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Women Friendly Nutri-Smart Interventions for Alleviating Malnutrition in Rural Areas

3-12 January, 2023



भा.कृ.अनु.प. - केन्द्रीय कृषिरत महिला संस्थान, भुवनेश्वर
ICAR-Central Institute for Women in Agriculture
Bhubaneswar, Odisha -751003



ICAR Short Course

Women Friendly Nutri Smart Interventions for Alleviating Malnutrition in Rural Areas

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Bhubaneswar- 751 003, Odisha, India.

e-Book

Women Friendly Nutri Smart Interventions for Alleviating Malnutrition in Rural Areas

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Foreword

Agriculture being a source of income for women can influence the intra-household allocation of food and other nutrition-enhancing complements. Women, compared to men, have been found to devote major portion of their earnings to collective household needs of food for the family. At the same time, heavy agricultural workloads and exposure to toxins and disease through agricultural activities can deleteriously affect women's health and nutrition and also have negative consequences for lactation and child-care. There is a link between household-level production diversity and diversity of diets among farm families. Agricultural productivity growth has long been seen as a promising pathway towards reducing malnutrition, therefore, an agricultural growth strategy for addressing nutritional concerns, with a specific focus on women's requirements will have exceptionally stronger effects on younger women.



Combating malnutrition in all its forms, a global health challenges as every country is affected by one or more forms of malnutrition. Malnutrition is amplified by poverty and the lack of access to resources and often affects the farmwomen disproportionately transmitting poverty from one generation to the next as a vicious cycle by increasing health care costs, reducing productivity, and slowing economic growth, all of which, in turn, perpetuate a cycle of poverty and ill-health. A well-nourished, healthy workforce is a pre-condition for sustainable development. At the same time, the nutritional well-being of a population is a reflection of the performance of its social and economic sectors; and to a large extent, an indicator of the efficiency of national resource allocation. In order to address the multiple factors that cause chronic under nutrition, inputs from many sectors and convergence of government services and programmes are required. This underlines the need for a multi-sectoral response, which includes both direct (nutrition-specific) and indirect (nutrition-sensitive) interventions. Nutri Smart Agriculture is a multi-dimensional concept, which links the availability of food through agricultural production, physical and economic access to food, as well as adequate use and utilization of available food by individuals. However, making Nutri smart agriculture a reality and enhancing the nutritional outcomes of agriculture necessitates effective participation of women both on and off farm. As agriculture in India is gradually becoming more feminized, development of women friendly technologies which can cater the specific cropping system, is essential. Use of less input intensive cropping

practices, better access to productive resources, inputs through community involvement, interventions to reduce their care giving activities, incorporation of rest and leisure time, etc will go a long way in improving their physical and mental health and nutritional status. Hence not only nutrition sensitive but nutri smart interventions are the need of the hour.

ICAR-Central Institute for Women in agriculture is a premier organization working relentlessly for development of technologies and practices for empowering women for achieving nutritional wellbeing for their families. Development of Nutri Smart villages is an important initiative of the Institute in this direction. The institute transformed 75 villages from subsistent to nutri smart by women friendly nutri smart interventions and created awareness in this regard among all the stakeholders.

The present ICAR sponsored Short Course on "Women friendly Nutri Smart interventions for alleviating malnutrition in rural areas" is an attempt made to sensitize participants from various ICAR Institutes, SAUs and KVVKs on role of women in agriculture, challenges of malnutrition in India, designing effective nutrition sensitive agricultural activities, use of bio fortified crops, collaboration and linkages for promoting NSA, effective management of family resources, promotion of millets and locally available nutritious vegetables for nutrition and income of farm families, e-marketing and value chain for nutri foods and strengthening extension advisory system for nutrition sensitive agriculture and management of nutri-smart agriculture at different scales of production.

I appreciate the efforts of resource persons in developing and sharing materials for the course, and compliment Dr. Laxmi Priya Sahoo, Course Director, Dr. Jyoti Nayak and Dr Tanian Seth, Co-Course Directors, Dr Neetish Kumar, Course Coordinator and Sri Manoranjan prusty, Sri Pragati Kishore Rout, Sri Subrat Kumar Dash the technical team for bringing out the e-Book of various lectures delivered during this short course. I hope the e-Book will be immensely useful to the participants for effective planning of the activities related to dissemination and promotion of Nutri Smart interventions for alleviating malnutrition in rural areas and making farm women an empowered partner in agricultural development.

Mridula Devi
Director

Preface

Agricultural initiatives alone cannot solve the nutrition crisis in India, but they can make a much bigger contribution than they have managed to date by understanding and addressing the other associated factors like access to nutritious foods and knowledge on nutrition, nutri smart interventions in life and livelihood of people particularly of rural areas, nutritional assimilations through access to affordable health care and moreover a robust extension delivery system and interdepartmental collaborations for making significant inroads into reducing malnutrition in India. Farming continues to be the primary source of livelihood for the majority of nutritionally vulnerable households in rural India. In order to maximize its nutrition-sensitivity, there is need to map the various links, pathways and disconnects between agriculture and nutrition by delineating the key pathways showing the relevance of the food, health, and care triad that underpin nutritional well-being of farm families. Key pathways like agriculture as a source of food, agriculture as a source of income, agricultural policy and food prices, income derived from agriculture and benefit sharing, women's socioeconomic and household decision making, intra household allocations of food, health, and care and women's own nutritional status. This necessitates the establishment of a multi-stakeholder platform to bring together all stakeholders to address key knowledge gaps and devise appropriate nutrition policy and programs. Leveraging the agricultural sector to combat the scourge of malnutrition is important as it is a major employer of women as there is a link between household-level production diversity and nutritional status among farm families influenced by socio economic and demographic parameters. Hence, in addition to agricultural growth strategy for addressing nutritional concerns, market access to farm produce and food provides an important context through income-nutrition pathway. Therefore, with a specific focus on women's malnutrition, women friendly nutri smart interventions in agricultural production domain and beyond will be essential for alleviating malnutrition in rural areas. Diversified farming, livestock interventions like goatery, poultry and dairy, adoption of bio fertilized