Fisheries	Available improved practices	Additional income (Rs.) generated per ha or per farm household	Constraints in implementation
<ul style="list-style-type: none"> • Feeding of imbalanced ration • Improper vaccination • Lack of awareness on scientific practices 	<ul style="list-style-type: none"> Hybrid Napier) ✓ Introduction of chaff cutter ✓ Feeding balanced ration along with supplementation of area specific mineral mixture ✓ Monitoring of health of animals through timely vaccination ✓ Gender sensitization for capacity building of farmwomen on scientific management of dairy animals ✓ Establishing linkage of farmwomen with dairy co-operatives for marketing milk and byproducts 	<p>Rs 10,000/- per household per month through rearing of 2 cows yielding 15 litres of milk/day</p>	<p>Strengthening forward linkage and value chain</p>

Extension Strategies for Socio Economic Empowerment of Women through Livestock Farming

- Decentralized Decision Making
- Bottom up Planning
- Farming System Approach
- Assistance to the economically weaker section of the community
- Cohesion and Co-operative self help in the community
- Development of the co-operative institutions
- Development of local resources including the utilization of manpower
- Promotion of rural industries
- Provides full integration to supply chain systems
- Participatory Research and Extension Approaches
- Value chain development
- Privatised extension services
- Farmer to farmer extension

- Farmers Field Schools
- Village adoption programmes
- Extension Pluralism
- ICT applications in livestock extension
- Strengthening market linkages

Strategies for Small-Scale Livestock Development and Extension Techniques

- **Planning for Livestock Development Projects:** Overview of small-scale livestock development; production resources analysis; critical analysis in livestock production system; basic economic analysis and financing for small-scale livestock development projects; livestock development for poverty alleviation.
- **Livestock Nutrition and Health:** Overview of animal nutrition and health management; nutrition needs and feed management for poultry, cattle and small ruminants; utilization of crops and crop by products, and crop nutrition; sanitation and epidemic control.
- **Livestock Production Extension:** Farmers' knowledge, attitudes and practices (KAP) survey; KAP data analysis and utilization for extension development; message and media design; planning and implementing farmers' training programs.
- **Farmers' Institution Strengthening:** Participatory problem analysis and development planning; strategies and approaches for farmers empowerment; participatory monitoring and evaluation technique.
- **Case Studies and Study Visits:** Case studies on small-scale livestock production management for commercial broiler, cross-breed backyard poultry, dairy and integrated crop-fish- livestock farms, promotion materials and extension activities for small-scale livestock development undertaken by government agencies, universities and private agri-business companies. Field visits to livestock research and extension stations, small-scale and commercial poultry, dairy, beef fattening and small ruminants farms.
- **Training Needs Assessment (TNA)- Keep It Short and Simple (KISS):** Farmers prioritize and analyse their problems, and identify skills needed to address these.
- **Constraints Analysis for a production process:** This supplements the TNA-KISS, helping farmers to identify the underlying cause of production problems, taking account of the roles of both men and women.
- **Farmer to Farmer Exchange:** Farmers from the production group analyse the results of the learning project and decide on follow-up activities. This involved other interested farmers as well as those in the original production group.

For animal husbandry production, possible programmes and policy interventions include the following broad classifications:

- On-farm interventions, adapted to specific agro-ecological conditions and production systems. These interventions commonly aim at increasing the availability or utilization of local feeds, control of economically important diseases (internal and external parasites) and/or improved housing and management.

- Institutional changes, including the structure and function of support services covering input supply, research, extension and training, processing and marketing and credit. Institutional programmes often complement technical interventions and aim at providing a support framework for livestock production that should be both cost-effective and congruent with overall government policies. The concept of "private" and "public" good will increasingly determine who will pay for such services.
- Genetic improvement programmes aimed at improving the livestock resource base. Options include within-breed selection of adapted indigenous breeds, substitution with exotic breeds or cross-breeding. The choice largely depends on the production system, its objectives and the resources at its disposal. Experience has shown serious misjudgement with policies aimed at importing exotic breeds with a corresponding neglect of indigenous breeds in many developing countries. Whatever breeding programme is adopted, equal attention needs to be given to the dissemination of improved genetic material. Dissemination concerns the institutional aspects as well as the choice of biotechnology, such as artificial insemination and embryo transfer.
- Animal health programmes aimed at limiting the impact of disease on animal production. Policy issues concern who will provide and pay for such services. Foremost is the need to control and protect (quarantine) the national livestock resource from major epizootic diseases, such as rinderpest, which is clearly a "public" good. Disease monitoring, veterinary investigation and legislation (public health and meat inspection) also fall within the public domain. On the other hand, control of diseases that cause production losses, for example, helminthiasis, is primarily a "private" good and determined on grounds of cost effectiveness. In this case, institutional policies that encourage the provision of private clinical services are required.
- Processing and marketing policies related to investment in the necessary infrastructure that enables livestock products to safely supply existing demands as well as those of the future. Such specific issues as the design of structures, equipment, training and quality, along with the question of the degree of state intervention (marketing boards, etc.) in the market, must also be addressed.

Conclusions

To increase productivity, the quality and judicious use of inputs need to be improved with efficient use of modern technology and crop diversification. To increase income of farmers, a range of strategies (Economic, Technological, Infrastructural/Information, Political/Policy and Social) need to be adopted to transform the current production-driven to income-driven farming system and reduce the disparity among farmers of different regions of India.

In a nutshell, the strategies for DFI may include;

Technological Interventions

- Promoting high yielding varieties, breeds and hybrids
- Capacity building programmes- Training and demonstrations
- Advisories and information bulletins on site-specific crop/livestock management/allied activities

- Soil test campaigns
- Promoting drudgery reducing farm tools
- Animal health camps
- Development of knowledge and skill on maintaining farm log books (expenditure and income)
- Development of knowledge and skill to reduce cost of cultivation/cost cutting
- Development of knowledge and skill on waste reduction/ waste recycling
- Development of knowledge and skill to minimize post harvest losses
- Introduction of zero energy cooling chambers
- Development of knowledge and skill on primary processing/ value addition
- Awareness creation on market linkages
- Regular interfaces and monitoring
- Convergence of developmental agencies

Integrating Gender

- Assessment of gender concerns in accessing productive resources and extension services among the farm families
- Consultation among the stakeholders about the challenges of men and women
- Equal opportunity for men and women in implementing the technological modules
- To promote community organizations- knowledge groups of men and women
- Motivation of rural youth to involve in agriculture and allied sectors/ adoption of various vocations with entrepreneurship mode
- Mode of ToT- Through implementation of gender sensitive extension models
- Counselling and gender sensitization of the community
- Gender sensitization of developmental agencies

Focus should be on;

- Recognising women's role as farmer/ agripreneur
- Promoting agricultural education among farm women
- Creation of well structured gender sensitive modules for effective transfer of technologies
- Gender mainstreaming in govt. Programmes & Policies
- Building resilience among farm women to cope with natural calamities and climate change
- Create database on women's participation in agriculture

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Duck Production: An Alternative Poultry Enterprise for Women Empowerment

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Introduction

Duck farming is becoming increasingly popular in Indian context next to poultry farming. As a diversified poultry species, it's considered as a real & viable livelihood option to most backyard sectors of the country. Duckery, alone or integrated with crop farming, has become popular across many parts of the world and Asia in Particular. With low input resources, economic security and wide margin benefits, it has attracted small, marginal and landless farmers alike. Being hardy and disease resistant, the ducks have enough potential for its commercial exploitation for alternate poultry farming. As a backyard poultry in rural sectors, it can be easily managed by women of the house on a part-time basis. Thereby it facilitates nutritional and economic security and plays role in women empowerment. It is now increasingly important to promote duck farming on a large scale with aim of sustainable egg and meat production, income, employment and women empowerment.

Status of duckery in modern India

As per latest livestock census, Govt. of India (20th livestock census, 2017), the ducks (*Anas platyrhynchos*) constitute nearly 4 to 5 % of the total domesticated poultry of India. They have an inherent equal or better in production abilities compared to chickens, which makes them superior in current scenario. In our country, in many ways, duck production has emerged 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.

In post-independent India, despite advent of many scientific know-how, agriculture still is a major force of economy and development. So therein, lies a huge scope for growth of animal husbandry. Poultry husbandry being the easiest and economic, has witnessed enormous growth in recent years. Unlike Chicken Industry's model in India, the growth of duckery sector remains feeble till date despite popularity, because of unsatisfactory private sector proliferations. Duckery is mainly concentrated in north-eastern and coastal states of India owing to availability of large aquatic bodies, dense population, more demand for egg and meat and less scope for animal husbandry. Duck farming mainly in backyard, has witnessed major shift in duck population, more interest for duck egg and meat and as subsidiary income source to small and landless farmers. It has attracted rural sectors owing to low or no cost feed requirement, easy management and nutritional support. The women folk (including elderly women) and aged people (in the age group of 50 to 70 too) are showing more interest towards duck keeping. 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 (FAO STAT, 2013). With this germplasm-base, India produces around 38 million tonnes of duck meat and 1.5 billion numbers of duck-eggs annually.

Duckery as alternate poultry farming

Diversified or alternate poultry farming has become popular in lower sections of society. In backyard, they can be managed with low input resources, less time and care to provide economic and livelihood security. Being easily managed by women of house side-by-side doing day-to-day household activities, they play a major role in rural women empowerment in terms of income, self-sufficiency, livelihood and nutrition. The diversified poultry species have enough merit for commercial exploitation, in this country, in the same way like chickens. As per latest census of Govt. of India (20th Livestock census, 2017), alone the alternate poultry species constituted ~10% of the total poultry populations in the country.



Owing dense population, marshy lands and adverse climatic conditions, the coastal areas are not suitable for chicken production and animal husbandry, as a whole, can be effectively utilized for duck production. With an initial of few thousand rupees in hand, duck farming can started in a small-scale, optimal for most coastal states of India. Furthermore, ducks are more productive than chicken and yield about 25 more eggs than courtyard chicken (Srikanth et al., 2018). Being pretty tough and disease resilient, they are well suited to free range system of rearing in rurals. A healthy native duck of India can produce near about 130-140 eggs/bird/year. Also duck eggs are reasonably bigger (65-75 gm/egg), weighing about 4.5% of duck's body weight and more nutritious than chicken egg. They have more profitable and prolific life because they lay eggs during second and third year too. Hence, it will decrease the nourishment cost. In general, ducks have the habit of laying eggs in the morning hours (Watson et al., 1993 and Srikanth et al., 2018), thereby making it very easy for a household, to collect their eggs having no fear about missing of the eggs, on default. Considering all benefits of duck farming as an alternate to chicken, it demands a lot of consciousness among the people for its improvement in prospecting future. For example, considering an area of 1 hectare of arable land getting converted by an entrepreneur, from just a cereal-crop-area (e.g. rice/wheat) to a fishery-cum-Duckery or even fishery-duckery-horticulture project, it could yield a >200% more output, than the cereal-crop alone, considering the tri-series outputs/produces: fish, eggs and fruits/veggies yielded, in return in an integrated and complementary-manner from farming systems (Rautaray et al., 2005; Adzitey and Adzitey, 2011; Nath, 2015; Gupta et al., 2015 and Biswas et al., 2016). Therefore, duckery in an integrated manner has the potential to go organic in nature, with little planning, which has a great future ahead !

Women empowerment through poultry revolution

The concept of women empowerment in modern India defines the women self-sufficient in terms of income, livelihood and nutrition. Empowering women can tune betterment of India by increasing per capita income while providing nutritional and livelihood security. In a developing country like ours, poultry revolution from chicken to alternate species especially duckery is important from economic and nutritional point of view. Also, a tribute to women empowerment. Being hardy and disease resilient, they can grow well with locally-available

feedstuffs and managed with less care and less equipped facilities. Duckery can get started with few thousand rupees without needing much. Therefore, women, especially elderly ones who are unable to contribute to family's income, can take up duck farming and be part of duck revolution. In a sense, the rural poultry acts as an "ATM", because as per family's needs, the birds and eggs can be sold at any anywhere in return for cash in hand.

Duckery: suited well in integrated farming

Integrated farming is an innovative step towards organic farming through suitable combination of crops and livestock with an aim for better economic return and employment opportunities. It holds promise for multiple-sources of income; involving wise and economic use of floor space, less time, labour and workload. Ducks being versatile poultry species (versatile feeding habit and farming nature) is well suited to organic way of integrated farming. Farming-system-approach of land use through integration of agri-horti crops, fishery and livestock has been found to be most suitable for livelihood security of tribal folk of the region. Therefore, integrated farming is becoming increasingly popular day-by-day. It mostly involves two or three-species integration models i.e. Duck-cum-Fish farming or Duck-fish-paddy cultivation depending on geography and climate (Gupta et al., 2015 and Biswas et al., 2016). There are many prevalent Duck farming systems which can be adopted in our country, is briefed below.

A. Foraging or free range System

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

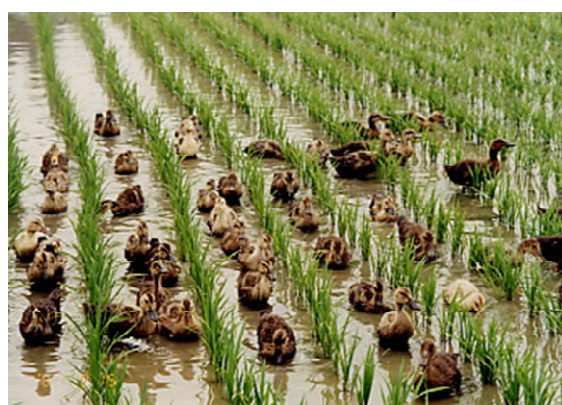


B. Backyard Rearing System

This backyard duck husbandry system is most suitable for small and rural farmers. Here, ducks are usually kept enclosed near to farmer's house, at night. During day time, they roam freely outside in search of feed and get mingled with chickens and other avian species, throughout the area. At night, they are brought inside by putting some extra feed in the night-shelters and nests (usually of earthen pots or wooded partitions) for laying eggs. In this system of rearing, Duck needs little care and small supplementary feedings. Flock-size under this system could range from 5 to 20 ducks. 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. The added advantage of backyard duck rearing is that: ducks go out to harvest their feed themselves. Therefore, its hallmark of low or no cost feed requirement can compensate for lower performances than intensive farming system. It has a major role in women empowerment through providing nutrition, livelihood and income.

C. Duck-Rice Integrated System

The duck-rice integrated system is a century old practice in rural India. It has attracted more attention in recent years owing to its connection to organic farming. The rice-duck system benefits 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 litter and excreta become the manure for the rice/paddy. While swimming duck aerate the water and increase oxygen availability, the condition is more suitable for paddy cultivation while reducing the growth of weeds. 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. Although this method accounts for a relatively limited volume of the duck industry, it is a major success for rural needs.



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.

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 happens to be more popular integrated farming system, rather being more of straight-forward system of mixed farming. It provides more and multiple source of income and worthy benefits to farmers. Combined duck-fish farming utilizes excreta and litter from duck shelter for fish culture in pond. Being organic manure, this enhances growth of aquatic microflora in ponds which is again augments in-pond fish feed and more fish production. Also, ducks swim in pond and distribute the wastes uniformly throughout the pond, serve as a good manure for fish. For duck, being active forager, can collect their own feed from pond in form of Insects, snails, tadpoles, earthworms etc. They can satisfy their own feeding need from pond with requirement of extra feed. Thereby, reduces or eliminates feeding cost for both duck and fish. Since the ducks are in the fishponds, it can inhibit the rampant-growth of aquatic weeds and aid to improve ecological output from the ponds. 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.

The duck-fish integration system is usually carried out in areas of constant ground water availability during most parts of the year. In this system, ducks only need shelter for resting, while have access to water for drinking and heat-stress alleviation. 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 depending on suitability. Number of ducks introduction into the pond depends upon the type of species and egg laying capabilities. For e.g. for an exclusive semi-intensive model of rearing, it may be recommended to introduce more of laying type or dual type ducks in pond and number-wise, upto 200 ducks per acre might be thought of, per acre of pond surface area, without becoming too dense for the pond. As a practice, for semi-intensive duck-fish model, a balance of water-weeds like *Azolla Pinnata*, *Lemnia Wolfia* or *Spirodella* (in combination or individually) and could be cultured in the pond, which are easy to grow and expand, without any sophisticated culture needs.

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.

In consideration of successful farming approach, different age group of ducks are introduced at the same time to ensure constant supply of manure. Likewise, a batch of small fish can be introduced before emptying out of old stock to ensure proper utilization of pond resources and constant productivity. 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 rearing, in one of 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.

E. Duck-fish-paddy cultivation

Duck and fish can be reared together in the paddy field in an effective and economic way. It gives better economic return to the farmer, side-by-side serves as continuous source of income throughout the year. Combined duck-fish farming in the same paddy field has added advantages for each member species. Easy to manage, economic use of labour and space,

steady income and more productivity have attracted farmers and concerned need for scientific research to develop better low-input technology. Experiences available at the ICAR-National rice research institute, cuttack shows that duck-cum fish-cum paddy cultivation can take advantages of 2 to 4 months of water-drenched paddy fields for their mutual growth and rendering the paddy insect and pest free, in a non-chemical and organic farming mode.

Conclusion

Citing most or all of above discussions, it worth concluding that agriculture of current century has got to be technology-intensive, innovative and resource-efficient venture, for enabling sustenance of billions. Envisaging the ever-increasing scarcity of water, over coming decades, the input-output auditing of water based agriculture vis a vis efficiency and importance of every agri-output has to be valued. In this scenario, the Duck cum Fish and Duck cum water-based enterprises are considered two very important models of backyard-Agriculture models. This system is not only 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 recycling of nutrients in the pond-ecosystem. Not only that the integration based agriculture is pro-organic, but also gender-friendly promising easy and wider uptake in rural agriculture system. Therefore, in summary, the duckery enterprises supported with either fish-duck or duck-rice based integration system can no-doubt be considered the most remunerative for water-efficient animal husbandry and agriculture systems, providing scopes for women empowerment and sustainable livelihood.

Livelihood Security and Farmwomen Empowerment Through Dairy Farming

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Livelihood security refers to the ability to continuously maintain or enhance a healthy and secure life. Livelihood is made up of 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. Livestock based production system is an integral component of agriculture in rural economy. Nearly 70% of the population residing in rural areas is engaged with traditional systems of animal husbandry. Dairy farming in India is a female dominated enterprise. About 75 million women as against 15 million men engage in dairying in India (Thakur and Chander, 2006). Most of the farm activities such as fodder collection, feeding, watering, health care, management, milking and household-level processing, value addition and marketing are performed by women. Women constitute about 69% of workforce engaged in livestock sector.

India is the world's largest milk producing country with a share of about 16 per cent in world's total milk production and rank 1st in milk production with a production level of 132.4 million tonnes of milk growing steadily at a compound annual growth rate of about 6.5 per cent (Anonymous, 2012-17). The major share of the credit for India's position as largest milk producing country in the world and the significant increase in the per capita availability of milk in the country is largely contributed by illiterate rural women dairy farmers. Dairy farming does not demand heavy labour and provides good opportunity for women to develop this activity as an enterprise and ensures steady cash returns throughout the year by selling milk, milk products, farmyard manure and biogas using agricultural by-products. Such mixed farming ensures an excellent nutrient recycling and represents a key solution for enhancing dairy production and safeguarding the environment through efficient utilisation of resource.

Rural women play a significant role in conducting small-scale dairy farming. They have full potential for achieving sustainable development and improvement of quality of life through their proactive participation in farming activities. Rural women have become effective role players in both income-generation and household management. However, lack of awareness and adoption of scientific managerial practices in animal husbandry, gender asymmetries like access to market, income generated from sale of livestock/produce, processing technologies and interventions, veterinary services, participation in dairy developmental programmes and policies are the major constraints for upliftment of farm women engaged in dairy farming. Special attention needs to be oriented towards the role of women and their empowerment in the local and regional dairy production system.

Role of Women in Dairy farming

Women play crucial and significant role in dairy farming, but their contribution is not yet recognised and they always remain invisible workers. In India, majority of dairy farm women

participated in the care of newborn calf, milking, cleaning of animal shed, cleaning of utensils, weaning and management of calf, preparation of cow dung cakes and construction of animal sheds but their participation was least in maintenance of farm records. Involvement of farm women in the care of newborn calf and cleaning of utensils and shed (100%), compost making (73%), milking of animals (70%) and weaning and management of calf (67%) is more (Lahoti *et al.*, 2012). Fodder management, sale of milk and health care of animals were important areas where farm women played a major role in decision-making. The participation of farm women was least in the economic activities like taking loans, purchase and sale of animals and choosing animals for dairy. They have less contact with progressive farmers, officials and banks resulting low level of involvement in decision-making (Upadhyay and Desai, 2011). Patriarchal type of society, illiteracy of women and low knowledge and skill also led to low participation in decision making (Lalitha and Seethalakshmi, 2001).

Despite their considerable involvement and contribution, significant gender inequalities also exist in access to technologies, credit, information, inputs and services probably because of inequities in ownership of productive assets including land and livestock. The rapidly increasing demand for dairy products creates opportunities for empowerment of women (Taneja, 2013). Women face greater constraints than men in accessing natural resources, extension services, marketing opportunities and financial services as well as in exercising their decision-making power. The nature of the work of women and men performed within the dairy sector may expose them to various health and safety related concerns, such as heightened exposure to zoonotic diseases (WHO, 2009). Therefore, there is a need to correct gender bias in dairy sector, research and service delivery system to enhance the effectiveness of women-oriented livestock development programs.

Perspectives of cooperatives in Dairy development

India is the world's largest producer of milk due to the policy initiatives of Government of India (GOI) and contributions by various institutions of animal husbandry and allied sectors. During the late 1960s, the GOI initiated major policy changes in the dairy sector to achieve self-sufficiency in milk production. Producing milk in rural areas through producer cooperatives and moving processed milk to urban demand centres became the cornerstone of government dairy development policy. This policy initiative i.e. Operation flood, gave a boost to dairy development and initiated the process of establishing the much-needed linkages between rural producers and urban consumers. The performance of the Indian dairy sector during the past three decades has been very impressive. The per-capita availability of milk was 128 gms in 1980-81 and gradually increased to 232 gms in 2004-05. Despite, it's being the largest milk producer in the world, India's per capita availability of milk is still lower than the recommendation (280 gm per day) of ICMR. The socioeconomic and demographic changes, rising income levels, urbanization and changing food habits and lifestyle, have also reinforced growth in demand for dairy products. Further, on the supply side, technological progress in the production and processing sectors, institutional factors, and infrastructure played an important role to the increased milk production in the country. In late 1980s, National Dairy Development Board placed a major emphasis on women's education as part of our co-operative development programme, an activity designed to strengthen the role of women members in the control and governance of the dairy co-operatives through *ANAND* pattern. Men were educated about the role of women in dairying and about 6,000 out of the 70,000 dairy co-

operative societies in India are women's societies (Sheela and Ramegowda, 2013). Because of their direct involvement in animal husbandry, women also know much more about the care and feeding of dairy animals, identifying first signs of oestrous in cattle and buffaloes, disease and pest problems. Women's dairy co-operatives perform better than men's because women are less political, more loyal to the cooperative concept, more inclined to co-operate with each other and to place their common interests and concerns above the superficial differences of religion, caste and political affiliation. Dairy co-operatives provide organizational frame work which enables the members of the community to handle tasks that enhance production and productivity, marketing and value addition, employment generation thus enhancing incomes and meeting social needs. India's dairy cooperatives can easily be replicated through better management that has foresight and constantly innovates to compete and search for excellence. The white revolution of India is now discussed all over the world for the wide span of development it has engineered. However, to improve production and generate livelihood support to the rural poor for upliftment of their economy, need based scientific ways of animal based production systems need to be intensified at farmers' door step.

Strategy to improve livelihood security of rural women

1. Breeding strategy

India has best milch breed of cattle and buffalo, but majority of them are maintained by small and marginal farmers. Low productivity and poor breeding efficiency, small herd size, lack of coordinated and organized efforts for breed improvement along with inadequate infrastructural facilities are major hindrance in breed improvement of programmes. Selective breeding for improvement of indigenous animals, grading up of local non descript cattle and buffaloes, cross breeding programme along with long term planning has to be initiated to change traditional animal production to commercial one. The rural youth can be employed effectively for providing doorstep A.I services by providing them a short para vet training.

2. Health care of animals

The health of dairy animals should be monitored through preventing 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, isolation of sick animals suffering contagious and zoonotic diseases should be emphasized for maintaining health of the herd.

Vaccination schedule of animals 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
Haemorrhagic 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

3. Safe milk and value addition to milk and milk products

Safe milk can be harvested through good milking techniques, separation of milk from sick animals and hygiene of milking equipments, milkers and keeping milking premises clean. Cooling of milk to the specified temperature and/or delivery to a processing plant in a specified time should be undertaken in time. Proper packaging can prevent microbial spoilage of milk. Indian dairy products are the most critical segments of dairy industry because of its size and integration with the socio economic and religious activities of our population. The traditional dairy products have great demand, but their manufacturing remain confined to small level operations associated with problems of inefficient use of energy, poor hygiene and sanitation and non uniform product quality which calls for process of mechanization. Concerted efforts have been made by NDDDB, NDRI and GCMMF to popularize the value addition of milk products for paneer, khoa *etc.* preparation in organized sector. Dairy entrepreneurship development scheme launched by Govt. of India also promote structural changes in unorganised sector so that initial processing of milk can be taken up at village level in a commercial scale to generate self employment. Consumer awareness on milk made functional foods i.e probiotic products, milk rich in omega 3 fatty acids, fruit based dairy beverages, diabetic sweets, whey based sports beverages, probiotic ice cream *etc.* is growing now a days by the urban people in order to prevent from various life style diseases. Adding value to dairy milk and milk products calls for dairy scientists and entrepreneurs to adopt a holistic approach to product development encompassing new dimension to value addition and processing know how.

4. Feed and fodder resource management

4.1 Feeding of balanced ration to animals

Rural women 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 should be provided to 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 5kg milk per day. 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.

4.2 Fodder resource 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. Legumes enriching the soil can be grown in mixtures with grasses in grasslands. Indigenous legumes such as clovers (*Trifolium pratense*, *T. repens*), *Medicago denticulata*, *Melilotus alba*, white clover, red clover have proved successful apart from Lucerne and Berseem.

The grass rangelands exhibited enormous gain in forage production through multi-tier silvipasture and hortipastoral techniques amalgamated with planting of multipurpose trees in wastelands followed by sowing/planting of grasses or legumes in inter-spaces of trees. Under alley cropping system, *Leucaena leucocephala* provide leaf fodder to get better crop production. Foliage of fodder trees could be fed mixed with crop residues and hay which improved their palatability and nutritive value.

4.3 Conservation of fodder resource

Green fodders of conventional source in excess during rainy season can be conserved as silage and hay making. Ensiling preserved green fodder in succulent form under anaerobic fermentation of carbohydrates. Excellent silage may be made from maize, sorghum, bajra and barely at flowering to milk stage (DM-30-35%) of cereal crops exhibiting yellowish-green in colour with a pleasant vinegar smell. Hay making ensure drying and storing of high quality forage by reducing the moisture content to the level of below 15%. Thin stemmed crops like berseem, lucerne, cowpea, soybean, oat and natural grasses at early flowering stage are suitable for hay making.

4.4 Improving quality of crop residues and agro industrial byproducts

The crop residues especially jowar, bajra, maize stovers, wheat and paddy straw are used as staple diet for dairy animals in our country are highly fibrous in nature with low crude protein and high energy content. But, their lingo-cellulose complex is more resistant for rumen microbial enzymes and reduce the bioavailability of energy source (cellulose and hemicellulose) to animals. Various processing methods like 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. Biological treatment with white rot and brown rot fungi also improve the nutritive value of crop residues and agro industrial by products.

The feeding value of crop residues and agro industrial by products can be improved if they are blended into complete feeds. Complete feeds with desired ratio of roughage, 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. 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)

5. Dairy farming in Integrated farming system

Integrating crops and livestock serves primarily to minimize risk and not to recycle resources. 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.

6. Community-based extension approach in Dairy farming

Dairy farm women 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 land use (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. However, legume and fodder tree/ shrub species and access to fodder minikits programmes need to be prioritised for production of good biomass. Management of natural forest by the community could be improved substantially, ensuring ecological stability and reducing biotic pressure on existing resources.

7. Cooperation of government - NGOs for feminization of dairy sector

Feminization of dairy industry lays in the formation of village level women self help groups (SHGs). Concerted 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). Local banks should encourage the rural women for dairy business by easily availability of loans with reasonable interest or providing subsidies to dairy farmers. 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 as well as NGOs must take initiative for proper functioning of artificial insemination 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. If all suggestive measures taken up by government then only the study area will get momentum in feminization of dairy sector.

8. Empowering women through Improved Dairy farming: Scope and Challenges

Training in technologies relevant to livestock management enhances knowledge and skills in animal rearing practices, disease management and feed management, which eventually improve income to the household (Nirmala *et al.*, 2012). Training on balanced feeding ranked highest in information need as compared to breeding, marketing, management of cattle shed, etc. Training has made tremendous change and interest among the trainees to gain more knowledge probably due to usage of method demonstration, audio visual aids and also their own different livestock species they could easily understand and remember the technologies taught in the training. Further, training if conducted frequently would increase the level of knowledge, which in turn reflects into better dairy farming and management and ultimately increases production performance of dairy animals and empowerment of farm women.

Dairying in India is a female dominated enterprise. Selection of breed, compounding balanced feed using locally available ingredients, feeding during pregnancy, health care and banking and insurance were the most preferred area in dairy farming. 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 the organisations planning and implementing livestock development programmes are sensitive towards the needs, resources, production systems and perceptions of the families and extension service is strengthened and targeted to the underprivileged families particularly the women. Action plans should be agreed and implemented based on the outcomes of the iterative interactions amongst the social groups and the technical teams regarding the ways to increase productivity and profitability and to improve the non-market functions of dairy farming at household, community and village levels. Success in dairy farming improved the socio-economic status and the position of the farm women in their home and village which ultimately leads to women empowerment through creating awareness and capacity building, leading to greater participation, greater decision making power, control and transformation action.

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Production of Hydroponics Green Fodder for Eco-Friendly Animal Production

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Introduction

For the development of eco-friendly animal production system, particularly dairy farming, availability of quality green fodder round the year is highly essential. However, the various constraints in the production of green fodder by the dairy farmers are small land holding or unavailability of land for fodder cultivation, scarcity of water or saline water, more labour requirement, requirement of manure and fertilizer, longer growth period (45-60 days), fencing to prevent fodder crop from wild animals and natural calamities etc. Further, the non-availability of constant quality of fodder round the year aggravates the limitations of the sustainable dairy farming. Due to the above constraints of the conventional method of fodder cultivation, hydroponics technology is coming up as an alternative to grow fodder for farm animals (Naik *et al.*, 2011; Naik and Singh, 2014; Naik *et al.*, 2015). The word hydroponics has been derived from the Greek word ‘water working’. Hydro means ‘water’ and ponics means ‘working’ and it is a technology of growing plants without soil, but in water or nutrient rich solution in a greenhouse for a short duration of approximately seven days. The use of nutrient solution for the growth of the hydroponics fodder is not essential and only the tap water can be used. The nutrient content of the seed is sufficient to fuel the growth of the fodder plant for short duration.

Production of Hydroponics Green Fodder

The hydroponics green fodder is produced in greenhouses, which can be hi-tech or low cost devices. The hi-tech greenhouse is associated with a control unit and may be with or without air conditioner. The control unit regulates input of water and light automatically through sensors. (Naik *et al.*, 2013a).



Hi-tech greenhouse for hydroponics green fodder production

The low cost greenhouse (devices or shade net structure) for production of hydroponics green fodder can be constructed with bamboo or wood or MS or GI pipes or brick masonry. The existing wall of a house can also be used to construct lean-to-shade net greenhouse, which reduces the cost of fabrication. The cost of the structure depends upon the type of construction material; but is significantly lower than the hi-tech greenhouse. In low cost greenhouse system, the irrigation of the hydroponics fodder can be made by micro-sprinklers (manual or automatic) or a knapsack sprayer at frequent intervals. In shade net structure, the internal environment of the greenhouse is more influenced by the outside climatic condition and therefore, the types of fodder to be grown hydroponically depends upon the season and climatic condition of the locality (Naik *et al.*, 2013b).



Low cost greenhouse for hydroponics green fodder production

Although many types of fodder crops can be grown under hydroponics technology (Naik *et al.*, 2012a; Naik *et al.*, 2015; Naik *et al.*, 2017a), in India, maize should be the choice grain for production of hydroponics green fodder due to its easy availability, lower cost, good biomass production and quick growing habit. The grain should be clean, sound, undamaged or not insect infested, untreated and viable. The maize seeds should be soaked in normal water for about 4 hours and strained before placing it in trays or troughs for sprouting inside the greenhouse, usually for 7 days. The quantified seeds of a particular day can be soaked in a bucket and the debris and broken seeds floating on the water can be removed easily.

The quantity of seeds loaded per unit surface area of the green house tray (seed rate) also affects the germination of the seeds as high seed rate enhances mould growth. The seed rate of 7.6 kg/m² can be recommended for growing hydroponics maize fodder for higher output (Naik *et al.*, 2017b). The trays are put inside the greenhouse and are allowed to sprout for about seven days and on 8th day generally they are harvested and fed to the animals. The germination of the maize starts on 2nd-3rd day and the extension of the roots are clearly visible from 3rd-4th day onwards. The hydroponics green fodder looks like a mat of 20-30 cm height consisting of roots, seeds and plants.

The water should be clean and free from chemical agents. It is observed that recycling of water enhances mould growth inside the greenhouse. Therefore, it is suggested that if water availability is adequate, water should not be allowed to recycle within the system instead regular drained water can be used in a garden or for cropping near to the greenhouse. In hydroponics technology, to produce one kg of maize fodder about 1.50 litres (if water is recycled) to 3.0 litres (if water is not recycled and drained out) of water is required (Naik *et*

al., 2013c). Cereal seeds germinate equally well under dark or light conditions and high intensity of light is not necessary for the growth of the plants. After harvesting, the trays should be cleaned by mild cleaning solutions. The holes of the foggers must be cleaned by pins for proper fogging. The floor and walls of the greenhouse also be cleaned properly to avoid growth of mould.

Feeding of Hydroponics Green Fodder

The yield of the hydroponics green fodder is highly influenced by the type and quality of the seeds and cleanliness of the greenhouse. Yields of 5-6 folds on fresh basis and dry matter content of 11-14% are common for hydroponics maize fodder; however, sometimes dry matter content up to 18% has also been observed (Naik *et al.*, 2014). Some farmers have revealed fresh yield up to 8-10 folds for hydroponics maize fodder in low cost greenhouse system (Naik *et al.*, 2013b). However, the fresh yield is mostly influenced by type & quality of the seeds; degree of drainage of free water prior to weighing; and clean & hygienic conditions of the greenhouse. The cost of production of the hydroponics fodder is mainly influenced by the cost of seeds; as it contributes about 90% of the total cost of production. However, in low cost greenhouse system with home-grown or locally purchased seeds, the cost of production of the hydroponics fodder is very reasonable (Naik *et al.*, 2012b).

Hydroponics maize fodder is more nutritious than the conventional maize green fodder (Naik *et al.*, 2012a). In comparison to conventional maize fodder, the hydroponics maize fodder contains more crude protein (13.6 vs 10.7; %), ether extract (3.5 vs 2.3; %) and nitrogen free extract (66.7 vs 51.8; %); but less crude fiber (14.1 vs 25.9; %), total ash (3.8 vs 9.4; %) and acid insoluble ash (0.3 vs 1.4; %). Different types of cowpeas such as DU-3 (Naik *et al.*, 2016a), NB-4 (Naik *et al.*, 2016b) and alsando (Naik *et al.*, 2017a) can be sprouted hydroponically for 6-9 days to use as feed supplement for dairy animals. The crude protein content of the roots (10.25%) and leaves (22.15%) of the hydroponics maize fodder are similar to the crude protein content of the non-leguminous and leguminous fodder, respectively (Naik *et al.*, 2017b). Besides, hydroponics green fodder has greatest enzyme activity, rich source of anti-oxidants (in form of β -carotene, vitamin-C, E), good sources of chlorophyll, enhancement of immune system, etc (Chavan and Kadam 1989; Sneath and McIntosh 2003). Hydroponics green fodder is palatable and relished by the dairy animals. The intake of fresh hydroponics maize fodder by dairy cows may be up to 25 kg/ animal/ day along with limited concentrate mixture and jowar straw (Naik *et al.*, 2016c). However, it is recommended to supplement 5-10 kg fresh hydroponics maize fodder per cow per day (Naik *et al.*, 2016d). Feeding of hydroponics green fodder increases the digestibility of dry matter (6.9%), organic matter (6.7%), crude protein (5.3%), ether extract (6.9%), crude fibre (11.2%) and nitrogen free extract (4.6%) of the ration; which contributes in the increase in the milk production of the lactating animals by 8-13% (Naik *et al.*, 2014). Hydroponics fodder can be fed to dairy animals by replacing maize of the concentrate mixture partially with improvement in the performance of the animals (Naik *et al.*, 2017c).

Conclusions

As green fodder is an integral part of dairy ration, in situations, where conventional green fodder cannot be grown successfully or progressive modern dairy farmers with elite dairy herd can produce hydroponics fodder for feeding their dairy animals. Hydroponics fodder is a

viable option for fodder scarcity and is a very promising technology for eco-friendly animal production in India.

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Mitigating Malnutrition Through Inclusive Agriculture in India

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“Malnutrition refers to deficiencies, excesses or imbalances in a person’s intake of energy and/or nutrients. The term malnutrition covers 2 broad groups of conditions. One is ‘undernutrition’—which includes stunting (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals). The other is overweight, obesity and diet-related non communicable diseases (such as heart disease, stroke, diabetes and cancer).”

As per the National Family Health Survey (NFHS)-4 following are the finding of the Extent of Malnutrition in India

- Due to acute undernutrition, 21% of Children aged between 0 to 5 years in India suffer from wasting.
- In India, 38.7% of children are stunted and the percentage of children aged 0 to 5 years who are underweight is a 36%.
- India is home to 3 out of 10 children suffering from Stunted growth in the world.
- 53% of women in India suffer from Anaemia (Haemoglobin below 11.0 g/dl), the percentage of children is 58% for the same
- The 2017 Global Hunger Index (GHI) Report ranked India 97th out of 118 countries with a serious hunger situation.

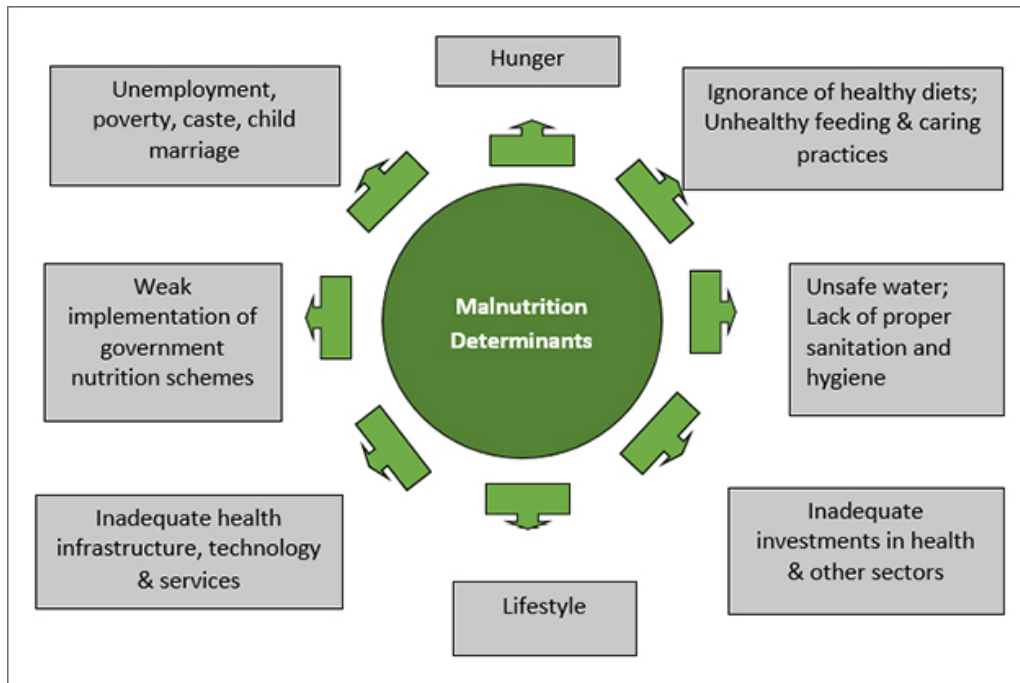
Following are the various factors which are responsible for such widespread Malnutrition in India. These factors have been derived from the National Family Health Survey (NFHS)-4.

- Mother’s health related factors like her weight, her Haemoglobin levels, and the age at which they give childbirth etc.
- Micronutrient intake, breastfeeding practices, etc which are determined by schooling and education of the mother.
- Availability of clean drinking water, open defecation, open drains and other factors which deal with Hygiene and Sanitation
- Poverty levels which have a direct impact on social an economic well-being immunization coverage extent and Incidence of diseases.

Malnutrition Impacts the Indian Population in Many ways, following are some of the direct and indirect Effects.

- The nation’s productivity is impacted because the population is more prone to diseases leading to higher mortality rate and morbidity because of Malnutrition.
- A country’s economic and fiscal resources are burdened because of High Disease Incidence.

- Malnutrition impacts a child's basic learning and cognitive skills which has a very negative impact for a country like India who is aiming to be a knowledge-driven economy
- Inequality of Income and an increase in poverty levels is also an effect of malnutrition.



Government of India has been taking the fight against Malnutrition quite seriously and have picked significant steps. Few of these steps have been listed below –

- MAA initiative – Which aims to promote exclusive breastfeeding by mothers during the initial few months after childbirth.
- To promote institutional deliveries, supporting pregnant and lactating mothers, providing information related to nutrient intake to mothers following schemes are run by the govt – PM Surakshit Matriva Abhiyan, PM Matru Vandana Yojana, Kilkari project, etc.
- To increase immunization among children and women, mission Indradhanush is launched
- To address the issue of hunger among children from poor families, schemes like National Food Security Mission, Mid Day Meal etc are run by the government.
- To address the issue of deficiency of micronutrient Government is promoting research on the field of biofortification of crops.

The Government has accorded high priority to the issue of malnutrition in the country and is implementing several schemes and programme:

Direct Targeted interventions:

- 1) Integrated Child Development Services (ICDS)
- 2) National Health Mission (NHM)

3) Mid-Day Meal Scheme

4) Rajiv Gandhi Schemes for Empowerment of Adolescent Girls (RGSEAG) or SABLA,

5) Indira Gandhi Matritva Sahyog Yojana (IGMSY)

Indirect Multi-sectoral interventions:

1) Targeted Public Distribution System (TPDS)

2) National Horticulture Mission

3) National Food Security Mission

4) Swachh Bharat Abhiyan

Other steps include:

- National Nutrition Strategy (NNS) has been published by NITI Aayog in 2017 with Vision 2022: “Kuposhan Mukh Bharat”.
- Promotion of appropriate infant and young child feeding practices that include early initiation of breastfeeding,
- Exclusive breastfeeding till 6 months of age and appropriate complementary feeding after 6 months of age.
- Central governments have initiated various programs like MAA (Mothers Absolute Affection) to promote exclusive breast feeding; Pradhan Mantri Surakshit Matritva Abhiyan;
- National Iron plus Initiative (NIPI) for Anemia control among children from 6 to 60 months of age.
- Village Health and Nutrition Days and Mother and Child Protection Card are the joint initiative of the Ministries of Health & Family welfare and the Ministry of Woman and Child for addressing the nutrition concerns in children, pregnant women and lactating mothers.
- Specific program to prevent and combat micronutrient deficiencies of Vitamin A and Iron & Folic Acid (IFA) in under-five children, children of 5 to 10 years of age, and adolescents.
- Management of malnutrition and common neonatal and childhood illnesses at community and facility level by training service providers in IMNCI (Integrated Management of Neonatal and Childhood Illnesses) training.
- Rashtriya Bal Swasthya Karyakram (RBSK) provides child health screening for common health conditions by expanding the reach of mobile health teams at block level and establishment of District Early Intervention Centres (DEICs) at the districts for early interventions services. Under the Rashtriya Bal Swasthya Karyakram (RBSK), systematic efforts are undertaken to detect nutrition deficiency among children and adolescents respectively.

Malnutrition is high despite all the efforts due to:

- 1) Corruption in implementation of schemes
- 2) Diversion of ration meant for mid day meal
- 3) Poor quality of food given in mid day meals.
- 4) Poor sanitation and hygiene decreases the nutrition absorption rate
- 5) Low social status of women
- 6) Lack of infrastructure in rural areas.

Policy and Programme Interventions

India’s Nutrition Policy of 1993 was shaped on the basis of a detailed understanding of the factors responsible for the occurrence of malnutrition. The policy called for the adoption of a multi-sectoral approach and the implementation of a wide range of measures to achieve the goal of optimum nutrition for all. Subsequently, numerous plans, programmes and missions were launched on various occasions (Box 1).

Box 1: Government Policy Interventions and Programmes to Combat Malnutrition

Direct Policy Measures	Plans, Programmes and Missions
<ul style="list-style-type: none"> • Expand the safety net through ICDS to cover all vulnerable groups (children, adolescent girls, mothers, expectant women) • Fortify essential foods with appropriate nutrients (e.g., salt with iodine and/or iron) • Popularise low cost nutritious food • Control micro-nutrient deficiencies amongst vulnerable groups <p>Indirect Policy Measures</p> <ul style="list-style-type: none"> • Ensure food security through increased production of food grains • Improve dietary pattern by promoting production and increasing per capita availability of nutritionally rich food • Effecting income transfers (improve purchasing power of landless, rural and urban poor; expand and improve public distribution system) • Other: Implement land reforms (tenure, ceiling laws) to reduce vulnerability of poor; increase health 	<ul style="list-style-type: none"> • Mid-day Meal Programme, 1962-63 • Goitre Control Programme, 1962 (now known as National Iodine Deficiency Disorders Control Programme) • Special Nutrition Programme, 1970-71 • Balwadi Nutrition Programme, 1970-71 • Nutritional Anaemia Prophylaxis Programme, 1970 • Prophylaxis Programme against Blindness due to Vitamin A Deficiency, 1970 • Integrated Child Development Services (ICDS), 1975 • National Diarrhoeal Diseases Control Programme, 1981 • Wheat-based Supplementary Nutrition Programme, 1986 • National Plan of Action on Nutrition, 1995 • Public Distribution System, 1997 • National Nutrition Mission, 2003

<p>and immunisation facilities, and nutrition knowledge; prevent food adulteration; monitor nutrition programmes and strengthen nutrition surveillance; community participation</p>	<ul style="list-style-type: none"> • National Health Mission, 2013 (subsumes former Rural & Urban Health Missions) • National Iron+ Initiative, 2013 • Promotion of Infant & Young Child Feeding Practices Guidelines, 2013 • Weekly Iron & Folic Acid Supplementation, 2015 • National Deworming Day, 2015 • Establishment of: Nutritional Rehabilitation Centres; Village Health Sanitation & Nutrition Committee • Bi-annual Vitamin-A Supplementation • Village Health & Nutrition Days (at Anganwadi centers)
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Source: National Nutrition Policy, 1993; Ministry of Health and Family Welfare. *Annual Report 2015-16*. Chapter 3 – Maternal and Adolescent Healthcare p. 27-31; Chapter 4 – Child Health Programme, p. 39. New Delhi: Department of Health and Family Welfare; The Indian Express, 30 December 2015, *Op.cit.*

Leveraging Agriculture for mitigating Malnutrition

1. Focus on increasing the **area under nutritious crops** to provide increased availability of nutrients per unit area.
2. Agricultural extension is important for **transferring relevant knowledge and information to farmers**. Agriculture extension has to be inclusive of nutrition - sensitive agricultural practices.
3. **Good quality and timely availability of agricultural inputs** : Access to seeds, fertilizers, pesticides and extension services has to be ensured. Proper demonstrations and orientation programmes should reach out to each and every farmer.
4. **Minimum Support Price (MSP)** , assured procurement and managing imports : The lack of an assured market and procurement forces farmers to choose crops such as rice, wheat and cotton in favour of millets or pulses. The timely announcement of MSP for pulses and millets is very important for farmers to plan.
5. **The role of women in agriculture** cannot be over- emphasized. FAO estimates that if women worldwide had the same access to productive resources as men, they could increase yields on their farms by 20-30 per cent and total agricultural output by 2.5 to 4 per cent.
6. **Efficient information dissemination** : Awareness of government schemes, new technologies and cropping practices is found to be largely lacking. The print and electronic media and ICT have to be effectively harnessed for better reach.

7. Linking farmers and farming households to institutional feeding programmes:

Aganwadi centres and schools for mid day meal should purchase vegetables from women farmers' groups and cook these for children. The initiative would also have a positive impact on empowering women farmers and promoting local value chain.

8. As in the case of vegetables, local procurement of millets and pulses and linking with food distribution programmes under the ICDS and MDM with coordination at the Panchayat or Block level will **promote local agri-food value chains for nutrition.**

9. There is evidence that household **nutrition gardens of nutrient dense vegetables and fruits** promote dietary diversity and they have to be actively promoted.

10. Homestead production of animal source foods from livestock, poultry and fish contribute to both household dietary diversity and incomes. Based on local resource availability and cultural practices, they have to be an integral part of the farming system model for better nutrition.

11. The importance of social and behavioural change cannot be over emphasised. Nutrition awareness on balanced diet, health hygiene and sanitation and behaviour change and communication are of crucial importance. Both traditional forms like street plays and folk songs, and ICT and mobile technology should be effectively harnessed for reaching out.

12. Nutrition sensitive agriculture is the key to ensuring the availability of nutritious cereals, pulses, fruits and vegetables and animal source foods

13. Farm Mechanization is also important. Women friendly tools and equipment should be popularised, so that it will not only enhance the productivity but also reduce the drudgery

Way Forward

- A decentralized approach should be promoted with greater flexibility and decision making at the state, district and local levels.
- The ownership of Panchayati Raj and urban local bodies is to be strengthened over nutrition initiatives.
- Mothers should be made aware of the right nutrition their child will need to stay strong and healthy.
- Medical solutions to the problem of malnutrition include de-worming and nutritional supplements. De-worming campaigns are quite effective and have been conducted in many daycare centre and health encampments.
- Overall sanitation and hygiene of rural and urban areas is to be increased. Poor sanitation and frequent illness reduces the child's nutritional absorption capacity.
- The whole mid day meal process should be made more transparent to make sure that the government initiatives bring out intended results.

Conclusion

An overview of the malnutrition situation in India presented in this paper has shown that a sizeable proportion of the country's population are malnourished and anaemic, and for this, numerous factors are responsible. Some of these factors directly cause malnutrition among people, whereas many others affect indirectly. Significant among these are poverty; unemployment; ignorance and lack of education; unhealthy lifestyle; lack of access to nutritious food, safe water, sanitation and hygiene; non-availability of reliable and timely data, and sufficient funds; and unimpressive performance by the government in the implementation of schemes. Many of the reasons for the occurrence of malnutrition, as well as the solutions to overcome the challenge, are known. Attention, however, needs to be paid to understanding what prevents the nation from achieving its goals related to nutrition. Undoubtedly, the agencies of State governments have to adopt a comprehensive and coordinated multi-sectoral approach which is formulated by taking into account the varied nature of local-level challenges. They have to demonstrate better governance, too. For its part, civil society must respond in a responsible manner. In particular, attention needs to be paid on building neighbourhood health and nutrition profiles and carrying out interventions based on identified needs.

Health Management and Bio-security in Livestock and Poultry Production

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Biosecurity is a procedure for protecting a flock or herd from infectious diseases that do not currently exist in its premises. It includes the precautionary measures that are taken to prevent diseases from entering the farm. This process can be applied to an individual, a farm, a district, or an entire country.

The consequences of a serious disease outbreak may place an entire enterprise at risk. By having in place a clearly documented set of disease prevention and control strategies, producers can greatly reduce the risk of disease entering or spreading within the farm.

Importance of biosecurity

Preventing disease occurrence through biosecurity is the most cost effective way of protecting animals and birds against disease. Diseases reduce the efficiency of production and decrease profits. Thus, it makes economic sense for farmers to ensure an adequate level of biosecurity to protect against losses and unnecessary costs associated with the control of diseases. The application of biosecurity measures will not necessarily guarantee prevention of disease entry but will limit the likelihood of entry and reduce disease incidence and dissemination.

Phases of Biosecurity

Biosecurity has four sequential phases:



Mitigation is a type of prevention that lessens danger or harm by securing premises against infectious diseases.

Preparedness includes planning and implementing mitigation practices. Producers analyze the weaknesses and strengths of their facilities to determine the most effective ways of protecting them.

Response is handling a disease outbreak efficiently and effectively. The first 24 hours are crucial. Abnormal animal health issues, including massive die-offs and unusual symptoms must be immediately reported to the nearest animal health personnel, development agent or animal health regulatory officials.

Recovery begins when the disease outbreak has been eradicated or controlled. During recovery, premises and facilities are restored to an acceptable operational level. Covering pits and disinfecting premises might be part of the recovery process.

Biosecurity program principles

A successful herd biosecurity program utilizes three important factors:

1. Increase the animal's ability to resist disease
2. Minimize the number of contacts that result in disease
3. Eliminate the sources of the infectious agent

1. Increase the animal's ability to resist disease

Resistance to disease may be non-specific, meaning that an animal is in good enough health to generally fight infection; or resistance may be specific, meaning that the animal's immune system is prepared to defend against a particular disease agent. Vaccines increase an animal's specific resistance to disease. Developing immunity to a disease is the protective response stimulated within an animal by vaccination.

However, vaccinated animals may still get sick because of the following reasons:

Pathogens different from those included in the vaccine were involved

The immune system was overwhelmed by the infection

The vaccinated animal failed to mount a protective immune response

Therefore vaccination programs must be considered as a supplement to other disease control procedures but do not replace them.

2. Minimize the number of contacts that result in disease

The number of effective contacts that may result in disease transmission can be reduced by physically separating animals. Methods of physical separation include

- quarantine of animals
- segregation, often by age or class of animal
- isolation of individuals
- reducing animal density by diluting the number of animals over a larger geographical area.

3. Eliminate sources of the infectious agent

Reservoirs of infection are animals or birds that the causative agent depends on for survival; including other cattle, sheep and goats, people, birds, rodents, manure, soil, and others. Infectious agents may reside in carrier animals that are infected but show no clinical illness or they may survive in the environment waiting to be transmitted to the host animal by direct or indirect contact.

The infection status of a herd is often classified as disease-free, usually meant in terms of specific diseases. This claim is often supported by disease testing or lack of incidence of a particular disease in that herd. When searching for new stock, it is best to acquire animals only from source herds that known to be free of infected animals.

General Biosecurity measures

- Write a biosecurity protocol taking into consideration the diseases of greatest concern, their mode of transmission, methods to diagnose the disease, and treatment options for those animals diagnosed as having a disease of concern.
- Limit visitors to your farm. Visitors should wear boots, disinfect them prior to entering the farm, and not have been on another farm for at least 48 hours. Boots and coveralls should be supplied by the farm to ensure compliance.
- Limit vehicle traffic onto the farm to those that are essential for farm business and provide an area outside the farm to disinfect tires.
- Control insect populations and the access of wildlife, rodent, bird, and domesticated animal populations to your farm.
- Ensure that feed is not contaminated by manure or urine.
- Do not reuse needles, and disinfect reusable equipment between animals.
- Culture the milk of all dairy animals to determine if contagious mastitis is present on the farm. Repeat cultures of all dairy animals annually. Examine your health records or perform serology to determine if hard udder has been identified on your farm.
- Examine your herd for diseases such as pink eye, external parasites, foot rot, sore mouth, respiratory disease, ringworm, diarrhea, external abscesses, mange, and the meningeal worm.
- Examine rams for the presence of epididymitis. If any of these diseases exist on your farm, design a control program and implement the program as soon as possible.
- Vaccinate your herd against rabies and the clostridial diseases of import in your area. Consider Enroll in the Federal Scrapie Control Program.
- Deworm on a regular schedule and run fecal exams semi-annually to ensure adequacy of the parasite control program.
- Treat animals returning from exhibition as new additions.
- Examine your herd's health records and determine if any animals have been affected with signs of chronic weight loss, neurological disorders, abortions, or arthritis. If any of these conditions have been seen within your herd, screen the herd for diseases such as Johne's disease, scrapie, chlamydiosis, campylobacteriosis, toxoplasmosis, brucellosis, and mycoplasmosis etc.
- Test any animals with signs of weight loss, abortion, diarrhoea, hard udder, arthritis, pneumonia or neurological symptoms for the appropriate diseases listed above.

Specific biosecurity measures

Bringing new animals into the herd

The most common source of new infections is new animals introduced into the herd. Animals can appear healthy while at the same time carrying a range of diseases. Purchasing animals that have the least disease risk must be a primary aim of farmers. The risk of buying infected

ones cannot be totally eliminated, but can be significantly reduced by making careful enquires regarding the health status of the animal.

Following situations could cause this scenario:

- The animal was incubating the disease at the time of purchase.
- The initial test was a false negative.
- The stress of movement caused a latent infection to reactivate.

The animal was exposed to the disease in transit or after reaching your farm

Once a decision is reached on buying an animal, follow these steps:

1. Find out the disease history of the herd of origin, the results of previous disease testing and the herd's current health.
2. Determine the pre-purchase disease status of the individual animal(s) that you are purchasing. Check teeth, udders, and in the case of males, ensure they are reproductively sound. Examine feet of all the cattle, sheep and goats and treat as necessary for foot rot. A veterinary examination prior to purchase and transport may help in identifying important diseases.
3. If the animals appear healthy, transport them in clean vehicles to your herd and place them in quarantine or an isolation area. The quarantine area should have adequate fencing to ensure containment of isolated animals. The location is important to minimize contamination of other paddocks and areas of the farm. If a disease has been introduced, vigilance will help detect the outbreak in the early stages, so that its spread can be prevented and damage minimized.
4. At the midpoint of the quarantine period a careful physical examination should be performed to ensure the animal is free of physically obvious diseases. At the same time consider retesting the animal for critical diseases to exclude from your herd. There exists a distinct possibility that the purchased animal will test positive to a disease for which it was negative at time of purchase.
5. At this time it may be beneficial to administer appropriate antibacterial drugs; deworm and vaccinate for common diseases found in the area and herd.
6. Acclimatize new animals to the environment, feed and water. This will allow the animal's innate resistance to be minimally stressed and will help the animal in preventing disease. Sudden changes in food and water are viewed with suspicion which means they may eat or drink less than they should.
7. At the end of the quarantine period it would be wise to allow exposure of the new animal to a small group of the herd. If these selected animals don't get sick after mixing with the purchased animal one can assume that the rest of your herd will be safe. If the selected animals do get sick, they can be kept in quarantine until cured or removed from the herd. By following this procedure, you prevent the whole herd from being infected with a potential disease and you have proven that the incoming animal is not a carrier of disease.

Diseases from other species

Cattle, sheep and goats share a number of diseases and mixing these species is not necessarily safe. Other animal species can also transmit disease. For instance, Toxoplasmosis is a disease that causes abortions in sheep and goats. The infectious agent is a protozoan parasite that is transmitted by the domestic cat. Cats get infected by eating diseased mice. Animals get infected when they fed grain contaminated with cat feces. Control rodent populations on the farm.

People (visitors): A strategically placed notice on the entry gate of the farm will help ensure that all visitors check in at the office before having contact with stock. Disinfecting footwear and wearing clean outer clothing should become routine practice for personnel arriving for work on the farm. It is best to keep people (especially other livestock producers) from entering and walking through your facility without following biosecurity measures.

Trucks and trailers: Trucks and trailers that are used for hauling livestock accumulate manure and other body fluids. If these vehicles are not washed and sanitized between loads they can serve as a very efficient fomite. Similar arrangements should be made for feed trucks and other farm service vehicles.

Feed: Feed can be a source of infectious material onto your farm. The feed can get contaminated at the mill, at the store, or on your farm by feces from birds or rats. This contamination could result in feeding grain mixed with Salmonella or other infectious agent to your animals. The solution is to buy feed from reputable suppliers, keep the feed in rodent proof containers and avoid having spilled grain on the premises as it serves to draw birds and rodents.

Water: Well water can be a source of contamination from manure or chemical (fertilizer, pesticide, etc.) runoff and may serve as a source of disease. Water that flows onto the property from other livestock enterprises should always be fenced off.

Movement of effluent between farms: Contact of uninfected animals with infected effluent coming from an adjacent infected farm can spread disease.

Dead animals: All mortality should be handled and disposed of properly to prevent access by herd mates, predators, rodents, cats, etc., and eliminate the opportunity for disease transfer.

Movement of contaminated personnel and equipment: Movement of people, clothing, footwear, equipment and vehicles between infected and uninfected premises should be avoided to limit disease spread within and between enterprises.

OTHER IMPORTANT STEPS FOR SPECIFIC BIOSECURITY:

Limit disease spread

Limiting the disease to a certain population of animals in the herd or to a certain geographic location in the herd and not allowing it to spread can be achieved by:

Follow an all-in-all-out policy

Another important concept of biocontainment is to bring a set of animals or birds into a facility, raise them to a specified production level, remove all animals at the same time, then clean and disinfect the facility prior to introducing the next group.

Immunization of the established herd

Health is a balance between the resistance of an animal to disease and the dose of disease to which it is challenged. Sanitation is the tool used to reduce disease challenges to animals.

Disease resistance is composed of environmental factors and immunologic factors. Animals that are well fed and housed will be more resistant to disease than those that are poorly nourished and poorly housed.

Animals and birds that are immunized through vaccination against a specific disease will be more resistant to it than those that have not been vaccinated and consequently do not have immunity. To protect from disease through vaccination, it is important that vaccination be carried out prior to the challenge of the disease.

Vectors

Immunize the herd from vector borne diseases. Try to keep them in vector free environment. Avoid waterlogging places for sheds. Use fly repellants.

Biocontainment By combining local information on disease occurrence with epidemiological knowledge, disease prevention program could be developed.

The program should include routine annual vaccination of animals for the following diseases:

- Foot and mouth disease
- Hemorrhagic septicaemia
- Black quarter
- Pox disease
- Anthrax
- Pest des petits ruminants (PPR)

During an outbreak of disease, a ring vaccination program around the outbreak area is conducted, serving as a barrier to halt the spread of infection.

Disease Surveillance

Disease surveillance is a very useful tool in disease control programs. Disease surveillance lets someone know how a disease control program is working at various points in time.

There are two general methods to survey the level of disease in a herd, examining animals and examining data collected from animals.

Necropsy

A very useful surveillance tool is to have post-mortem performed on dead and moribund animals. Whenever there is an unexpected death in the herd it would be appropriate to have your veterinarian perform a necropsy to find the cause of immediate death.

Carcass disposal

Mortality happens on all farms. A biosecurity protocol should have a disposal plan. The following methods of carcass disposal can be applied:

Incineration: the most expensive way but has the advantage of speed and effectiveness.

Burial: cheap but may cause problems of contamination of ground water and odors. It is recommended to bury the carcass at least 1 meter deep and at least 2 meters above the water table.

Composting: cheap, environmentally friendly method of carcass disposal but requires some knowledge of the technique to work successfully. If done improperly, composting can create odors and contaminate ground water.

Identification

Individual identification of animals will help to evaluate individual animals. Each animal will need a tag, tattoo or ear notches so that anyone can identify it. Due to the nature of sheep and goats it is wise to use at least 2 forms of identification in case one is lost. Never mix different species of animals together.

Extension Strategies for Economic Empowerment of Women Through Livestock and Fish Farming

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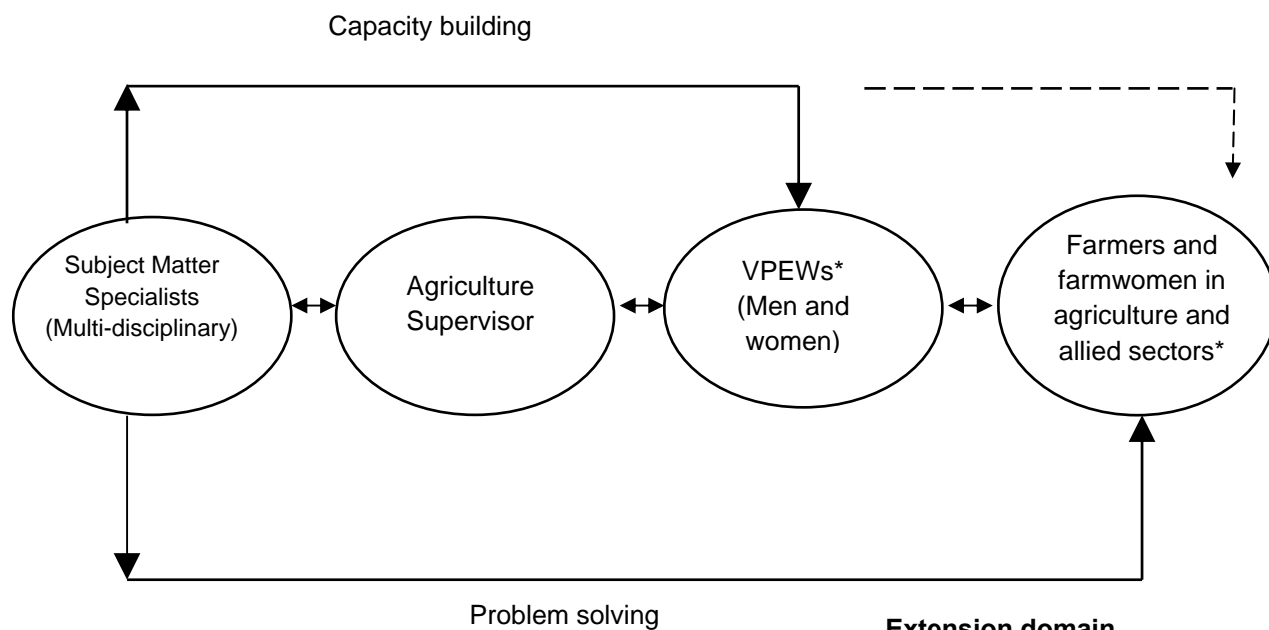
Participation of Farmwomen in Agriculture: Agriculture contributes 25% of GDP which is a female dominated activity. In dairy sector, 75 million women and only 15 million men are involved where as in animal husbandry, 20million women and 1.5 million men are there. According to FAO (2007) Southeast Asian women provide up to 90 percent of the labor involved in rice cultivation and that Sub-Saharan African women produce up to 80 percent of basic foodstuffs for household consumption and sale. But, there is a cultural perception that “women don’t farm” (World Bank and IFPRI 2010). However, women earn one tenth of world’s income but own less than one hundredth of the world’s property. According to FAO, the women receive extension support only 2 to 10%. In Ghana, the World Bank and IFPRI (2010) study shows that of the 70 agricultural extension agents surveyed, only 10 were female. So it is difficult for a male extension worker to deliver extension services to a woman. On the other side, various studies indicate that increasing women’s control over assets has positive effects on development outcomes such as food security, child nutrition, and education (Quisumbing 2003). Therefore, to reach the unreached farm women in Indian socio-culture, various extension strategies are required. Some of the extension strategies are stated below which have been developed at ICAR-CIWA, Bhubaneswar.

(i) Gender Sensitive Extension Model:

Background: Need for gender sensitive extension in agriculture and allied fields has gained considerable importance at the national level to stream line extension services for farm women. The growing demand for agricultural extension services specially in gender perspectives at the local level coupled with resource crunch with the state governments have created a need for an alternate extension model which must incorporate the essential dimensions of extension. The report of working group on Gender issues, Panchayat Raj Institutions, Public Private Partnership, Innovative Finance and micro-finance in agriculture, Planning Commission, January 2007 for the Eleventh Plan (2007-2012) suggested to appoint village youths as para-workers for agricultural extension.

Technology description: The Central Institute for Women in Agriculture has begun efforts to test gender sensitive extension model with a focus on involvement of a group of Village level Para Extension Worker (VPEW) in extension. An attempt was made in such a way which can be accommodated in the existing institutional frame of the State and Central Government. To describe briefly it is a model in which the Village level Para Extension Worker (VPEW) is considered as the most important pillar to support the model. Keeping the above fact in view an extension model based on public-private partnership was developed to address gender sensitivity, cost effectiveness, leadership development among farmwomen, technological location specificity and subject matter support from specialists.

Schematic Gender Sensitive Extension Model:



* Village level Para Extension Workers

Extension domain

- Gender sensitive
- Location specific
- Problem solving
- Broad based
- Cost effective
- Convergence

- The project should be taken up in an action research mode.
- Provision of honorarium/services charges for VPEW
- Required qualification for VPEW would revolve around gender biasness, skills in communication, physical vitality, background in agriculture, interest to serve the community and willingness to work with the scientists.
- Benchmark data should be collected through survey as well as on the ability of the Village level Para Extension Workers (VPEWs).
- All the Para Extension Workers should be provided pre-project as well as pre-seasonal trainings at the institution to give them exposures on basic methods of transfer of technologies in gender perspective
- The Para Extension Workers should give tips to render advisory services, advocacy, conduct discussion, meetings and organize methods and result demonstrations.
- Feedback and transfer of solutions were taken up through telephone calls and visits of Para Workers to the institution.
- The Subject matter specialists in their respective fields participate for capacity building of the Para Workers, test the gender sensitivity of the farm technologies and provide the solution to different location specific problems.
- The Technical Assistant/Supervisor implements the technical programs and monitors the activities of the Para Workers.
- Monitoring, concurrent evaluation, case studies, problem analysis, productivity analysis and group dynamics were taken up during the period of project implementation.

How it is women friendly:

- Balanced gender composition of VPEWs
- Assured women leadership development
- Equal participation of farm women as men
- Equal benefit of farm women as men
- Vigorous extension service towards women
- Gender sensitization of the clientele

Performance:

- Excellent gender awareness in locality
- SC, resource poor women and WSHGs derive maximum benefits from the model
- Increase in skills of farm women in the areas of:- nutrition garden cum seed production, mushroom cultivation, value addition, plant protection, fish culture, ornamental fish farming, back yard poultry rearing and vegetable cultivation
- Additional income of farm women specially from mushroom, backyard poultry, small ruminants, fry production, vegetable production, floriculture, and rice production
- Improvement in nutrition, employment, skill development, gain in knowledge and drudgery reduction

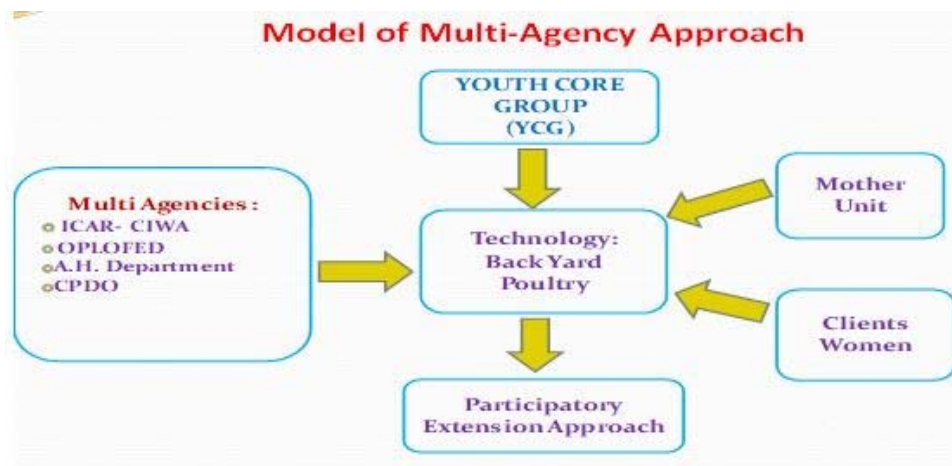
(ii) Multi Agency Participatory Extension Model:

Background: The major problem of farm women in poultry rearing has been observed that they are very rarely included in any skill training for their capacity building. They are lacking scientific practices of poultry production. They are also ignorant about sources of chicks, feed, immunizations, other marketing agencies, etc. But they require more earning and employment round the year. This is possible when the farm women become trained and aware of locally existing institutions. So, the need of the hour is to enhance the skill of women through involvement of local multi-agencies to ensure more earning and techno-socio-economic empowerment.

Technology description:

- The project designed in action research mode to evaluate the effects of the model on sustainability of backyard poultry farming by involving the resource poor farm women.
- The Youth Core Group (YCG including 1 male + 1 female) was selected with some criteria from four experimental villages to act as a bridge between the villagers and the agencies.
- The identified multi-agencies were distributed their respective roles and responsibilities.
- The Mother Unit concept was introduced in the villages to rear the day old chicks up to one month to reduce the mortality rate.
- Provision was made for monthly honorarium/service charge of YCGs.
- The capacity was built for both the Youth Core Groups and the farm women through training, demonstration, exposure visit and literatures.
- Youth Core Groups gave tips to render advisory services, advocacy, and meetings and organize demonstrations.

- Feedback and transfer of solutions were taken up through telephone calls and visits.
- Monitoring, concurrent evaluation, case studies, problem analysis, productivity analysis and group dynamics were taken up during the period of project implementation.



How it is women friendly:

- Provides family nutrition, the domain of women
- Women become decisive in management
- Needs less investment
- Women have more affinity towards homesteads where backyard poultry exists
- The model emphasized gender needs
- Developed women leadership in the locality
- Provide attractive colour egg and chicken to family
- Can be adopted by small, marginal and land less farm women

Performance:

- Created awareness in the locality for rearing backyard poultry
- SC,ST, OBC and resource poor women derived maximum benefits
- Increased knowledge and skill of farm women in the areas of care and maintenance of mother units, vaccination of the birds, feeding and drinking, and marketing.
- Provided additional income of farm women by selling egg and meet
- Improved family nutrition, employment and skill
- Developed small women entrepreneurship

(iii) Checklist for Assessing Gender Sensitivity in Extension Methods

Background: There are number of extension methods being used throughout the globe for dissemination of technology, knowledge, information etc. in the field of agriculture. It has been observed that there is discrepancy in the level of understanding and implementation of the technologies, knowledge and information among men and women. This suggests that either there is gap in the content or the method of extension to reach people. Therefore, modified gender sensitive extension methods are required that suits to the rural women to empower them in agriculture.

Technology description: This checklist follows a gender analysis framework and is intended to be comprehensive, flexible and adaptable. The checklist consists of 14 statements/items to

be used as check while assessing gender sensitivity in the extension methods. The equal weightage is assigned to each statement/item in checklist. The checklist statements may be administered to the extension personnel on two point continuums, viz. *Yes* and *No* with the scores of 1 and 0, respectively. The overall possible maximum and minimum scores are 14 and 0, respectively. Thus, gender assessment value of each response/method ranges from 0 to 1 i.e. when it is lowest, the score will be 0 and when it is highest, the score will be 1. The higher gender assessment value indicate greater gender sensitivity in extension method. It is calculated by following formula;

$$\text{Gender Assessment Value} = \frac{\text{Obtained Score}}{\text{Maximum Possible Score}} = \frac{\text{Out of 14}}{14}$$

Use the following checklist for assessing gender sensitivity in extension method:

Sl. No.	Statements	Weightage	Yes	No
1	Did you consider both farm men and women as an audience?	1/14		
2	Did you identify farm men and women key communicators from the village before communication?	1/14		
3	Did you consider the topic for communication as per interest of farm men and women?	1/14		
4	Did you preferred local language for communicating to farm men and women?	1/14		
5	Did you select gender balance team for communication?	1/14		
6	Did you select gender friendly audio-visual aids for effective communication?	1/14		
7	Did you consider farm men and women's resource base before communicating technologies?	1/14		
8	Did you consider the personnel, time and location accessible to both farm men and women during extension activities?	1/14		
9	Did you ensure the participation of farm men and women in extension activities?	1/14		
10	Did you allow both farm women and men to speak or raise their issues during the program?	1/14		
11	Did you cite farm women's and men's success stories to encourage both of them?	1/14		
12	Did you maintain the gender disaggregated data?	1/14		
13	Did you communicate the identified gender issues to research institutes?	1/14		
14	Did you motivate to farm men and women for equal participation in future activities?	1/14		

How it is women friendly: It ensures the effective implementation of gender perspective in the extension methods to reach farm women effectively.

Performance: It can be tested with any extension method.

(iv) Checklist for Integrating Gender Perspective in Agricultural Extension Research Project:

Background: The under-representation of farm women's perspective in agricultural research badly affects gender sensitive technology development. Extension research system is having inbuilt component of gender but remain inattentive. Hence, there is need for special reforms to focus especially on gender aspects which can reinforce to take in account both farm men and women equally. All agricultural research institutes in have inbuilt component of technology transfer to farmers but women farmers are bypassed inadvertently. Hence, the proposed checklist is designed to assist project investigator/team for bringing gender perspectives in agricultural extension research projects. It can be used as a planning guide for bringing gender perspective in new extension research projects, as a review procedure for the extension research projects in progress, and as a criterion for gender assessment of completed extension research projects.

Technology description: This checklist follows a gender analysis framework and is intended to be comprehensive, flexible and adaptable. The checklist consists of 28 statements/items to be used as check while incorporating gender perspective in the extension research projects. The equal weightage is assigned to each statement/item in checklist. The checklist statements may be administered to the project investigator on two point continuums, viz. *Yes* and *No* with the scores of 1 and 0, respectively. The overall possible maximum and minimum scores are 28 and 0, respectively. Thus, gender assessment value of each response/project ranges from 0 to 1 i.e. when it is lowest, the score is 0 and when it is highest, the score is 1. The higher gender assessment value indicate greater gender sensitivity of project. It is calculated by following formula;

$$\text{Gender Assessment Value} = \frac{\text{Obtained Score}}{\text{Maximum Possible Score}} = \frac{\text{Out of 28}}{28}$$

Checklist for Integrating Gender Perspective in Agricultural Extension Research Project

Sl. No.	Statements	Weightage	Yes	No
1	Have both farm men's and women's major income generating activity and gender division of labour been determined?	1/28		
2	Have the existing needs for farm men and women been identified?	1/28		
3	Have both farm men and women been consulted directly regarding their needs?	1/28		
4	Has any of the following	➤ Production/Productivity	1/28	
		➤ Access to and control over resources as well as benefits	1/28	

	related gender issues been focused to address?	➤ Gender relations	1/28		
		➤ Health and nutrition	1/28		
		➤ Drudgery	1/28		
5	Have gender balanced and gender aware project team been selected?		1/28		
6	Are the project objectives adequately addressing to identified gender issues and needs?		1/28		
7	Have the measurable gender indices to assess progress been developed?		1/28		
8	Have the tools to collect gender disaggregated data been prepared?		1/28		
9	Have methodology for analysing the data from gender perspective been developed?		1/28		
10	Have the organisations working for gender and development might contribute to the project been identified/consulted?		1/28		
11	Have the gender balance in selecting project beneficiaries been ensured?		1/28		
12	Are the targeted beneficiaries from vulnerable social groups?		1/28		
13	Have the constraints for farm men's and women's participation in the project been identified?		1/28		
14	Have the personnel, timing and location relevant and accessible to both farm men and women for the project activities been determined?		1/28		
15	Have the strategies for facilitating farm men's and women's participation in the project activities been planned?		1/28		
16	Have the strategies for ensuring project's extension system delivery reach to both farm men and women been planned?		1/28		
17	Has the separate budget for those strategies been allocated?		1/28		
18	Have the farm technologies according to need of farm men and women been identified or developed?		1/28		
19	Are the identified or developed technologies consistent with existing gender denominations in the farming communities?		1/28		
20	Has any of the following related changes been expected?	➤ Production/Productivity	1/28		
		➤ Access to and control over resources as well as benefits	1/28		
		➤ Gender relations	1/28		
		➤ Health and nutrition	1/28		
		➤ Drudgery	1/28		

How it is women friendly: It ensures the development of gender sensitive extension research projects for well being of farm women.

Performance: It can be tested with any extension research project.

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Fodder Supply Round the Year: A Viable Option for Profitable Dairy Enterprise

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In most small scale farming systems livestock graze in pastures or grass and other herbaceous plants. During the wet season these lands provide to some extent maintaining the green forage requirements. The trend of decreasing land holding size and common grazing area leads to increase the gap in requirement and demand. In the dry season however, the quantity and quality of forage greatly decreases and is generally low in nutritional value. Livestock sustained on such diets often lose weight and productivity. To avoid this problem farmers must provide their animals with quality feeds to augment dry season forages. One option is to supply expensive concentrates or supplemental feeding. For most small scale farmers this is not possible due to high costs and limited availability of supplements.

In Odisha mostly dairy cattle are raised with paddy straw which is a very inferior quality of fodder as the DCP content is almost zero and a very minimal quantity of energy is present (TDN 40-45%). Secondly paddy straw contains more lignin, silica and oxalic acid that interfere with the digestibility of fibre and calcium absorption respectively. Use of pesticides and insecticide in the rice resulted residues in straw that also hampers the growth and production potential of the animals. Besides paddy straw, gram stalks, maize stover, ground nut haulm are also available in much higher quantity in Odisha but a few of them have been utilized by the farmers due to lack of processing.

Green fodder is an economic source of nutrients for the livestock. However its availability in our state as well as in the country very is limited. Since independence the land diverted for fodder cultivation has been remaining constant of 4% of cultivable land but at the same time the dairy population has been increased many fold. With the limited land under fodder cultivation, there is a need to focus to improve productivity of fodder crops, utilizing common grazing lands and demonstrate to conserve surplus green fodder to enhance availability during the lean period.

Green fodders are much more superior than dry fodder as

- a) More palatable and digestible
- b) The crude protein is more than dry fodder (leguminous)
- c) Main sources of fibrous carbohydrate, which are well utilized by the animals
(the non-legume fodders are rich in carbohydrate)
- d) Good sources of important minerals like calcium and iron
- e) Rich source of carotene and vitamin E
- f) Economically viable than dry fodder with concentrate feeds

Strategies to increase green fodder production and availability

- a) Use quality seeds of high yielding varieties/hybrids of fodder crops
- b) Follow recommended agronomical practices of cultivation
- c) Follow suitable crop rotation
- d) Sow legume as an inter-crop or as a mixed crop with a non-legume crop to enhance the nutritional value of fodder and improve soil fertility
- e) Plant perennial grasses like hybrid napier bajra/guinea grass in about 15 to 20 per cent of the cultivated area to get green fodder round the year
- f) Plant fodder trees/shrubs on farm boundaries to get green fodder during the lean period
- g) Harvest fodder at the appropriate stage to get the maximum nutrients
- h) Adopt modern practices for hay and silage making to ensure supply of fodder during scarcity and avoid wastage of surplus green fodder
- i) Use chaff-cutter to minimise wastage of fodder

Various fodder crops/grasses/trees

1. Annual

Legumes : Berseem, Lucerne, Cowpea, Guar, Rice bean

Cereals : Maize, Sorghum, Oats, Millets, Barley

Miscellaneous : Mustard, Turnip, Fodder beet, Soya bean, sunflower

2. Perennial

Grasses : Hybrid napier bajra, Guinea grass, Para grass

Range Grasses : Anjan grass, Blue panic grass, Marvel grass, Rhodes grass

Pasture legumes : Butterfly pea, Stylo, Siratro

Shrubs & trees : Hedge lucerne, Subabool, Siris, Khejari, Gliricidia

Important fodder crops

Maize (*Zea mays*): Maize is one of the best cereal fodder crops grown during summer, rainy and/or early winter season. It produces rich and nutritious green fodder which is a good source of carbohydrates. The green fodder is particularly suitable for silage making. The yield varies from 30 to 40 tonnes/hectare.

Important varieties: African tall, JS-1006 and Vijay composite

Sorghum (*Sorghum bicolor*): It is the most important cereal fodder crop grown in summer/rainy season. Covering the maximum cultivated area among fodder crops, sorghum is grown in all parts of the country except the cool hilly areas. It has high tolerance to drought and excessive rainfall. There are single, two and multi-cut varieties/hybrids of sorghum giving one to six cuts per crop producing 50 to 100 tonnes/hectare of green fodder. To avoid prussic

acid or cyanide toxicity to livestock, the crop should be harvested at about 50 per cent flowering or after irrigation at the pre-flowering stage. The crop is also useful for hay and silage making.

Important varieties: PC-1, PC-6, PC-9, PC-23, HC-136, HC-171, PSC-1, Pant Chari-5, Pant Chari-6 and Sorghum sudan hybrid.

Berseem (*Trifolium alexandrinum*): It is a legume crop of the winter season grown mainly in Bihar, Haryana, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh. It gives six to seven cuts between November to May and produces 70 to 80 tonnes/hectare of extremely palatable and nutritious green fodder containing about 20 per cent crude protein. Berseem fodder is known as the 'milk multiplier'. Being a leguminous crop it also fixes atmospheric nitrogen in the soil and improves soil fertility.

Important varieties: JB-1, BL-1, BL-10, BL-42, UPB-110, Mescavi and Wardhan.

Lucerne (*Medicago sativa*): Known as the 'queen of fodder', lucerne is the most popular fodder crop in the country after berseem and sorghum. As a winter legume, lucerne is grown mainly in Gujarat, Madhya Pradesh, Maharashtra and Rajasthan. The crop can give seven to eight cuts from November to June with an average green fodder yield of 60 to 80 tonnes/hectare. The fodder contains about 20 per cent crude protein. The crop is appropriate for hay making. In some areas, it is cultivated as a perennial crop.

Important varieties: T-9, A-2, A-3, RL-88, CO-1 and LLC-5.

Cowpea (*Vigna unguiculata*): This legume crop is grown under both irrigated and rainfed conditions. It is widely cultivated across the country excluding the temperate hilly areas. It has great potential as a mixed crop when sown with maize, sorghum and millets to produce an ideal 'legume & cereal' fodder mixture. It grows quickly and can yield 25 to 45 tonnes/hectare of green fodder. It also finds use as green manure.

Important varieties: EC-4216, UPC-287, UPC-5286, GFC-1, GFC-2 and GFC-4.

Oats (*Avena sativa*): It is a winter season cereal fodder crop, mainly cultivated in Bihar, Haryana, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh. It has excellent growth and shows quick regeneration capacity after cutting. The green fodder is succulent, rich in carbohydrates and palatable. The yield ranges from 30 to 50 tonnes/hectare. The crop can also be used to prepare hay and silage.

Important varieties: Kent, UPO-94, UPO-212, OS-6, OS-7, OL-9, JHO-822, JHO-851 and HFO-114.

Crop rotation

Suitable rotation of crops not only enhances the productivity of land but also ensures availability of green fodder round the year.

An indicative list of some crop rotations is given below:

Sl No	Crop rotations	Green fodder production Potential(tons/hec./year)
1	Hybrid napier bajra + Cowpea – Berseem + Mustard	285
2	Maize + Cowpea – Maize – Cowpea – Oats – Maize + Cowpea	165
3	Maize + Cowpea – Rice bean – Berseem + Mustard	110
4	Hybrid napier bajra + Guar – Lucerne	250
5	Sorghum + Cowpea – Maize + Cowpea – Maize + Cowpea	110
6	M.P chari – Cowpea – Berseem + Mustard – Sorghum + Cowpea	168

Benefits of feeding green fodder

Growing green fodder is the most important investment for dairy farmer because it can continue to reduce food costs for years to come. Although the farmers may be required to pay initial outlay cost to set system for cultivating fodder, these costs will be covered by financial savings on feed purchase costs within a relatively short amount of time. Depending on the size and scale of the fodder growing system, most livestock farmers fully cover the costs of their initial investment within 6 to 9 months of getting the system up and running. Once the farmer has covered the initial investment costs of the system, any further financial savings made on the cost of animal feed (as compared to the cost of other types of livestock feed) start to translate as profit.

A study by Hossain et al. (2017) on effect of feeding green fodder based diet in lactating buffaloes found that average dairy feeding cost reduced significantly by 12.70% among the treatment group and net income increased by Rs. 31.03 after incorporating green fodder in the ration of buffaloes. The cost of milk production also reduced from 15.65 to 15.31 per kg. Reduction in feeding cost was mainly due to the incorporation of green fodder (pearl millet, Lucerne) which is cheaper than concentrates and dry roughages. Similarly, Sanh et al. (2002) also stated that the feed cost per kg milk produced was lowest for the cows fed 70% forage, followed by the cows fed 50% forage and then the cows fed 30% forage. As green fodder are the comparatively cheaper source of essential nutrients, their inclusion in diet significantly reduced cost of feeding in terms of rupees per day, subsequently reduced the cost of milk production and generates higher net daily income.

Effect of feeding green fodder on nutrient intake, milk production and economics in lactating buffaloes

Parameter	Control	Experimental
Body weight	503.36±14.91	509.93±8.71
Nutrient Intake		
Dry matter intake(kg/d)	15.36±0.48	15.43±0.43

Protein intake(kg/d)	1.72±0.13	1.65±0.04
Metabolizable energy intake (Mcal/d)	29.62±1.15	29.46±0.76
Calcium intake(g/d)	72.48±3.16	78.95±2.09
Phosphorus intake(g/d)	38.92±2.06	38.41±0.87
Milk yield and composition		
Milk yield(kg/d)	8.46±0.50	8.71±0.31
Fat (%)	7.36±0.20	7.24±0.18
6% FCM yield(kg/d)	9.74±0.54	9.92±0.30
Protein (%)	4.31±0.12	4.26±0.10
Solids not fat(%)	9.71±0.24	9.76±0.13
Economics		
Daily feeding cost(Rs./buffalo)	170.01±11.79	150.15±7.53
Cost of production (Rs./FCM)	17.65±0.46	15.31±0.91
Income from sale of 6% FCM (@Rs.50/kg)	486.98±19.62	498.15±15.08
Net daily income(Rs)	314.97±11.98	346.00±14.18

Nutrient Requirement Vs Green Fodder

- Ideally Maintenance requirement of a desi/crossbred dairy animal=2-2.5kg/100kg body wt.
- Milk Production (4% butter fat) requirement of an desi/crossbred dairy animal=0.4kg/liter of milk.
- Roughage requirement of dairy animals consists of around two third of total feed requirement on DM basis.

Dry fodder (2/3rd): paddy straw, wheat straw, sorghum Stover, dried areca sheath, dried grasses, ground haulms, dried tree leaves etc..

Green fodder (1/3rd): cereals (2/9th): maize, bajra, oat, hybrid Napier, para grass, mature sorghum, guinea grass etc.

Legumes (1/9th): berseem, Lucerne, cowpea, rice bean, stylo, dhanicha etc.

- In case of only legume fodder availability total dry matter from green will be 1/4th of total roughage DM.
- We can maintain an animal giving 5 liters of milk with only green and dry fodder without providing any concentrate.

Example:

For a 400 kg crossbred cow with 4% butter fat we can feed in following ways:

Feed ingredient (kg)	High green fodder availability	Moderate Green Fodder Availability	Low green fodder availability
Cross breed cow having with 5 litters of milk/day			
Green roughages	35.0	20.00	2.0
Dry roughages	3.5	3.00	4.0
Concentrate]	0.00	1.8	5.3
Cross breed cow having with 7.5 litters of milk/day			
Green roughages	35	20.00	2.00
Dry roughages	3.5	3.00	4.00
Concentrate	1.2	3.00	6.8
Cross breed cow having with 10.00 litters of milk/day			
Green roughages	35.00	20.00	2.00
Dry roughages	3.5	3.00	4.5
Concentrate	2.4	4.20	8.00

Dry-season management with fodder bank

Dry-season fodder production is a main objective of fodder bank management. In areas with severe dry-seasons special management practices should be followed. Six to eight weeks before the beginning of the dry-season trees should be cut to the recommended height. The new foliage produced over the next few weeks will be retained well into the dry-season when it is most needed. Left uncut for 4-6 months, *Gliricidia sepium* will not retain its leaves into the dry-season. This may be true for other species as well.

When the dry-season is very long or the area of fodder bank very large, the pre-dry-season harvest should occur in phases. This will assure that fodder is available throughout the dry-season. During these pre-dry-season harvests the amount of fodder available may exceed normal needs. The excess may be used to increase animal rations, make silage for dry-season use, or mulch crops. Dry-season regrowth will be slow, and cutting frequencies may need to be extended.

Fodder varieties introduced In Odisha through project jointly ILRI and Govt of Odisha

1. Perennial multicut fodder Hybrid Napier Bajra (Co-5 and Sampoorna)

It is an inter-specific hybrid between *Pennisetum glaucum* and *Pennisetum purpureum*. Among the grasses, it gives the highest forage yield per unit area and time. It is propagated by either root slips or stem cuttings. It performs very well under irrigated conditions. Once sown, can be maintained minimum for 4 to five years. This crop can be grown in any type of soil other than purely sandy, high acidic and problematic soil. For better growth of plant, the day temperature should be between 24⁰-35⁰ and it shouldn't below the 15⁰.

This variety performs well in Kharif season but can be grown round the year having irrigation facilities. Inter culture should be done between rows after 30 days of sowing seed and one round of inter culture is required after each cut of green fodder grass. Per acre 18000-19000 root slips or stems cutting are required for planting.

Fertilizer Application (per acre):

Just after 15 days of sowing 30 kg of Nitrogen, 20kg of Phosphorous and 20 kg of Potassium should be applied per acre. After 35 days of sowing 30 Kg Nitrogen should applied for better growth of the plant. Subsequently 20 kg of nitrogen should be applied after each cut of green fodder. After each cut of green fodder, 30 kg of Nitrogen, 20 kg of Phosphorous and 20 kg of potassium should be applied. Per acre of land, 3 to 4 tons at least manure is required for better growth of plant.

Green fodder Yield:

- First harvest is 75-80 days after sowing and thereafter, the ratoon crop may be harvested at 55 to 60 days interval.
- Plant should be cut above 10 to 15 CM of soil for better growth of plant.
- A farmer can harvest green fodder six times in a year and get at least 600 to 700 quintal of green fodder.
- A farmer can earn 1, 30, 000 INR by investing around 60,000 INR from cultivating one acres of land.

Crud Protein content:

- These two fodder varieties contain about 8-10% of crude protein.

2. Dual Purpose Cereal Crops (Maize, NK-6240)

This is superior dual purpose crop which has high grain yield and Stover yield as well quality. This variety is best for livestock field. Land preparation is similar to COFS-29 or 31. 8 to 10 kg of seed required per acre of land.

1st application: Just after 15 days of sowing 30 kg of Nitrogen, 20kg of Phosphorous and 20 kg of Potassium should be applied per acre.

2nd application: After 35 days of sowing 20 Kg Nitrogen should applied for better growth of the plant.

The use of manure is like COFS-29 and 31.

From an acre of land, 150 to 170 quintal of Stover can be procured.

3. Perennial multicut fodder jowar varieties: CoFS- 29 and CoFS – 31

It is commonly known as Jowar and comes under Sorghum Bicolor. These two are drought tolerant and high yielding perennial varieties of fodder Jowar. It performs well even in dry land due to its drought resistance and limited water requirement. Once sown, can be maintained minimum for 3 years. Under rain fed conditions, 3 cuts can be taken per year, if sown at the beginning of monsoon season (1st June to July). With irrigation, 5 to 7 cuts can be

taken per year and annual green fodder yield will be over 60 to 70 tons per acre. This crop can be grown in any type of soil other than purely sandy, high acidic and problematic soil. For better germination, the day temperature should be between 24^o-35^o and it shouldn't below the 15^o. This variety performs well in Kharif season but can be grown round the year having irrigation facilities.

Inter culture should be done between rows after 30 days of sowing seed and one round of inter culture is required after each cut of green fodder grass. Though seed size is very small, to cover one acres of land around 2.5 kg of seed is required. Spacing- 30 cm between rows *15 cm between bunds (for Poor soil the gap is less up to 4 cm between plants).

Fertilizer Application (per acre):

1st application: Just after 15 days of sowing 20 kg of Nitrogen, 20kg of Phosphorous and 20 kg of Potassium should be applied per acre.

2nd application: After 35 days of sowing 20 Kg Nitrogen should applied for better growth of the plant. Without this dose also plant can grow.

Subsequent fertilizer application: After each cut of green fodder, 20 kg of Nitrogen, 20 kg of Phosphorous and 20 kg of potassium should be applied.

Fertilizer application method: The fertilizer should be applied about 2 to 3 inches away from the plant by making a hole of 2 inch of depth.

Per acre of land, 3 to 4 tons at least manure is required for better growth of plant.

Green fodder Yield

- First harvest is 60-70 days after sowing and thereafter, the ratoon crop may be harvested at 50 to 55 days interval.
- In irrigated area, a farmer can harvest green fodder five times in a year and get at least 600 quintal of green fodder. In case of rain fed condition, a farmer can get minimum 450 quintals of green fodder in a year.
- A farmer can earn 1, 10, 000 INR by investing around 51,000 INR from cultivating one acres of land.

Crud Protein content: These two fodder varieties contain about 9% of crude protein.

4. Hedge lucerne ('Dasaratha')

- Perennial legume fodder crop
- Can give 6 to 7 cuts per year
- Drought tolerant and can perform well even under low fertile soils.
- 6 to 8 kg seed is required per acre and row spacing is 30 cm
- NPK dose (kg/acre) : 30-20-20
- First harvest 70 to 80 days after sowing and there after the ratoon crop may be harvested once in 50 days.

- Green fodder yield is 250 to 400 Quintals per acre per year
- Can be grown as an intercrop in hybrid Napier Bajra.
- This contains 16% of crude protein.

5. Agasthi (Fodder trees)

- The fodder tree leaves are good source of crude protein and minerals like calcium and copper.
- Providing top feeds from the trees will help to bridge the deficit of green fodder.
- Trees like Sesbania (Agasthya), Subabul, Gliricidia, Melia etc. perform well even in dry lands.
- The normal farmers' practice of lopping only the side branches and allowing the uninterrupted growth of main stem reduces the yield.
- Instead, main stem is to be pruned to a height of about 5 feet when the trunks of fodder trees are about 1.5 inches in diameter.
- Normally, fodder trees take about 8 to 10 months after sowing to reach the pruning height.
- After the first lopping, subsequent harvests can be done at an interval of around 60 days.
- The amount of tree leaves included in the diet should not exceed 30% of the total daily amount of feed consumed by the animal.
- Tree leaves contain over 15% of crude protein.

Processing of Dry fodder

In Odisha mostly cattle are raised with paddy straw which is a very inferior quality of fodder as the DCP content is almost zero and a very minimal quantity of energy is present (TDN 40-45%). Secondly paddy straw contains more lignin, silica and oxalic acid that interfere with the digestibility of fibre and calcium absorption respectively. Use of pesticides and insecticide in the rice resulted residues in straw that also hampers the growth and production potential of the animals. Besides paddy straw, gram stalks, maize stover, ground nut haulm are also available in much higher quantity in Odisha but a few of them have been utilized by the farmers due to lack of processing. The main objective of treating poor quality roughage is to increase its digestibility and/ or voluntary intake so as to increase the intake of digestible energy.

Economics of feeding Processed Straw

Feeding of processed straw can cost of Rs. 1915/ per year and net gain may be Rs. 3925/year in a medium yielder cow (5-7 liters/day).

Table: 1. Net Income from feeding of chopped of Paddy straw (per cow)

Expenditure for chopping straw					Income from Feeding Chopped paddy straw					Net income (Rs)
	Price (Rs)	Life span (yrs)	Daily (Rs)	Annual (Rs)		Daily (L)	Annual (L)	Cost (Rs)	Annual (Rs)	
Chaff cutter	20000	15	3.65	1330	Milk Yield (liter/d)	0.400	146	30	4380	
Electric charges			1.0	365	Saving straw/d	4 bundle		1	1460	
Misc. charges			0.6	220						
Total				1915					5840	3925

In Odisha the cultivation of maize has been increased tremendously due to high demand from poultry and also human (Sweet corn). To see the impact of maize Stover on livestock productivity a feeding trial experiment was implemented by ILRI under the project cereal System initiative for South Asia. This green maize Stover can very well be used for animal purpose if it is chaffed otherwise it is difficult to utilize by the dairy animals and the animals will take the leafy portion. It was observed that farmers have shown their interest for feeding maize stover and animals relish to take this processed green maize stover. There was improvement of milk yield of about 600-900 ml/day in the dairy cows when fed with mineral mixture. It was calculated that there was net gain of Rs.6000/ per cow in a year. The cost benefit analysis of feeding trial has been shown in below table.

Table: 2. Economics of feeding processed Maize Stover immediate after cob harvesting

Expenditure for chopping straw					Income from Feeding Chopped paddy straw					Net income (Rs)
	Price (Rs)	Life span (yrs)	Daily (Rs)	Annual (Rs)		Daily (L)	Annual (L)	Cost (Rs)	Annual (Rs)	
Chaff cutter	20,000	15	3.65	1330	Milk Yield (litre)	0.760	277	28/L	7756	
Electric charges			1.5	550	Money earned after replacing paddy straw	3 bundle		1/ bundle	1095	
Mineral mixture @ Rs.50/kg – 40 g per day			2.0	730						
Misc. charges			0.6	220						
Total				2830					8845	6015

Conservation of fodder as Silage

It is preserved fodder obtained from the anaerobic fermentation of green fodder. Cereal fodder crops rich in carbohydrates make good silage. About 5 to 1000 tonnes of green fodder can be preserved as silage in a surface silo.

These are common methods/steps we follow to make silage

- (i) harvest the crop at 30 to 35 per cent dry matter stage
- (ii) chop the crop into small-sized pieces (2-3 centimetres)
- (iii) fill the chopped fodder into a silo
- (iv) press the green fodder either manually or mechanically to create anaerobic condition
- (v) seal the silo with a polythene sheet and cover with soil and
- (vi) leave it for a minimum 45 days to complete the process of anaerobic fermentation. The silage is ready for feeding animals.

Conclusion

For economically dairy farming green fodder production is very much essential and feed at least 10-15 kg of green fodder daily. The farmers of our state should divert at least some part of their cultivable land for fodder cultivation. Govt. farms and some progressive farmers can take the fodder production as a business and can sell the fodder at the market. Perennial as well as seasonal fodder and some fodder trees to be planted for round the year fodder availability. It not only increases the milk production but also help in maintaining good reproduction.

Gender Sensitive Family Farming: A Way Forward to Nutritional Security and Income

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In 2015, the global community achieved a landmark by agreeing on a comprehensive development agenda under the rubric of 17 Sustainable Development Goals (SDGs). India attaches high priority to the 2030 agenda for Sustainable Development Goals (SDGs) which the United Nations adopted unanimously in September, 2015, and which will have great significance for the well-being and progress of humankind. India has, over the past years, directed its development pathway to meet its priorities of employment, economic growth, food, water and energy security, disaster resilience and poverty alleviation. India has also aimed to restore its natural capital and adopt transparent and robust governance along democratic lines. However, emerging challenges of climate change impacts, increasing inequities, and lagging human development indices are well recognized by both the citizens as well as the government.

Of these 17 goals, zero hunger and gender equality are the one that directly relates to family farming and lives of rural women. The world faces a grave nutrition situation – but the Sustainable Development Goals present an unprecedented opportunity to change that. A better nourished world is a better world. Yet despite the significant steps the world has taken towards improving nutrition and associated health burdens over recent decades, this year’s Global Nutrition Report shows what a large-scale and universal problem nutrition is. The global community is grappling with multiple burdens of malnutrition. Our analysis shows that 88% of countries for which we have data face a serious burden of either two or three forms of malnutrition (childhood stunting, anaemia in women of reproductive age and/or overweight in adult women).

Nutritional Status in India

According to the data revealed by the report, India is facing a serious threat of under-nutrition where more than half of the women of reproductive age suffer from anaemia. About 38 per cent of the children under five are affected by stunting and about 21 per cent of children under 5 have been defined as ‘wasted’ or ‘severely wasted’ – which means that they do not weigh enough for their height. Moreover, 51 per cent of the women of reproductive age suffer from anaemia and more than 22 per cent of adult women are overweight. The percentage of overweight men in the country is slightly lower and stands at 16 per cent of adult men (Global Nutritional Report, 2017). The report found that there is a critical need for better data on nutrition - many countries don’t have enough data to track the nutrition targets they signed up to. The Global Nutrition Report 2017 concludes that the five core areas for development which nutrition can contribute to and also benefit from are: sustainable food production, infrastructure, health systems, equity and inclusion and peace and stability. Also, the report indicated that improving nutrition can have a powerful multiplier effect across the

SDGs. Indeed, it indicates that it will be a challenge to achieve any SDG without addressing nutrition.

Improving Nutrition: A Catalyst for achieving Sustainable Development Goals (SDGs)

Nutrition is an indispensable cog without which the SDG machine cannot function smoothly. We will not reach the goal of ending malnutrition without tackling the other important factors that contribute to malnutrition. Poor nutrition has many and varied causes which are intimately connected to work being done to accomplish other SDGs.

Sustainable food production is key to nutrition outcomes. Agricultural yields will decrease as temperatures increase by more than 3°C. Increased carbon dioxide will result in decreased protein, iron, zinc and other micronutrients in major crops consumed by much of the world. Unsustainable fishing threatens 17% of the world's protein and a source of essential micronutrients. Policies and investments to maintain and increase the diversity of agricultural landscapes are needed to ensure small and medium-sized farms can continue to produce the 53–81% of key micronutrients they do now.

Family Farming: Part of the Solution to the Hunger Problem

More than 90% of farms are run by an individual or a family and then produce about 80% of the world's food occupying around 70-80% of farm land. The United Nations declared the year 2014 as International Year of Family Farming aims to raise the profile of family farming and smallholder farming by focusing world attention on its significant role in eradicating hunger and poverty, providing food security and nutrition, improving livelihoods, managing natural resources, protecting the environment, and achieving sustainable development, in particular in rural areas. The goal of the 2014 IYFF is to reposition family farming at the centre of agricultural, environmental and social policies in the national agendas by identifying gaps and opportunities to promote a shift towards a more equal and balanced development. The 2014 IYFF will promote broad discussion and cooperation at the national, regional and global levels to increase awareness and understanding of the challenges faced by smallholders and help identify efficient ways to support family farmers.

What is Family Farming ?

- Family farming includes all family-based agricultural activities, and it is linked to several areas of rural development. Family farming is a means of organizing agricultural, forestry, fisheries, pastoral and aquaculture production which is managed and operated by a family and predominantly reliant on family labour, including both women's and men's.
- Both in developing and developed countries, family farming is the predominant form of agriculture in the food production sector.
- At national level, there are a number of factors that are key for a successful development of family farming, such as: agro-ecological conditions and territorial characteristics; policy environment; access to markets; access to land and natural resources; access to technology and extension services; access to finance; demographic, economic and socio-cultural conditions; availability of specialized education among others.

- Family farming has an important socio-economic, environmental and cultural role.

Advantages of Family Farming

- **Diversified basket:** In contrast, cropping systems in the family farms vary widely depending upon the local cultural, culinary and curative needs. Different types of vegetables, fruits and other edible plant species can be included in the cropping systems of the family farms.
- **In harmony with nature:** Family farming is in harmony with natural ecosystems. Crop rotations and multiple-cropping systems help keep pests below the ‘economic injury level’. Family farms conserve biodiversity and rule out eradication of species and make plants resilient to pests. With vegetable and fruit crops alongside cereals, pulses, oilseeds and fodder, the beneficial organisms in the soil (e.g. earthworms, nitrogen-fixing bacteria, etc.) and above the soil (e.g. pollinator insects, predators, parasites) flourish.
- **The healthier option:** Health risks associated with use of chemical pesticides left in the soil, plant parts and water bodies are significantly reduced due to use of organic pesticides.
- **Sharing the work load:** From preparing the land to sowing and raising the crops to post-harvest processing, the work involved is shared amongst women and men in the family. Manual labour supplemented with use of farm animals for work greatly reduces the need for fossil fuels.
- **Resilience:** Family farms which raise indigenous varieties of diverse crop species are more resilient to the extreme hydro-meteorological events such as floods, droughts, cyclones, etc. Use of farm animals in small farms is also beneficial as they provide milk, eggs, meat and draught.
- **Adopting sustainable intensification:** Although the process of achieving the yield is slower than in chemical-based intensification of agriculture, family farming is not ‘exploitative’ and focuses more on ‘sustainable intensification’.

Characteristics of Family Farms in India

- Small size of farm
- Suffers due to poverty
- Largely rainfed: highly vulnerable
- Subsistence farming
- Poor access to new technology, input, credit, market and government schemes

Women and Family Farming

Agriculture Sector employs 4/5th of all economically active women in the country. 48% of India’s self-employed farmers are women. There are 75 million women engaged in animal husbandry as compared to 1.5 million men. Despite such significant contributions of women those engaged in formulating packages of technologies, services and public policies for rural areas have often tended to ignore the productive role of women.

Family farms have traditionally placed a heavy workload and responsibility on the shoulders of the women who have no right over the land they work on. Women-managed small family farms are usually handicapped for credit as well as technological support. Support systems should be put in place to ensure women-run farms do not lag behind in the race. According to Food and Agriculture Organization of the United Nations (FAO), the role women play in family farming is becoming increasingly important, but truly unleashing their full potential requires a transformation of the technical assistance and rural extension systems with a gender-based focus.

In February 2011, Action Aid International claimed that: Women are not recognized as farmers by their own families, or communities, and definitely not by governments or donors. The net results of all this are that the needs of women farmers are ignored when it comes to policy, legislation, extension services, research, or other government support. Women are desperately short of secure and adequate land, basic tools and inputs, credit, extension services and technical advice, relevant research, and appropriate infrastructure and technology. In short, women farmers have not received the support they need in order to thrive”.

The 2014 State of Food and Agriculture (SOFA) Report, on the other hand, ‘Innovation in Family Farming’, stresses the importance of gender and intergenerational considerations, noting that “policies will be more effective if they are tailored to the specific circumstances of different types of farming households within their institutional and agro-ecological settings”. For example, “the needs of different types of family farms as well as different household members in farming families need to be addressed” in ensuring rural advisory services are relevant; special attention also needs to be given to boosting the capacity for innovation of women and girls “based on their needs and roles in agriculture and rural livelihood strategies”.

Family farming vs. Gender Equality? Are they actually compatible?

Many family farms are effectively managed by women yet family farms do not provide autonomy to women workers or the means to realize their potential as farmers. Hence a nod toward gender equality is not enough. The problems women face as farmers are structural and deep-rooted, and would need to be addressed specifically redistributing productive assets such as land and inputs within peasant households in gender-equal ways, and directing state services to cater better to the needs of women farmers, such as services relating to credit, extension, training, information on new technology, field trials, input supply, storage and marketing. Institutional innovations involving only women rather than entire families hold potential gains, both in terms of productivity and equity.

How will unequal gender relations embedded within families be tackled? Indeed an emphasis on family farming, which often depends on women’s unpaid labour, could go in the opposite direction, unless intra-household inequalities are addressed. The issue of gender inequality is especially complex and may be difficult to address by prioritizing individual family farming. Alternative institutional arrangements based on proactive farmer cooperation in production, especially cooperation among women farmers, may be more conducive to gender equality, but that could go contrary to individual family farming.

The various forms of co-operative and group/collective farming can be an alternative to individual family farms, which may be more empowering and transformative for women.

All these points indicate that family farming as it is generally perceived might not be so compatible with gender equality, but that perhaps the two can be compatible if creative and innovative alternatives to standard models and approaches are pursued.

Moving Forwards from the International Year of Family Farming

The major recommendation was "support for women farmers should be tackled in the context of the need for greater gender equality, the main issue being their empowerment to acquire capacities and rights to act as family farming leaders and entrepreneurs, the entire society needs to be involved, including, most importantly, those in power".

Development of Gender Sensitive Family Farming Approach : A Success Story

The gender sensitive approach in family farming was designed and tested in Sankilo village of Cuttack district with the involvement of over fifty participating farm women during 2012-17 and is being carried forward in an entrepreneurial mode since then. The village was selected after making due consultations with the households and finding the social climate relatively better in gender sensitiveness. Preliminary meetings, genders sensitization programmes, gender gap analysis and PRA studies were undertaken by involving both male and female key informants separately to identify major gender issues in rice farming.

The major gender issues in rice farming identified include women-friendly technologies, access to resources & information, labour sharing, benefit sharing, capacity building, group mobilization, decision-making pattern, societal gender mindset, constraints in farming, linkage with financial & marketing institutions etc. Accordingly, suitable technological and institutional interventions were provided and evaluated. The male heads of the families/ the legal owners of lands were sensitized and motivated through personal contacts and close interactions to allocate about half an acre rice growing land to all the participating family farm women. A women development group in the name of 'Ananya Mahila Bikash Samiti' was formed and registered after mobilizing all fifty farm women for deriving maximum institutional benefits and for group sustainability. Intensive awareness camps were organized and trainings imparted for desirable changes in their skill, knowledge and behaviour with regard to the objective of the programme, rice production technologies, market support and possible outcome of the project.

Demonstrations on rice production and crop management practices on popular and suitable rice varieties based on women's preference and market demand were conducted in the allotted half acre land by each during *kharif* season. Apart from rice, during *rabi* season, technological interventions on cultivation of high value vegetable crops, pulse crops and preparation of value added food products were also given. Seeds and planting materials were provided free of cost as critical inputs during initial years only. Improved rice production technologies like growing of mat type nursery, seed treatment, line transplanting, use of rice transplanters, balanced dose of fertilizer application and need based pesticides application were provided along with technical backstopping in women's perspectives. Similarly, for harvesting and post-harvesting management, training-cum-demonstrations on drudgery-reducing and women-friendly machines and technologies like rice-parboiling unit and rice-

husk combustor; and demonstration on paddy-straw mushroom cultivation was also conducted for additional revenue generation and family nutrition from rice by-products.

Looking at their acquisition of enough technical competencies and managerial abilities, the group was made as a signatory to the Rice Value Chain for ensuring greater economic benefits of the participating women members. Reactions of the farm women were recorded at regular intervals to assess the effects of interventions and modify accordingly, if called for. The major impacts of the project in terms of outputs and outcomes as found out through concurrent and end-term evaluations are briefly outlined below.

- a) **Change in attitude towards gender mainstreaming:** Significant change in attitude towards gender mainstreaming was established. The male members of the family as well as in the village are now giving more importance and recognition to the farm women in farm, family and community matters. More so, they were happy and motivated to see and watch the success stories of their village in print and electronic media. They are now allowing female members to attend agricultural meetings and programmes outside.
- b) **Mindset of male members of family/society:** Findings indicate that there was major change in the mindset of male members of family/society towards women-managed rice farming (90%). All the farm women were feeling recognized by other members of the family as well as village due to their increased capacity in farm and home management activities and leadership in organizing group and social activities.
- c) **Competency of farm women:** As opined by the farm women, remarkable changes in behavior of women rice growers were found with regard to agricultural knowledge (100%), technical skill (93.33%), decision-making capacity (86.67%) and undertaking group activities (76.67%). Improvement in skills in nursery raising, handling farm implements, disease and pest management were also observed.
- d) **Women friendly production technologies:** Technologies with regards to raising of mat-type seedlings for mechanical transplanting, seed treatment, mechanical line transplanting, use of small farm equipments were found drudgery reducing. Among the women-friendly farm machineries demonstrated, rice husk combustor, finger weeder and 4-row manual drum seeder were perceived as more appropriate by 85.71%, 70.37% and 57.14% farm women respectively. Paddy straw mushroom cultivation as an income generating activity by converting rice byproduct (straw) was also rated as more appropriate by 88.46% farmwomen.
- e) **Effect of demonstrated technologies:** All the participating farmers adopted scientific production practices based on their socio-economic feasibilities. The analysis of the data shows that majority of the respondents had positive perceptions with regards to comparative advantage of recommended/demonstrated rice varieties over earlier grown varieties in terms of yield, resistance to pest/diseases, tolerance to weeds/drought, labour saving, profitability and marketability.
- f) **Access to productive resources:** Significantly increased access of women to farm inputs was observed through the approach, as evident from the expansion of allotted half an acre land to over one acre in many families by end of 2-3 years. This

expansion of area under the control of farmwomen signifies more trust and confidence on women farmers by their male counterparts and a positive impact of the project. Similarly, accessibility to family land (100.0%), seeds (100.0%), fertilizers (100.0%), and money (45.45%) were found.

- g) **Entrepreneurial opportunities:** Since, the farm women had their expertise in preparing traditional value added food products (VAP), they were encouraged and supported to convert the traditional value added rice products into demand driven marketable products through improved food technology process. A book on 'Traditional Rice Foods - The Rich Heritage of India' was also brought out containing the processes of making over hundred traditional rice-based value added products, primarily collected from the women group.
- h) **Partnering in RVC:** By working in groups, the women realized their inherent capacity, developed friendly atmosphere and learnt the importance of working in groups in the society. Accordingly the registered group also took up entrepreneurial activities as a signatory to the NRRI rice value chain and in turn potential women entrepreneurs were recognized.
- i) **Outstanding public recognition:** Among others, one of the successful farm women Smt. Rukmini Nayak of the group was conferred with 'Best Innovative Farmer Award' during 'Krishi Unnati Mela-2017' at IARI, New Delhi and with 'Best Farmer Award' during 'Akshay Tritoia & Farmers Fair-2016' at NRRI, Cuttack and received the awards from Hon'ble Union Minister of Agriculture & Farmers Welfare, Govt. of India.

Way Forward

Access to productive resources is critical for enhancing women's economic choices. Since, formal credit institutions rarely lend to this weaker sex, special institutional arrangements has become necessary to extend credit to those who have no collateral to finance their enterprise. In order to have access to credit, social, institutional and government support is required. More than half of the farm labour is contributed by farm women. Moreover, as evident from several literatures, they have also proven their competencies over time and again to manage efficiently and effectively at par with the male members of the society, provided they were supported socially, economically, technologically and institutionally. There is a need to identify their hidden capacities and entrepreneurial abilities and link them to the market. If they can be made technologically competent and socio-economically empowered, they could be the efficient drivers in achieving accelerated agricultural growth and development of the country in general and in boosting family income in particular. Organizing women into groups has been proved to be a good intervention. It can transform women from the status of 'beneficiaries', into 'clients', who are in a long-term can have a reciprocal relationship with the institutions meant to serve them.

Conclusions

- While we talk of empowerment of women in family farming, the discussion invariably focuses around access to and control of women over productive assets and their effective use for sustainable livelihood and income.

- Creating and sustaining competitive and equitably-oriented value chains that help small-scale farmers, especially women, will require explicitly examining gender issues and proactively integrating gender components into value chain analysis and development strategies.
- It is inferred from the findings that, the farmwomen could be the efficient drivers of national agricultural growth and development, if they can be made technologically competent and socio-economically empowered through development of gender sensitive entrepreneurial approaches. This, in turn, would make Indian agriculture more sustainable.

Policies to Support Small Family Farms

- **Agricultural Service Centres in each Panchayat – timely availability of quality inputs, farm implement services and technical information**
- **Enhanced support for risk management-**
 - (i) diversification – integrated farming systems
 - (ii) hassle free credit
 - (iii) insurance
- **Ensuring higher returns**
 - i) high-value commodities; nutri-farm
 - ii) increasing productivity
 - iii) market linkage - Promotion of Producer Organizations
- **Support for children’s education; gender equity**
- **Infrastructure support- Irrigation, storage structures in the vicinity, electrification and power availability etc.**

What is Required?

Concerted Global Action with Specially Focus on Women

Women Friendly Farm Tools and Equipment in Agriculture and Allied Sector - Issues and Mitigation

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Agriculture in India employs 263 million human workforce, of which about 37% are women workers. By 2020, the ratio of agricultural workers to total workers will go down to 40% from 56% at the present and the number of workers would be around 230 million, of these about 45% will be women workers as against 37% at present. Farm mechanization saves time and labour, cuts down crop production costs in the long run, reduces post-harvest losses and boosts crop output and farm income. Empirical evidence confirms that there is a strong correlation between farm mechanization and agricultural productivity. States with a greater availability of farm power show higher productivity as compared to others. There are about 120 million agricultural machines operated by either tractors, power-tillers, electric motors, diesel engine, animal or human workforce. The number of agricultural hand tools is about 400 million.

Negative effects of farm mechanization on women in agriculture :

It is observed that the women labourers growth was less as compared to male agricultural labourers during this 2001 to 2011 indicating reduction of share of women workers in agriculture. It is because of the fact that when a machine is introduced for some operations (which may be women dominated), it is generally operated by male workers, reducing opportunities for women workers. This leads to displacement of the work, causing majority of rural women to have insufficient income. Women are forced to do low-paid, labour-intensive arduous agricultural tasks (weeding transplanting, harvesting etc) Farm mechanization implies changing skills, thus causing deskilling of women. Because of this women are often displaced in favour of men. Due to improper notions such as “machines for men” the skills of women have become irrelevant or ill adapted to the needs of new production technologies. There is loss of wage labour opportunities for poor rural women due to introduction of technology that mechanises task that they traditionally perform (rice mills, papad making machines).

Women in agriculture and allied sector:

Women play different type of roles in the field of agriculture and allied sector. Field operations in crop production such as sowing behind the plough, transplanting, weeding, interculture, harvesting and threshing. Argo-processing activities like cleaning / grading, drying, paraboiling, milling, grinding, decortication and storage etc. Operations in commercial agriculture such as Tea plucking, tobacco leaf harvesting, lac cultivation and processing. And animal upkeep and dairy activities

Women in Poultry, Dairy and Fisheries:

Livestock

Live stock (dairy, goat etc) rearing is an activity which supplements agriculture income in most of the Indian rural families. It also plays a vital role in ensuring a proper nutritious intake in the family members. Women are engaged in various activities such as

- Cleaning of animal and sheds
- Watering of cattle
- Milking the animals
- Fodder collection
- Preparing dung cakes
- Collection farm yard manure

Except grazing and sales, other activities are predominantly performed by women. Men, however, share the responsibility of taking care of sick animals. It is evident that the women are playing a dominant role in the livestock production and management activities.

Poultry

Back yard poultry comprises 25 % of total poultry production in India. Feeding and management to marketing is entirely handled by women. The following activities are taken care by women in backyard poultry:

- preparation of shelter for birds,
- care of newly hatched chick,
- brooding,
- feeding,
- watering,
- collection of egg,
- preservation of egg,
- care of hatching egg,
- care during natural incubation,
- control of broodiness,
- control segregation of young chicks from adult,
- identification of ailing birds, and taking birds for treatment,
- marketing of live bird etc

Fisheries

In India out of a population of 5.4 million fishers, 3.8 million are fishermen and 1.6 million are fisherwomen. The major activities in which women contribution is visible in fisheries sector is

- Aquaculture (ornamental fisheries)
Breeding, Taking care of hatcheries and fingerlings
- Fish processing (pre and post harvest operations in captured fisheries)
Curing , Peeling, Drying
Value addition (fish pickle, chutneys, RTS etc)

- Marketing
- Making of nets
- Sea weed collection etc

Why there is a need for adoption of mechanization by women?

Studies show that 37.2 % agricultural labour force in India is female (AICRP on ESA). And it is predicted that this value is going to increase. Major reason behind this is the male rural-to-urban migration. Male members of the family are leaving the agriculture profession and migrating to cities in search of higher paying jobs. This leaves the females incharge of the house and the farm. Hence, women face increasing workload and wider scope of agricultural task, decision making etc., but the degree to which they have access to improved agricultural technologies needs a special consideration.

As men leave there is unavailability of labour during critical time period of farm operation. Thus, there is a need for skilled agricultural labour along with improved work efficiency to complete the operations timely operations.

Hence it can be concluded that women are playing the dual role of labour and also that of a decision maker. There is a rapid feminization of agriculture. So, it is essential that we equip the women with the agricultural advances for enhancing productivity and reducing the drudgery.

At present, majority of the agricultural workers including women in our country are used as a source of muscular power. However, it is known beyond doubt that human beings are not suited best as a source of muscle power, but, as controller of machines. They have a vast potential and capacity for information processing and taking actions on that basis. Therefore, as far as possible, it is always better to use human workforce as controller of machines.

In future, for most of the farm activities, there will be machines available which may be self propelled or power operated or engine operated manually guided. It is estimated that as of today, in case of male workers about 20% work as controller of machines and 80% as source of power. In case of women workers, the corresponding figures are 99.99% and 0.01%. This situation is going to change in future and it is projected that by 2020, in case of male workers about 30% will work as controller of machines and remaining 70% as source of power. The corresponding projections for female workers are 5% as controller of machines and 95% as source of power.

Promotional issues for the technology adoption by women in agriculture and allied sectors:

They can be categorised in three ways.

1. R & D issues
2. Extension issues
3. Social and general issues

1. Research and development issues :

Rural women are rarely considered as research clients. Women have different physique and stamina than men therefore present technology may not be relevant to women's needs.

Safety issues like wearing loose clothes (sarees, dupatta), social taboos, casual approach, lack of cautionary tips also cause to lower rate of adoption of the tools and equipment.

2. Extension issues :

Technical training and extension programmes are exclusively targeted at men. Lack of land, credit etc., leads unintentional bypassing by extension services (5% extension services, FAO) Improper assumptions such as “women to be tied down to household, children or are shy, difficult to reach and oppose innovation”

3. Social and general issues:

Traditional system – limits women’s access to resource and impose sexual division of labour (traditional gender roles). Poor purchasing capacity. Lack of awareness. Non-availability of tools, equipments and their maintenance facility in women’s vicinity. Manufacturers often show lack interest to fabricate these tools as they are set in their ways or these tools have small adjustments made to them

Solutions to be adopted for mitigating issues :

1. Research and Development issues :

Considering the ergonomic needs and differences of farm women

- Anthropometry : Clearance, reach, posture, strength 6 to 21 % lower than male
- Muscular strength : 11 to 153 % lower than male
- Aerobic capacity : 65-75% that of the men’s capacity
- Physiological cost of operations: 0.7 l/min and 110 bpm for men while for women it is 0.6 l/min and 105 bpm
- Posture: avoid squatting or bending, use sitting or standing (farm women prefer sitting)
- Load carrying capacity : 21 % less
- Safety : proper protection gear for women, covering machine moving parts etc

2. Extension issues :

- Facilitating counselling and creating awareness of existing technologies
- Training women in safe handling and safety precautions
- Developing a database of
 - Activities and multiple roles of women
 - Women specific tools and equipments
 - Success stories
- Using progressive farm women as a resource person
- Training of trainers
- Training for women farmers for skill up-gradations to increase productivity and reduce drudgery.

3. Social and general issues :

- Attitudinal changes are needed specially amongst the male member about the machinery operation by women workers
- Organising women groups for custom hiring of tools to avoid individual purchase
- Advocating policy prescriptions
- On-the-spot guidance/maintenance systems
- Manufacturers of improved women friendly tools and machines need to be given incentives through various policy initiatives.
- Encouragement in the form of awards may be given

Work done for equipping the women in agriculture with proper tools and equipments :

Central Institute for Women in Agriculture (CIWA), Central Institute of Agricultural Engineering, All India Coordinated Research Project on Ergonomics and Safety and All India Coordinated Research Project on Home Science and SAUs carried out ergonomical evaluation/ refinement/ development of hand tools/ equipment suitable for women workers.

Central Institute for Women in Agriculture:

CIWA work on dissemination of the developed technologies to the women. But first and foremost they work for creating the awareness, gender mainstreaming and empowerment of women in agriculture. Thrust areas for R & D activities for CIWA are :

- Creating a repository of gender disaggregated data and documentation
- Technology assessment & evaluation
- Farming system approach
- Capacity building of R & D functionaries
- Resource management
- Gender mainstreaming
- Nutrition and livelihood security

ICAR-CIWA, with its mandate of research on gender, has been striving to address gender issues in agriculture for achieving higher efficiency and productivity in agriculture. In order to demonstrate the output and utilities of gender research, ICAR-CIWA is forging partnerships with ICAR institutions, KVKs, SAUs, development agencies, NGOs and international organizations to strengthen the efforts of gender mainstreaming which is very much required to achieve gender equality which is one of the Sustainable Development Goals before the global community.

Improved Tools and Equipment for Women Workers

The improved hand tools and equipment help to achieve one or more of the following:

- Reduce drudgery.
- Increase utilization efficiency of inputs.
- Ensure timeliness in field operations and reduce turn around time for next crop.
- Increase productivity of worker-machine system.

- Conserve energy.
- Improve quality of work and also quality of produce.
- Enhance the quality of work life of agricultural workers.

Thus it can be concluded that, farm mechanization enhances the food productivity of country. Women need to be equal beneficiaries of the technological advances in the agricultural sector. Certain technological, sociological and economical aspects cause hazards in promoting the women friendly tools and equipments. Proper design methodology, extension practices and attitudinal change can lead to better adoption of women friendly farm tools and equipments, thus ensuring enhanced productivity and reduced drudgery.

List of women friendly improved Equipments in technologies for the poultry, dairy and fisheries sector

1	Poultry	Incubation	1. Custom hatching unit for rural women
		Growth stage	1. Bird cage for rural women 2. Automatic feeder 3. Automatic watering device
2	Livestock	Milking	1. Revolving stool with stand (manual milking) 2. Portable milking machines
		Dung collection	1. Gopal Khore
3	Fisheries	Hatching	1. Portable FRP Hatchery 2. Eco hatchery
		Growth stage	1. Cages for carp farming
		Processing	1. Low cost fish drying rack for quality dry fish 2. Ecofriendly hybrid solar dryer 3. Low sodium dried fish product 4. Hand held descaling machine 5. Fish descaling machine 6. Fish processing cum retail unit 7. Mobile iced fish storage and transport chamber 8. Sausage filler 9. Flour mixing unit for fortification

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The Design and Statistical Analysis of Animal Experiments

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Design of experiments is important in animal science research. Proper understanding of design of experiment helps the experimenter to use minimum number of animals, analyze the data correctly and extract all useful information from the resulting data. Any experiment should be started with a clear idea of how the resulting data are to be analyzed. Therefore, investigators must follow statistical rules from the beginning stage *i.e.* at the design stage.

Here we define some important terms and concepts normally used in experimental designs and some widely used basic designs along with example in sequel.

Experimental unit is piece of experimental material to which treatment is assigned and applied. Example: experimental plot, patient, tree, cattle etc.

Observational unit is the unit on which observations/measurements are made. Experimental Units and observational units may be same. Example: entire field - for yield, sample of plants - for plant height, entire herd - for milk yield, sample of cattle - for height and weight etc.

Partition of variation: Total variability/ response = assignable causes + error

Assignable causes: Variation due to treatments and variation due to any other known factor

Error: Variation due to all unassignable causes

Analysis of variance (ANOVA): Technique of partitioning total variance into assignable causes and error. ANOVA is used to test whether treatment differences are significant or not using F-test. Different designs differ in how total variation can be partitioned. ANOVA can be performed when the response variable is quantitative and the explanatory variables are qualitative in nature.

Example: Let average milk production of cows is 12 litre/animal/day. The cows are given concentrate, BST and there was improved management practices which resulted in average milk production of 16 litre/animal/day. There was increase of 4 litre/animal/day milk. ANOVA can then be used to answer the question how much proportion of milk was improved due to Concentrate, BST and improved management?

Here we provide some information about important designs widely used in agriculture and animal science research.

Completely Randomized Design (CRD)

- Assign treatments randomly to the experimental units
- Model: Response = Treatment + Error
- Simplest of all
- Null Hypothesis: All treatments (means) are equal

- Alternative Hypothesis: At least one of the treatment is different from other Assumptions in CRD
- All experimental units are Homogeneous (no differences between experimental units)
- Number of replications for each treatment need not be equal
- Treatments and errors are independent
- Errors are independently distributed
- Errors have constant variance
- Errors are distributed as Normal distribution

ANOVA Table for CRD

Source	d.f.	S.S.	M.S.	F-Ratio	P-Value
Treatment	t-1	SST	MST	MST/MSE	
Error	n-t	SSE	MSE		
Total	n-1	TSS			

t – number of treatments

n – total number of experimental units (each treatment must be replicated at least twice)

Interpretation

- Find out significance of F-value (Rule: if P-value is <0.05 => significant at 5%)
- If significant, reject null hypothesis, “All treatment means are same”
- Rejection shows at least one treatment is different from other, then multiple comparison tests are performed to identify the best treatment (highest value or lowest value)
- If Null hypothesis is not rejected, analysis is stopped

Multiple Comparison Tests

- Multiple comparison or Post Hoc tests are useful for finding out “best” treatments
- Various Multiple comparison tests: LSD, Duncan, Tukey, etc.
- Best – Tukey’s HSD (Honestly Significant Difference)
- Valid only when treatment effects are significant (null hypothesis is rejected)

Example CRD: There are 3 feed treatments randomly assigned to a number of similar cattle (similar in the sense having similar age, health, milk yield, feeding habit, same location, same environment etc) and all other conditions are kept controlled (no other special treatment is given to any cattle). One can find which out of three feed treatments is the best one in increasing milk yield of cattle.

Interpretation and multiple comparison tests are common for most of the designs, therefore, for all below designs these text is not repeated.

Randomized Complete Block Design (RCBD)

- Total Experimental units are divided into sets of homogenous units, called blocks
- Each treatment is assigned to one experimental units within each block randomly
- Number of blocks = number of replications of each treatment
- Removes one additional source of variation
- Model: Response = Block + Treatment + Error
- Null Hypothesis: All treatments (means) are same
- Alternative Hypothesis: At least one treatment is different from others
- Block effects can also be tested (usually of not interest)

Assumptions

- All experimental units within a block are homogeneous
- Every treatment appears once in every block
- Errors are independent of block & treatment effects
- Errors have constant variance
- Errors are normally distributed

ANOVA Table for RCBD

Source	d.f.	S.S.	M.S.	F-Ratio	P-Value
Treatment	t-1	SST	MST	MST/MSE	
Block	r-1	SSR	MSR	MSR/MSE	
Error	(r-1)(t-1)	SSE	MSE		
Total	rt-1	TSS			

Example RCBD: There are 3 feed treatments randomly assigned to 4 milk yielding groups of similar cattle (similar in the sense having similar age, health, feeding habit, same location, same environment etc within a group) and all other conditions are kept controlled (no other special treatment is given to any cattle or any group). One can find which out of three feed treatments is the best one in increasing milk yield of cattle.

Latin Square Design (LSD)

- Total Experimental units are divided into t^2 units such that there are t rows and t columns and t treatments are assigned in such a way that each treatment appears exactly once in each row and each column
- No. of rows = No. of columns = No. of treatments = No. of replications
- Model: Response = Row + Column + Treatment + Error
- Removes two additional sources of variation
- Null Hypothesis: All treatments (means) are same
- Alternative Hypothesis: At least one treatment is different from others
- Row and Column effects can also be tested (usually of not interest)

Assumptions

- Errors are independent of row, column & treatment effects
- Errors have constant variance
- Errors are normally distributed

ANOVA Table for LSD

Source	d.f.	S.S.	M.S.	F-Ratio	P-Value
Treatment	t-1	SST	MST	MST/MSE	
Row	t-1	SSR	MSR	MSR/MSE	
Column	t-1	SSC	MSC	MSC/MSE	
Error	(t-1)(t-2)	SSE	MSE		
Total	t²-1	TSS			

Example LSD: Suppose there are four feeds you wanted to test on milk yield of cows. The feeds would be tested over time during the lactation period. This experiment would require 4 animals (rows: 4 animals). There would be 4 feeding periods at even intervals during the lactation period beginning early in lactation (columns: 4 periods). The treatments would be the four feeds. Each animal receives each treatment one time only, all other factors care controlled. One can find which out of four feed treatments is the best one in increasing milk yield of cattle.

Split Plot Design

- One factor requires larger plots (main plots) & another requires smaller plots (sub plots)
- First, a design with main plots is taken, then, main plots are split into as many parts as the number of sub plots, randomization takes place in each step
- Main Plot treatment may be in factorial structure
- Sub Plot treatment may be in factorial structure

Assumptions

- Errors are independent of replication, main plot & sub plot effects
- Errors have constant variance
- Errors are normally distributed

ANOVA for Split Plot Design

Source	d.f.	S.S.	M.S.	F-Ratio	P-Value
Rep	r-1	SSR	MSR	MSR/MSE _a	
Main Plot Treatment (A)	a-1	SSA	MSA	MSA/MSE _a	
Rep * Main Plot (Error A)	(r-1)(a-1)	SSE _a	MSE _a		
Sub Plot Treatment (B)	b-1	SSB	MSB	MSB/MSE _b	
A * B	(a-1)(b-1)	SSAB	MSAB	MSAB/MSE _b	
Error (B)	a(b-1)(r-1)	SSE _b	MSE _b		
Total	abr-1	TSS			

Factorial experiments

- Factorial experiments are not experimental designs, factorial experiments are used to create treatment combinations (treatments) that are further studied using some designs like CRD, RCBD, LSD, Split plot etc.
- When number of factors are more than one, then factorial experiments are used
- Treatments are combination of levels of different factors
- Treatment effect may be divided into main effects and interaction effects
- If interaction is absent, saves time, resources and increases precision
- If interaction is present, gives more information
- When both main and interaction effects are significant, then, the interaction effects are to be interpreted not the main effects

Many more designs are available in literature. Experimenter needs to use proper design that fits for the experiment. One can get more detail about above said designs in any standard statistical book on experimental design. Designs available in books or generated through software (offline/ online) or manually generated following right steps and randomization is needed before implementing the design in the experiment. A number of statistical software like SAS, R, SPSS etc. can be used for data analysis. There are in built options in the software to perform ANOVA and the post hoc tests/ multiple comparison tests. Care is required in data entry and data import in any software. One need to verify logically that the data has been imported correctly in the software for analysis. Further, online help files of different software and different research centres/ universities along with different books may be used for proper experimentation because only these can help one in finding the best treatment or set of best treatments.

Women Entrepreneurship Development through Small Scale Poultry Production in Rural Areas

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Indian economy is basically agrarian economy. On 2.4 % of world land, India is managing 16 % of world population. Agriculture is the main source of livelihood for over 80% of the rural poor in India. Out of 149.8 million women workers in India, 81.3% live in rural areas. 77.3% of the women workers living in rural areas are engaged as cultivators and agricultural labourers. Among them (About 50%), most of their earnings are spent on meeting their basic needs, particularly food. As per the 2011 Census, Agriculture is India's largest private-sector enterprise, engaging about 119 million farmers and another 144 million landless labourers. One question comes to everybody's mind is farming really a business? Entrepreneurship can be considered as both an opportunity and also a necessity for improving the production and profitability. Agripreneurship is one stop solution for many economic problems like poverty, urbanization, unemployment and economic development. It helps in rural development. But development of agri-entrepreneurship requires special skills like human development, knowledge of agriculture, knowledge of global agriculture market. Developing entrepreneurs in agriculture can solve many problems viz. reduce the burden of agriculture, generate employment opportunities for rural youth, control migration from rural to urban areas, increase national income and support industrial development in rural areas.

Small scale poultry rearing is an age old practice in rural India and rural poor women plays a significant role in it. Spectacular growth has been achieved in commercial poultry sectors. But the rural poultry sector has remains unchanged. Rural poultry sector contributes nearly 21 % of the national egg production in India, but remains one of the most neglected sectors. In the present scenario most of the commercial poultry production is concentrated in urban and peri-urban areas. The 25 % urban population consumes about 70-80% of eggs and poultry meat leaving the rural areas far behind. It has been observed that poultry products are quite expensive in rural areas mainly due to their non availability and lack of market chain. The non-availability coupled with low purchasing power of the rural people deprives them of access to the highly nutritious products like egg and meat resulting in mall nutrition. Free range and small scale semi-intensive poultry production can be promoted in rural areas to enhance the nutritional status of women and children and also to improve the economic conditions of population in these areas. Poultry production in the rural areas is generally considered as 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. Rural areas 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. By increasing women's income small scale poultry farming also enhances women's social status and decision making power in the household.

Constraints faced by women for entrepreneurship development

Agriculture is mainly a means of survival for most of the farmers in India. Majority of the farmers are illiterate and in the absence of adequate knowledge, resources, technology and linkage with the market, it is very difficult to turn agriculture into an enterprise besides these women are facing a variety of constraints starting from physical to social, while beginning entrepreneurial activity.

- **Lack of confidence and faith**

Self confidence is the key to victory, or we can say the first step towards success. Lack of role models impedes the self confidence level of women entrepreneurs. The activity of selling is considered offensive to the female gender.

- **Social Acceptance**

The society plays a major role in entrepreneurial venture and success. The most common problem which a woman faced is the no-cooperation from her guardians/ husband / family members. Most of the women can devote all their time and energies to their children, home and older dependent family members. Apart from this, these kind of family related hurdle, dual responsibility, risk bearing ability etc., the women has to flourish in her business.

- **Gender gaps in education**

While women are making major strides in educational attainment at primary and secondary levels, they often lack the combination of education, vocational and technical skills, and work experience needed to support the development of highly productive businesses.

- **Lack of finance**

Access to finance is one of the most common challenges to entrepreneurs. Women entrepreneurs must have adequate knowledge and information of the various financial institutions which are rendering financial incentives. They have to depend on own saving as the lending practices of banks and government funding agencies are believed to be constrictive and unfriendly to women.

- **Mobility Constraints**

Due to conservative nature of Indian society, the mobility of women is limited and depends on either father or husband. For security reasons, the women's movement is always encircled in depend with any of male member.

- **Lack of Proper Marketing**

Most Women entrepreneurs are selling their products for under value due to lack of knowledge about the pricing and marketing. The middle man exploits them. Women needs proper knowledge on market, updating of market, other exposures etc., Government can provide trainings on these field and connect networks for them.

- **Poor infrastructure and operational knowledge**

When coming into the production stage, the women entrepreneur struggle to find raw material at optimum cost and an interrupted supply of them and they lack in necessary technical skills and knowledge about infrastructure facilities etc.,

- **Lack of extension facilities**

Our government enact number of laws to protect women entrepreneurs and announced numerous incentive schemes, training programmes towards their development. NGO's have strong role in propagating these schemes as they are the bridge between government and public. The women entrepreneur can make use of these programmes and develop the business. But the awareness on this field is less to women entrepreneur.

- **Lack of right public/ private institutions**

Most public and private incentives are embezzled and do not reach the woman unless she is backed by a man. Also many trade associations like ministries, chambers of commerce do not entertain to women expecting women's organizations to do the necessary thing.

Personal and environmental prerequisites for entrepreneurial development

Personal prerequisites

- Emotional maturity
- Hard work
- Powerful urge
- Risk bearing capacity
- Strong determination
- Knowledge: Technical, Legal, Marketing
- Ability to use available resources
- Administrative skills
- Education
- Far sightedness
- Innovativeness
- Previous experience/entrepreneurial parents

Environmental prerequisites

- Proximity of supporting organization
- Technically skilled labour
- Availability of infrastructural facilities
- Accessibility of suppliers.
- Venture capital availability
- Attitude of the area population

Strategies for Promotion of Successful Enterprises

The idea of entrepreneurship is complex. When a farmer introduces a new enterprise into his farming system, there are different stages of development that the enterprise goes through.

The skills of the farmer must also change and develop to meet the management demands of the enterprise

Some of the important conditions necessary for successful entrepreneurship are below:

- A common programme between among government and farmers about the need and benefits of promoting self-employed youth or private entrepreneurs to facilitate the farmers to enhance agricultural production and profitability.
- Introduction of concessions and incentives by the Government for encouraging entrepreneurs development.
- There should be a monitoring agency to check the technical skills and ability of the entrepreneurs, quality of the services and the charges collected from the farmers to ensure high standards and also to avoid exploitation.
- A wider publicity about the services available to the farmers through the Agricultural Extension Agencies and Farmers Organizations to popularize the services of the entrepreneurs.
- Developing networking of entrepreneurs to share their experiences. Network to close link with Research Institutions and Universities to update with the latest research findings and seek solutions for their field problems.



Fig. Different Stages of entrepreneurship

Why small scale poultry production?

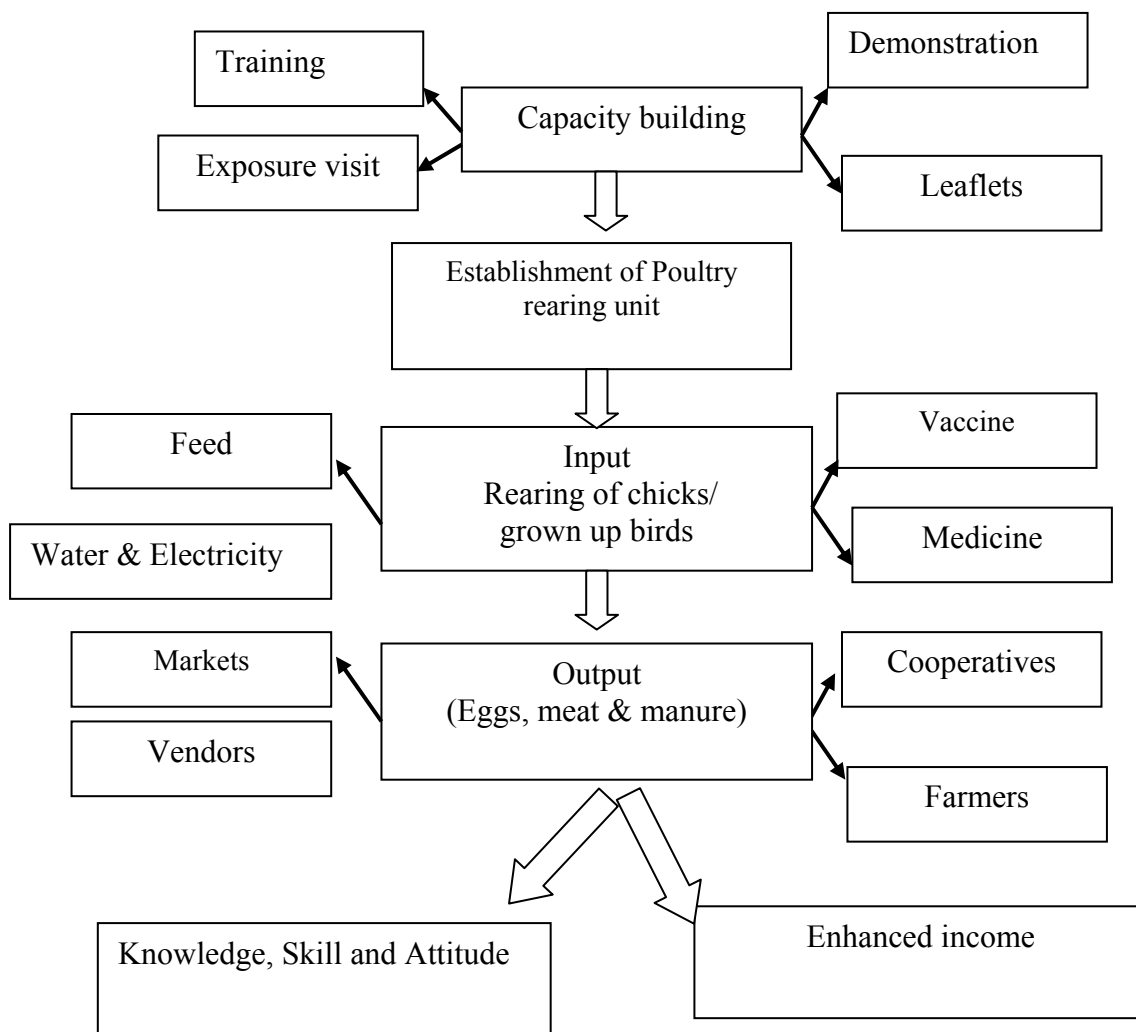
- It is easy to manage and handle.
- It needs minimal use of land, labor and capital. There is higher demand and higher price for eggs and birds of native fowl.
- It requires little intervention in rearing, the major intervention is in the areas of feed and water supplementation, over night housing and 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.
- The egg and meat are highly nutritious and the biological value of egg is very high. So it helps to fight poverty and malnutrition and provide scope for high employment

Chicken Varieties Suitable for Small Scale Poultry Production:

Realizing the importance of small scale rural poultry farming in India, research efforts were initiated in the past at ICAR Institutes and SAUs for developing suitable chicken varieties for rural farming. These chicken varieties developed have multicoloured plumage and resemble

the native chicken in their feather pattern, produce more meat and eggs than the natives. Some of the chicken varieties developed for rural poultry farming are Giriraja, Girirani, Swarnadhara, Vanaraja, Gramapriya, Krishibro, Srinidhi, CARI Debendra, CARIBRO Dhanraja, CARI Nirbheek, CARI Shyama, Upcari, Hitcari, Krishna J, Narmadanidhi, Nandanam IV, Gramalakshmi, Kalinga Brown, Rajasree, Nicrorock, etc.

Entrepreneurship model for small scale poultry production



Economics of Egg type rural poultry production in semi intensive system (200 birds)

Capital investment (initially)

Particulars	Total cost (Rs.)
Cost of low cost house for birds (50 no.s)	80000
Cost of feeders ,waters and electrification	20000
Total	100000

Cost Economics

Particulars	Total (Rs.)
Expenditure	
Chick cost @ Rs.25/ birds	5000
*Rearing cost of male birds from 4 to 15 weeks of age @ Rs. 30 /bird	3000
*Rearing cost of female birds from 4 to 72 weeks of age @ Rs. 300 /bird	30000
Total	38000
Income	
Sale of males at 15 weeks (1.5 kg body weight) @ Rs. 150/kg - total 24 birds	14250
Sale of eggs (180eggs/bird) @ Rs. 5 per egg	85500
Sale of culled birds (2.0 kg body weight) @ Rs. 75/kg	7125
Total	103875
Profit (Income – expenditure)	62875

Strategies for Drudgery Reduction of Farm Women in Livestock and Fisheries

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The rural women are the backbone of agricultural workforce but worldwide her hard work has mostly been unpaid. She does the most tedious and back-breaking tasks in agriculture, animal husbandry and homes. They perform various activities in the home as well in the field throughout the day but don't get any chance to take a nap and work like a machine without any break as compare to the men. Still women are considered as secondary workers in the economic scenario. The farmwomen perform very heavy tasks along with household work. The majority of the activities performed by them demand heavy work which lead to drudgery and have not been supported by the mechanical advantages of tool and appliances.

Farm women's activities in Livestock

Rural women play a major role in animal rearing. They involved in gathering dung, cleaning shed, feeding animal, grazing animal, preparation of animal feed, buying feed, milking, processing of milk, fodder collection and chaffing of fodder. In animal rearing activities, women's participation is highest in cleaning shed (82.7%), gathering dung (81.7%), feeding animal(63.8%), grazing animal(1.2%), preparation of animal feed (68%), buying feed(26.9%), milking, processing of milk(81.5%), Fodder collection (69.8%) and chaffing of fodder (13.5%) and lowest involvement (only 1.2%) was found in animal grazing activity by farm women. Most of them carry out traditional practices in their household levels. Among different animal rearing activities cleaning shed and gathering dung, milking, collecting fodder and chaffing of it are the tedious activities performed by women are drudgery prone. They used to carry head load for disposal of dung, fodder and feed material. They use traditional tools such as *fowda*, broom, trolley, bullock cart, sickle in various activities. A study regarding farm women initiation in taking/ carrying out animal rearing activities independently without assistance of male workers revealed that gathering and disposal of dung were such activities which were performed by 75.6 and 74.6 per cent women are drudgery prone which create several health related issues including musculoskeletal disorders. These activities may lead to hazard if not properly performed with care. It was also found that body parts (leg, eye and hand) of some of the farm women injured due to hurt by animal. Mostly women undertake indoor jobs like milking, feeding, cleaning etc. with management of animals and fodder production.

Farm women's activities in Fisheries

The fisheries sector is an important source of life and livelihood for millions of people around the world. As the world's largest wild food harvest, fish provides a vital source of protein as well as cash income for many families in the developing world. More than 120 million people throughout the world are estimated to depend on fish for all or part of their incomes. The highest numbers of fishers and aquaculture workers are in Asia (85 per cent of the world

total), followed by Africa (7%), Europe, South America, North and Central America (about 2 % each) and Oceania (0.2 %). Fishers, like farmers, are not just men. Millions of women around the world work, paid or unpaid, in the fisheries sector. Although women are mainly involved in the tasks that come before and after the fish are hauled out of the water, they may also be there for the catch or the harvest. At the artisanal level, their preparatory work includes making and mending nets, baskets and pots, baiting hooks and providing services to the fishing boats. They practice their own fishing both for commercial and subsistence purposes, often from canoes and in areas close to their community. There are hardly any authentic statistics available on the number of women involved in fisheries-related work, though it is well known that women play important roles in the sector.

Women engage in a wide range of activities in the fisheries and in fishing communities all around the world:

- As workers (paid and unpaid) within the fisheries, in pre- and post-harvest activities, including liaison work with institutions and agencies. In many countries, it is mostly women who are engaged in inland fishing and aquaculture.
- As workers in seafood processing plants
- As caregivers of the family and in maintaining social networks and the culture of the community
- As workers in non-fisheries sectors to supplement the household income, and the often erratic returns from the fisher

It is estimated that there are 5.4 million people fully engaged in fisheries activities, of which, 3.8 million are fishermen and 1.6 million are fisherwomen. However, there is a sizeable difference in the income earned between males and females with the former being paid the higher benefits even in the lean season. The major role play by women in fisheries are commission agents, retailer, vendor, entrepreneurs, processing, pre-processing, managers, value addition and aquaculture. Observations have shown that women have been involved in both harvest and post-harvest activities. Their roles in harvesting have been limited to collection and hand picking and fishing from smaller water bodies. Clams, crabs, fish fry, seaweed, chank etc. have been fished by women in states like Kerala, Tamil Nadu, West Bengal, Andhra Pradesh, Orissa and the North East. Employment opportunities are generally seasonal in nature and wages poor.

Drudgery

Tedious, menial, or unpleasant work can be termed as drudgery. Drudgery is generally conceived as physical and mental strain, agony, fatigue, monotony and hardship experienced by human being, while all these result in decline in performance of men and women alike. The plight of women in this regard is alarming as they are constrained by illiteracy, poor health, unemployment, low technical know-how and skills. The farm women put in hard physical labour beyond their capacity. A continuous work affects adversely their mental and physical well-being. In relation to drudgery faced by farm women in different farm activities, based on opinion of farm women it has been reported that maximum degrees of drudgery perceived by the respondent were in rice transplanting and harvesting followed by manure application, preparatory work during seedbed, weeding, sowing, irrigation, fertilizer

application, pesticide dusting, carrying crops to threshing, threshing, and grain carrying operations (Sirohi, 1996, and Singh et al, 2006).

Factors Affecting Drudgery

- Illiteracy
- Poor health
- Unemployment
- Low technical know-how and Skills
- Hard physical labour beyond the capacity
- Continuous/ Monotonous work
- Awkward postures
- Repetitive motions of upper and lower limb
- Contact force
- Stress & Strain

All the above factors during work affects adversely to the worker's mental and physical well-being.

Drudgery of farm women in Livestock and Fisheries

Drudgery is associated with a worker when he/she is doing a difficult task or a something he/she does not looking forward to doing due to tedious, menial, or unpleasant work. This affects the worker's physical and mental health and decrease the working efficiency or capacity. The worker remains disturbed and doesn't concentrate upon his/her assigned tasks. There are more chances of increasing rate of accidents at work places and absence of workers due to sickness. Women are more vulnerable in all cases because of their poor health condition, nutritional status, poor level of knowledge and skills, lower education, less awareness and exposure to different technologies and working for long duration at unsuitable workplace or working environment with awkward posture and repetitive motion of body parts. These are the factors which are directly or indirectly responsible for leading drudgery in various activities among rural women. In rural India women perform various activities such as household, farming and animal rearing along with rearing of children and caring of old family members. They devote their time according to their priority of the work. Cleaning animal shed, fodder chaffing, milking and disposal of animal dung are also very tedious activities in case of animal rearing for rural women. In animal husbandry activities, Lakhotia (1996) revealed that rural women perceived maximum amount of drudgery in collection and disposal of dung, collecting and bringing of fodder, cleaning cattle-shed, taking animals to pasture and milking. Moderate amount of drudgery was perceived in preparing dung cakes and their storage, taking care of sick animals and making butter from milk while preparing feed and bathing/cleaning of animals were the least drudgery-oriented tasks. Tripathi et al.(2017) studied the gender issues and their effect on the health status of fisherwomen among 71 fishermen and fisher women in Udupi of Karnataka. They observed that the gender bias was obvious while performing different tasks in fish catching and processing. Tasks like fish catching were exclusively done by men, whereas tasks like cleaning and sorting were done exclusively by women. Loading/unloading the catch from the boat to the harbour and selling fish was done by both men and women. Most of the fisherwomen are involved in various post-harvest operations and are mostly engaged in peeling, trading, processing, and

other related aspects. Studies have shown that about one-third of all health-related absences from work are due to musculoskeletal disorders. Back injuries are the most common site of these disorders (approximately 60%), followed by injuries of neck and upper extremities. Awkward postures such as prolonged standing, lifting/carrying heavy weights, bending down, etc. were acquired by fishermen and fisherwomen during performing the tasks, which is a contributory factor for most of the musculoskeletal disorders. Lack of social services, double burden of household responsibilities and work, and insubstantial control over the use of income places both social and economic constraints on the empowerment of women of this community.

Some of the Risk Factors at the workplace

- Performing the same task over and over
- Working in the same position for long periods
- Bending or twisting back in an awkward way
- Lifting or transferring dependent loads
- Continuing to work when injured or hurt
- Inadequate training in injury prevention
- Heavy lifting
- Awkward lifting
- Lifting in combination with twisting
- Pushing, pulling, carrying
- Repetition
- Accidents, slips, trips, falls
- Vibration
- Contact stress
- Occupational health hazards

Signs and Symptoms

- Some people recognize symptoms in specific areas, while others feel weakness or tenderness over a large area, such as the shoulder.
- Signs and symptoms of injury may appear suddenly or gradually over a period of weeks, months or years.
- Discomfort, pain, numbness, tingling, burning, swelling, change in colour, tightness, loss of flexibility

Need for drudgery reduction

The quality of work life of women in agriculture, livestock and fisheries are characterized by long hours of work, awkward postures and drudgery experiences at work due to work load and unsuitable farming equipments. The education level was very poor and there was less awareness about using different agricultural implements. There were more drudgery and stress among the farm women found in the field. 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. They need more attention for better health and productivity. Above all women friendly ergonomically designed farm tools or implements should be designed to reduce drudgery and health hazards. This also leads in the direction of women empowerment.

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. Introducing women friendly improved farm tools and equipment can reduce drudgery in farm operations.

Strategies for drudgery reduction

Development/ refinement of technologies with women's perspective: Farm women use various traditional tools for different farming, household and animal rearing activities. Sometimes these tools and equipments are not women friendly. They face difficulty while handling and it induce drudgery. Therefore these 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. Improved tools and equipment help to achieve one or more of the following :

- Increasing utilization efficiency of inputs
- Increasing working efficiency
- Able to finish timeliness in field operations
- Improve quality of work/ produce
- Reduce drudgery
- Enhance the quality of work life of agricultural workers

Materials and information handling: These 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

Suitable working environment: The 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.

Application of Ergonomics for drudgery reduction:

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 behavioural, 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.

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

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 5th and 95th percentile values/limits. The anthropometric criteria deal with issues of clearance (95th percentile limit), reach (5th percentile limit), posture (as per job requirement) and strength (5th percentile limit). Based on 5th 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. Physiological cost of operation

Physiological cost of any operation is expressed in terms of heart rate and oxygen consumption rate. For an 8 hour work period for 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.

C. 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.

D. Load carrying capabilities

Load carrying and transportation is one of the important activities in livestock and fisheries for example carrying loads or packages of packed fish, carrying fodder, disposal of dung 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. During modification of commercial fertilizer broadcaster unit, reduction of total weight of equipment including weight of fertilizer filled in was also one of the factors that were reduced. Further, the static loading of hands and arms may be avoided while carrying/ transportation.

Promotion of gender friendly tools and equipment required livestock and fisheries related activities: Gender friendly tools and equipment required livestock and fisheries related activities can be promoted through various govt schemes and projects. Selected tools and equipment can be multiplied and provided to the stakeholders with minimal cost or subsidies. Awareness generation and capacity building are the foremost step for orientation and popularization of gender friendly tools and equipment. Various demonstration and trials of women friendly technologies can be conducted at field level for better sensitization and adoption. Follow up services can be provided for maintenance and monitoring of the activities.

Conclusion

The quality of work life of women in livestock and fisheries related activities are affected by long hours of work, awkward postures and drudgery experiences at work due to work load and unsuitable farming equipments. There were more drudgery and stress among the farm women due to adoption of very awkward static postures and performed task repetitively which was responsible for drudgery, musculoskeletal disorders and leads to occupational health hazards. They need more attention for better health and productivity. Above all women friendly ergonomically designed farm tools or implements should be designed to reduce drudgery and health hazards. It also provides a platform to the researcher to refine the work station at various working environment and fit the worker within the environment. 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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Integrated Farming System: A Way to Sustain Livelihood for Rural Women

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India is an agrarian country, where a major proportion of its population derive their livelihood from agriculture and allied activities. With emerging issues of climate change, population explosion and depletion of natural resources, the sustainability of the production system becomes doubtful. In such existing situation, it is the need of the hour to sought out some strategies to make the agriculture more stable and sustainable. Integrated farming system with components of multiple farming systems and crop diversification offers an effective mechanism for the agrarian population to strengthen their livelihood along with ensuring the nutritional security. The agricultural scenario of our country is very dynamic due to varied agro-ecological conditions, which enables the production of various agricultural, horticultural and allied components with the involvement of wide group of growers. The small and marginal farmers who cannot take farming on a commercial basis can effectively integrate various components of farming suitable for their piece of land for ensuring continuous production of various agricultural and allied commodities and thus can strengthen their livelihood with the existing resources. Integrated farming system can be considered as a form of traditional farming, where the use of agri-inputs were minimum and farming was done organically with locally available resources. However, with Green revolution, the use of fertilizers, high yielding and hybrid varieties brought a transition in the conventional farming. Farmers opted for commercial farming in which the use of agro-chemicals and fertilizers were so rampant that the entire farming community started depending upon the private companies for supply of quality seeds, fertilizers and pesticides. With excessive use of agro-chemicals, the soil and environmental health started declining, even there are several health hazards imposed by use of such synthetic agri-inputs. In a developing country like India, where most of the farmers are small and marginal, couldn't compete with big farmers who could easily afford the necessary inputs and initiate farming in a commercial way. Thus, IFS offers solution for the small and marginal farmers who can integrate various components of farming in their existing farm and can produce surplus from the existing resource base through waste recycling and effective space and time utilization, thus enabling in conserving the environment.

Integrated farming system and its concept:

Integrated Farming or integrated production is a complete organic farm management system which aims to deliver more sustainable agriculture. 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. There is a judicious mix of agricultural enterprises like dairy, poultry, piggery, fishery, sericulture, apiculture etc. suited to the given agro-climatic conditions and socio-economic status of the farmers for better revenue generation from the farming system.

Benefits of IFS:

- Higher productivity thus enabling to meet the food requirement of the exploding population of our nation.
- Increased farm income through multiple farming components and proper waste recycling.
- Enhanced soil fertility and productivity through organic waste recycling.
- Availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins to the family members
- Integrated farming will help in environmental protection through effective recycling of waste from animal activities like piggery, poultry and pigeon rearing
- There will be better promotion of organic farming by avoidance of use of chemical fertilizers and pesticides.
- Reduced production cost of components through input recycling from the by-products of allied enterprises. The end product of one enterprise could be effectively used as an input for the other enterprise.
- Regular stable income through the various diverse products like egg, milk, mushroom, vegetables, honey and silkworm cocoons from the integrated activities.
- Reduced energy crisis by inclusion of biogas & agro forestry in integrated farming system.
- 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, buffalo, goat, sheep, pig and rabbit.
- Firewood and construction wood requirements could be met from the agroforestry system without affecting the natural forest.
- The components of agroforestry, in various forms such as horti-siliculture and agri-siliculture will result in avoidance of soil loss through erosion thus enabling in maintaining an optimum soil health.
- Generation of regular employment for the farm family members of small and marginal farmers.

Role and constraints of Women in Indian Agriculture and IFS as an alternate solution:

Though India is no longer an "agricultural economy", 70 percent of its rural households still depend primarily on agriculture for their livelihood (FAO, 2018). The magnitude of female workforce is enormous, around 63 % of all female workers, and 75 % of rural female workers are in Agriculture (NSSO 68th Round 2011-12). Women make remarkable contribution in agricultural activities, starting from planting material production, transplanting, care and maintenance of crop to post-harvest processing & value chain. In allied activities such as tending of animals, bee keeping, mushroom cultivation, sericulture and poultry farming their contribution is immense. Their involvement is more significant in all monotonous, time consuming and tiresome activities. There are several constraints faced by women farmers in agriculture, few being lack of ownership and access to productive resources, lack of technical

competency in carrying out the farming activities, lack of decision making in farming issues and lack of access to market to sale their produce. Integrated farming system is a family approach which can be initiated with minimum resources. It is a form of traditional farming with better management strategies to maximize the production from unit area and time invested. Women farmers can exercise better control in such farming system which is inclusive and holistic. There will be reduced dependence on external resources as the component of one system can be utilized in other system, for instance the wastes from mushroom farming, crop residues, animal waste can be effectively utilized in vermicomposting, thus reducing the application of inorganic fertilizers in the production system. Integration of several Indigenous Technical Knowledge in pest and disease control such as use of *panchgavya*, use of botanicals etc. will promote in organic production by avoiding the use of agro-chemicals. The inclusion of fodder crops for milch cattles and use of compost and cow dung in enriching the soil will and various other forms of bio-resource flow will enable efficient utilization of resources, optimum production of healthy foods, environment protection and conservation of natural resources, thus bringing more sustainability to the production system.

Different components of IFS:

Field crops: The field crops include various agronomic crops such as cereals, pulses, oilseeds, fibre and fodder crops. The choice of the crops for the region depend upon the soil conditions, rainfall and its distribution, length of growing season and market demand. The needs and resource base of the farmers are also crucial which decides the selection of IFS components in any farm.

Suitable grain crops: According to soil type we can select suitable crops.

Black soil:

Cereals: Maize
Millets: Sorghum, bajra
Pulses: Green gram, black gram, red gram, chickpea, soybean, horse gram
Oilseeds: Sunflower, safflower
Fibre: Cotton

Red soil

Millets: Sorghum
Minor Millets: finger millets
Pulses: green gram, red gram, soybean, horse gram, cowpea
Oilseeds: Groundnut, castor, sesame

Suitable forage crops:

Black soils: Fodder sorghum, fodder bajra, fodder cowpea, Rhodes grass, *Elusine sp.*, Thomson grass.

Red soils: Fodder bajra, Blue Buffel Grass, fodder ragi, fodder cowpea, Stylo, marvel grasses, spear grass, vettiver

Suitable tree species: The tree species such as *A.tortilis*, *A.albida*, *Neem*, *Holoptelia integrifolia*, *Manja neythi*, *Hibiscus tilifolia*, *Gmelina arborea*, Casuarina, Subabul and *Adina cordifolia* are suitable for black soils. Tamarind, Simarouba, *A.mellifera*, *Neem*, *Hardwickia binata*, Ber, Indian Gooseberry, Casuarina, Silk cotton etc. are suitable for red gravelly/sandy red loam soil.

Some of the underutilized fruit trees such as Karonda, Jamun, Custard apple, Jackfruit, Aonla, Carambola can also be successfully grown as wasteland crop. These tree species helps in effective reclamation of the degraded soil. Various forms of Horti-silvi-pastoral, agri-silivi-pastoral and hort-silivi-agri-pastoral forms can also be integrated for effective raising of various crop species in limited areas.

Horticultural component:

Various horticultural crops like fruit crops, vegetables, spices, flowers, medicinal, aromatic and plantation crops can also be effectively integrated in the farming system. Intercropping in the fruit orchards with seasonal vegetables during initial years of orchard establishment will enable in maximizing productivity. The seasonal vegetables should be selected on the basis of market demand. The off season vegetable cultivation in poly houses and shade-nets should also be incorporated for better livelihood option. Spices and plantation crops are also integral component which can ensure profitability to the farming system.

Various farming models like the multi-storey cropping which integrates the plantation crops like coconut, arecanut, oilpalm in the first storey, Banana/papaya/guava in the second storey, pineapple and shade loving plants like ginger/turmeric in the 3 rd storey with black pepper trailing over the coconut can also be adopted in the production system for efficient spatial and temporal utilization for maximizing production. Other allied activities include mushroom farming and apiculture. Integration of livestock and horticulture such as "Integrated fish cum horticulture", which includes pisciculture along with planting of short duration fruit crops viz. banana and papaya, trailing cucurbits viz. bitter gourd, ridge gourd, ivy gourd in the river banks or the embankments of the ponds, "Integrated poultry in orchards" in which poultry birds are raised within the orchards in a mutual mechanism, "Integrated fish-cum duckery cum horticulture" are some of the successful forms of integrated farming systems.

Suitable livestock and birds: Various animal and bird components include Goat, sheep, pig white cattle, black cattle, rabbit, poultry birds, pigeon, quail, duck, turkey birds etc. The provision of fodder crops for the cattle, Azolla or cereal based feed for the poultry birds and the utilization of the animal wastes (cow dung, poultry droppings etc.) in the crop fields are successful examples of integration of livestock and crop components. Fish farming for raising fishes such as carp, tilapia, salmon, and catfish commercially in tanks or enclosures in small ponds are also remunerative. Cage system of fish rearing, Composite fish culture, Irrigation ditch or pond systems for raising fish are some of the successful forms which can be integrated in IFS.

Challenges in IFS:

Despite of several benefits of the IFS some of the challenges include the viability of the system, which depends upon efficient managerial skills and judicious management to ensure efficient resource flow, stable production and steady income generation. Operation of each of

the activities simultaneously needs sufficient planning, vigilance and dedicated efforts. Other challenges include the hazardous impact of unpredictable climate change. Thus the strategies of climate resilient agriculture and climate smart agriculture are required to be encouraged among the farming community through rigorous trainings and capacity building programmes.

Integrated farming system offers a platform for the farmers to combine several forms of farming in a consolidated manner. Failure from one form of farming could be neutralized from the profit of the other farming, thus reducing the risk of complete devastation as in case of crop failure in monocropping. The unutilized time during lean period can be successfully dedicated for other enterprise, thus enabling in increasing the net income earned from the entire production system.

Value Addition in Fisheries for Livelihood Improvement

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Fish is a very perishable food commodity that requires proper handling and preservation to increase its shelf and retain its quality and nutritional attributes. Processing fish involves primarily the application of preservation techniques in order to retain quality and increase shelf life. It may also deal with value-adding to produce a wide variety of products. A number of methods are used to preserve fish like refrigeration or freezing; drying, salting, smoking, freeze-drying, microwave heating or ionizing irradiation. Techniques are also used that are based on oxygen-reduction, such as vacuum packaging.

There has been vast advancement in the post harvest fisheries technologies particularly due to the changing needs of the consumers. Value added products of different descriptions are slowly becoming popular as 'convenience food' in the wake of changing life styles. Present day consumers demand hygienic ready to cook or ready to eat products. The increased purchasing capacity, lack of time and space and increased employment among women, consciousness towards hygiene and health and increased emphasis on leisure pursuits are compelling them to demand the value added fish products. Consumers, especially urban consumers, are willing to pay higher price for value added fish and fish products. Value addition improves the natural and conventional form, quality and appeal of a product subsequently increasing the consumer valuation beginning from the farm level to marketing of finished products (Mwinyihija, 2010). Value addition of fish also plays a major role in employment generation, entrepreneur ventures and boosting exports from a country. Value addition in fish could range from a simple display of hygienically dressed and iced fish which lures the customers to preparation of dry fish, mince based ready to cook or ready to eat products or byproducts like fish silage.

Chilled fish and Frozen Fish fillets

Nowadays fresh fish and frozen fish outlets are common in cities. Chilling is an effective way of reducing spoilage by cooling the fish as quickly as possible without freezing. Immediate chilling of fish ensures high quality products. Chilled fish fetches more price than frozen fish. Modern packaging techniques viz., vacuum packaging, modified atmospheric packaging and active packaging significantly enhances the shelf life of chilled fish products. Freezing and storage of whole fish, gutted fish, fillets etc. are methods for long-term preservation of these species. Fish fillets can also be used for the production of ready to serve value added products such as fish in sauce and fish paste.

Battered and breaded products

The most prominent among the group of value added products is the battered and breaded products processed out of a variety of fish and shellfish. Battered and breaded items are included in the value added products because the process of coating with batter and bread crumbs increases the bulk of the product thereby reducing the cost element. As a convention 50% fish portion is expected in any coated product. Coated products viz., fish fingers, fish cutlets, fish nuggets, quid rings, cuttlefish balls, fish balls and prawn burgers form one of the major fish and shellfish based items. The production of battered and breaded fish products involves several stages. The method varies with the type of products and pickup desired. In most cases it involves seven steps. They are portioning/forming, pre-dusting, battering, breading, prefrying, freezing and, packaging and cold storage.

Ready to serve fish products in retortable pouches

Ready to serve fish products viz. curry products, in retortable pouches are a recent innovation in ready to serve fish products for local market. The most common retortable pouch consists of a 3 ply laminated material. Generally it is polyester/aluminium/cast polypropylene. These products have a shelf life of more than one year at room temperature. As there is increasing demand in National and International market for ready to serve products the retort pouch technology will have a good future.

Extruded product- Fish kure

Fish Kure is a fish based extruded food product and have application as snack food. Usually, extruded products are prepared using cereal flour, which have less protein content and are limited in some essential amino acid. By incorporating protein-rich fish mince instead of cereal, the product is protein enriched snack food. The production process involves fish meat is mixed with cereal flours, spices and salt and extruded using a twin screw extruder. The dried and coated products are then packed in metalized polyester polyethylene pouches using nitrogen gas filling and the product is acceptable up to 3 months at ambient temperature.

Curing

The traditional methods of processing fish by salting, drying, smoking and pickling are collectively known as curing. Cured fish consumption is more in areas where the availability of fresh fish is comparatively limited, namely interior markets and hilly areas. This is also the cheapest method of preservation, since no expensive technology is used. In India roughly 20 % of the fish caught is preserved by curing. Considerable quantities of cured fish are also exported, mainly to Singapore, Sri Lanka and to the Middle East. Simple sun drying was the widely practiced traditional method of fish preservation. By this, preservation was achieved by lowering of water content in the fish, thereby retarding the activity of bacteria and fungi. The heat was able to destroy the bacteria to a certain extent. Later on, a combination of salting and drying or salting, smoking and then drying were developed. There are basically two methods of drying fish, sundrying and artificial drying. Sun drying depends heavily on the natural weather conditions since the fish is dried by heat from the sun and the air current

carries the water away. Here there is no control over the operations and many a time the losses cannot be substantiated. In mechanical driers, removal of water from the fish is achieved by an external input of thermal energy. This is an expensive method since there is need for fuel for heating and maintenance of the temperature.

Salting

This is one of the oldest methods of preservation of fish. Salting is usually done as such or in combination with drying or as a pretreatment to smoking. During salting osmotic transfer of water out of the fish and salt into the fish takes place, which effect fish preservation. Loss of water during salting limits bacterial growth and enzyme activity, thus preserving the fish. The high salt content prevents the growth of normal spoilage microflora in the fish; but halophiles, which can survive 12-15% of salt, will survive.

Fish Pickle

Like vegetable pickles, fish pickle has also gained popularity in the recent past. Fish/Prawn pickle, when carefully prepared under most hygienic conditions with addition of required quantity of salt, preservatives and spices will have generally an average shelf life of one year. Most of the sea fish like Prawn, Tuna, Pomfret, Mackerel, etc are ideally suitable for making fish pickles.

Fish flakes/wafers

Thread fin breams and cat fishes are used in the preparation of flakes or wafers. Fish flesh is boiled, mixed with maida, salt, etc. to prepare flakes or wafers.

By products from fish

Chitin is the second most abundant biopolymer on earth next only to cellulose. It is a white, hard, inelastic nitrogenous polysaccharide extensively used for several purposes. In India, the single largest source of chitin is the shrimp shell and head waste. Chitin is produced from the shell waste by deproteinisation and demineralization. Chitosan is produced by the deacetylation of chitin. Chitosan has several industrial and medicinal uses.

Shark fin ray is a valuable byproduct from the shark. The shark fins are dried, soaked overnight in 10% acetic acid solution. The skin and the softened muscle are scraped off and the rays are separated individually. They are then washed thoroughly and dried. Shark fin rays are an essential ingredient in some exotic soups.

Squalene is a highly unsaturated hydrocarbon present in the liver oil of certain species of deep sea sharks mainly *Centrophorus* and *Squalidae* spp. The liver oil of these species contain high percentage of squalene (90%) which can be isolated and purified and can be used as a dietary supplement.

Isinglass is prepared from fish maws (dried air bladder). Fish maws is soaked in water for 24 hours, washed and extruded, dried at 450 c and then powdered. It is mainly used for the clarification of wines.

Fish protein concentrate (FPC) is a stable protein concentrate prepared from whole fish or other aquatic animals or parts thereof. Protein concentration is increased by removal of water, oil, bones and other materials. It is incorporated as a protein supplement in human diet. 5-10 per cent level FPC in bread and biscuit is considered the acceptable limit. 35 g per person per day is a recommended level of use of FPC.

Fish Gelatin is a protein that lacks in an essential amino acid tryptophan, and hence cannot be considered as a sole source of protein in animal or human nutrition. But it is a relatively high source of lysine and methionine, which are deficient in cereal proteins. However, gelatin finds extensive use in food as also in the formulation of some industrial products. Gelatin can be extracted from the skin and bones of fish.

Fish oil is obtained by extracting from the entire body of the fish or only from the liver. The oil obtained from the entire body is known as body oils and are grouped into drying and semi drying oils. The drying oil comprises oils of sardine, salmon, herring, mackerel, anchovy, and white fish, while the oils of sprat and carp constitute semidrying oil due to the low iodine content. The body oil is edible and used for industrial purposes. Liver oil extracted from the liver, is of medicinal importance and contains vitamin A and D.

Fish meal is a preparation where fresh fish is ground, cooked and dried. It is highly nutrient rich and is an excellent poultry and animal feed, which has proven to increase egg and milk production. As fish meal contains calcium, phosphorus, iodine and rich variety of vitamins and micronutrients it forms an excellent feed in aqua- culture.

Fish silage is a liquid product which can be made from waste of fish or whole fish, which are liquefied by the action of natural enzymes present in the fish. There are two processes by which silage can be made. One is acidification where the natural enzymes in the fish are activated by addition of organic or inorganic acid or a mixture of both. The second process is fermentation, where the enzyme activity is catalysed by the acids produced by the fermentation of added sugar with or without the presence of lactic acid bacteria. The technology of fish silage production has the following advantages: Simple technology, less capital investment and low skill requirement, hence women friendly, nutrient composition similar to that of raw material (Fish waste), no offensive odour, Fast ensiling under tropical climate (2-3 days), shelf life of more than 6 months for chemical silage and 2 months for fermented silage and alleviates environmental pollution and Low cost of production. Fish silage finds its major use in the area of animal nutrition, where it is mainly used as a source of protein. Several research studies have been conducted at the Central Institute for Women in Agriculture, Bhubaneswar, to validate the potential use of fish silage as poultry feed ingredient. 10% fish silage in broiler poultry diets reduced the feed cost by Rs 5/kg. A poultry farmer could increase his profit margin considerably by using the technology. In Japanese quails, the consumption of fish silage resulted in an increase of 8% in egg production. Vanaraja, a most popular dual purpose poultry breed, popular in the rural areas of the India, also showed positive growth performance when fed with fish silage. Thus, the protein to the tune of 35-39% in acid treated silage and 15-19% in fermented silage which could otherwise

go as waste can be converted to alternative feed ingredient through this low cost technology. Another probable use of fish silage is as organic fertiliser as it contains the nutrients suitable for plant growth, soil microbes and earthworms and is free from off odour. The production of organic manure from fish silage could be an innovative livelihood option for rural women. Experiments in horticultural crops like Okra (*Abelmoschus esculentum*) and Cowpea (*Vigna unguiculata*) were conducted to study the manurial properties of fish silage. In Okra, treatment with 50% farm yard manure and 50% fish silage gave higher pod weight, pod length, pod number, and average yield which is 12.98%, 0.2%, 10.93% and 31.85% higher than 100% farmyard manure. Application of vermicompost enriched with fish silage had a positive effect on growth and yield of cowpea in terms of better average yield of fruits per plant, plant height, total number of branches per plant, weight per fruit and number of seeds per fruit.

Marketing of value added products and by-products is completely different from fresh seafood marketing. It is dynamic, sensitive, complex and expensive. Market surveys, packaging and advertising are a few of the very important areas, which ultimately determine successful launching and popularisation of a new product.. One appropriate channel would be supermarket chain; which want to procure directly from source of supply. Appearance, packaging and display are all important factors leading to successful marketing of any new value-added product. The retail pack must be clean, crisp and clear and make contents appear attractive to consumer. The consumer must be given confidence to experiment with a new product from, target group, market area, species used and so on.

Leadership for Impact in Agriculture Development

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Introduction:

Leadership is the art of motivating a group of people to act towards accomplish a common goal. Effective leadership is based upon ideas or plans (whether original or borrowed), but won't happen unless those ideas or plans can be communicated to others in a way that engages them enough to act as the leader wants them to act.

Leadership development is expressed as the "expansion of a person's ability to be effective or productive in leadership roles and processes". These roles and processes are ones that aid in setting direction to achieve goal, creating alignment and maintaining commitment in groups of people sharing common work. Most of the organizational leadership research and educational programs mostly focused on developing individual-based knowledge, skills, and abilities associated with formal leadership roles (human capital) of individuals. Leadership development therefore results by investing in human capital.

Leadership development can be achieved by expanding the collective capacity of organizational members to engage effectively in leadership roles and processes.

Leader's responsibilities:

- Guide and coordinate team members
- Provide structures for team
- Clarify working methods, practices and protocols.
- Focus on performance.

Leadership Types or Style:

Transformational Leadership, Transactional Leadership, Servant Leadership, Autocratic Leadership, Laissez-faire Leadership, Democratic Leadership, Bureaucratic Leadership, Charismatic Leadership, Situational Leadership, Participative Leadership, Directive Leadership, Supportive Leadership, Achievement Oriented Leadership etc.

Leadership traits:

Personal traits play a crucial role in determining who will and who will not be comfortable leading others. The effective leaders should have the following traits,

- Emotional stability
- Dominance.
- Enthusiasm.
- Conscientiousness
- Social boldness

- Tough-mindedness.
- Self-assurance
- Compulsiveness
- High energy
- Intuitiveness
- Maturity
- Team orientation
- Empathy
- Charisma

Leadership Behaviour:

- Communicate effectively
- Recognise the developmental requirements of team members
- Set goals and motivate the team to accomplish them
- Provide enthusiastic and creative encouragement
- Model acceptable behaviour

1. Communicate Effectively: An effective Team Leader provides a high level of communication to the team members about

- The goals that have been achieved
- Any goals that still need to be achieved
- How to achieve these goals
- Where team members can go for support

When communicating with their team members, an effective Team Leaders use a consultative approach. This requires actively listening to team member concerns and opinions before deciding upon an appropriate strategy. An effective consultative approach also refers that Team Leaders should provide feedback to their team members on a regular basis.

2. Recognise the developmental requirements of team members:

An effective Team Leader will identify the developmental needs of the team members and will install a process to ensure that each individual's needs are developed. This has direct benefits to both the individual and the team, as it increases morale within the team and helps to ensure that the best is attained from each team member.

3. Set goals and motivate the team to achieve them:

An effective Team Leader will set clear, identifiable and achievable goals and will be able to plan and monitor a team's progress against these goals.

4. Provide enthusiastic and creative encouragement:

Effective Team Leaders encourage creative and innovative approaches to problem solving.

5. Model acceptable behaviour:

An effective Team Leader provides the team with an appropriate role model. The Team Leader will demonstrate both acceptable behaviour and the relevant skills required by the team to undertake their roles within the enterprise.

Leadership Approaches:

The Qualities or Traits approach: leaders are born, not made; effective leadership consists of certain inherited personality, traits or qualities.

The Functional or Group approach: Under this approach leadership can be learned and developed. This approach mainly focuses on the task, accountabilities, responsibilities and functions of the leader and the nature of the group. Also examines how the leader's behaviour affects and is affected by the group of followers.

Adair's Action-Centred Leadership is one of the key theories of the functional approach. This approach focuses on the function of the leaders and the need to balance the needs of the individual, the task and the team.

Behavioural style approach: focuses on the behaviour of people in leadership positions, the importance of leadership style and how it influences group performance.

Status of women leaders in India:

India ranks 24th out of 135 countries in regards to women's political participation as per the World Economic Forum's Gender Gap Index (2009). Women still hold a mere 10% of seats in India's Parliament, in the world's largest democracy. According to a global survey by Grant Thornton – Women in business: New perspectives on risk and reward, India continues to rank third lowest in the proportion of business leadership roles held by women for the third year consecutively,

Senior roles are held by women in India is only 17 percent . The survey of 5,500 businesses in 36 economies further revealed that 41 percent of the Indian businesses surveyed have no women in leadership roles, 7 points higher than the last year. Only 7 percent of the senior management (CEO/ Managing Director) roles were held by women in India revealed from this survey. Human Resources Director (25 percent) and Corporate Controller (18 percent) are the most common roles held by women in India.

Gender and Leadership:

Effective leadership is not the exclusive domain of either gender and both of them can learn from the other. Women's leadership style is, different from men. Women's leadership styles are not at all likely to be less effective; in fact, they are more effective within the context of team-based, consensually driven organizational structures that are more prevalent in today's world.

Women are effective leaders due to following reasons;

- Women leaders are more assertive and persuasive.
- They have a stronger need to get things done and are willing to take risk than male leader. Women leaders found to be more empathetic and flexible.

- Stronger in interpersonal skills than their male counterpart.
- Enabling them to read situations accurately and take information from all sides.
- They have the ability to bring others around to their point of view.
- They genuinely care and understand about where others are coming from, so that the people they are leading feel more understood, supported and valued.

Constraints in Farm Women leadership:

- Women have more family responsibilities than men
- Roles allocated by society to men and women
- Masculine social culture
- Women have insufficient exposure to decision making
- Few role models for women
- Mentors to nurture leadership among women are few and far between.
- Men not socialised for promoting women leadership
- Lack of organisational gender equity policy and programmes
- Leadership skills based on gender stereotypes
- Lack of leadership training for women
- Lack of flexible work solutions

Objectives of leadership development in Farm women:

- Strengthen the capacities and competencies of rural women leaders in a sustainable way;
- Build support from their male colleagues and counterparts for gender equality and women's leadership;
- Strengthen the competencies of key members of project stakeholders and representatives of beneficiaries in project areas to allow them to express themselves, choose their leaders appropriately and hold them accountable, and manage their own organizations effectively.

Partnership for Effective Delivery of Technology

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Background: People in government, corporate, public, and private sectors have been implementing various development projects for improving livelihoods of people in their respective region, district and state of the country. Each institution or organisation puts its best effort and strategy to contribute in the field where they work. Organisations, many times work in silos and compare their work and achievements with others, concluding that they are the better, often missing opportunity to actually do better. This happens when people are unable to think beyond, out of box and seek support from other potential people or institutions. People working for any organisation might have certain skill sets and not have many.

Based on the above-mentioned description and considering the limited individual potentials, if someone could think of taking the support from other organisations whose skill set could complement, then both jointly achieve greater results. It always gives the best result and satisfaction to both the complementing partners by understanding and enhancing each other's expertise on a common objective. So, here the word comes convergence, once an organisation decides to work together, then it immediately relates to a partnership, may be any kind, which needs a formal understanding.

Introduction to Partnership and its need: It refers to a working condition or business environment where individuals or institutions mutually agree to work on certain aspects of business or programme towards achieving a common goal. This arrangement gives an opportunity for partners to understand each other's strength, weaknesses, share, care and build upon individual expertise for the larger benefit of the project or programme that they carry.

If we think for a while, one could imagine that Public-Private-Partnership(PPP) has worked well in some sectors like infrastructure, health, education and disaster management, but remains to be explored fully in the field of delivering livelihood services. Public extension services are under pressure owing to their own poor performance and are often criticised for not being: efficient and effective; lacking clear objectives, motivation and incentives, being poorly managed and not accountable to clients; and lacking in relevant technologies(Haug,1999). However, now-a-days policymakers and implementers have been putting much of effort in this regard to bring convergences to strengthen the extension delivery system for addressing the livelihood needs of people on the ground. Again, the draft "Policy Framework for Agricultural Extension" (PFAE) of the Ministry of Agriculture affirms that the "policy environment will promote private and community-driven extension to operate competitively, in roles that complement, supplement, work in partnerships and even substitute for public extension" (DAC,2000). Thus, it is important that for all of us to understand the meaning and benefits of partnership in general and exploring the possibilities of working on it, if feasible.

Basic pre-requisites of partnership: Before deciding of working with an organisation through a partnership, each of the organisations must discuss about the expertise, strength areas and common goal. There should be a mutual exploration process knowing each other professionally, it might take some time but it is highly essential. But because of the programmatic urgency, organisations just go ahead without adhering to this kind of processes, which later creates stumbling blocks in the partnership affecting the very purpose of partnership that was mutually agreed upon.

Ethics of partnership: Partnership is a kind of mutual trust and building a mutual relationship. Irrespective of challenges, we must be honest and open to our partners for really addressing the issues. In a partnership kind of agreement, each partner has equal rights to share and draw attention to any issues. Both the partners work together for any kind of decisions related to the project they carry out. Any issues or concerns must be amicably resolved. If something is not resolved, then, it must be documented and signed evidence must be ensured

Dos and Don'ts in partnership: All the correspondences and communications (written or verbal) should be polite (proposition, suggestion, feedback, request etc.) in nature rather than direction or order. The partners should be proactive in seeking suggestion and providing feedback as well for the betterment of individual and project.

Programmatic advantages or benefits of partnership: As every one of us know, no one is cent perfect in his/her area of expertise and one should not expect that one should have all the skills which is required for the project. Likewise, it is applicable for the organisation as well. So when we partner with an organisation, it is based on some expertise which we expect from the partnering organisation as a complement to fulfil the lacking expertise. So that it strengthens the skill that is required for achieving the common goal.

Secondly, it helps in optimal use of resources (both finance and program) because of the local presence of the partners in a particular area. The delivery of the services or technology becomes faster, and coverage becomes more with a rational way because the partner know about the area and people.

Conclusion:

Working through partnership mode is always good if both the partners work together on the basic principles of partnership and are transparent enough in sharing issues, concerns and bringing amicable solutions. In the current world, partnership is very seriously seen at all levels for bringing more talents and resources to the country. Key challenge remains with the partners how best they could manage and grow professionally with each other, achieving the big picture.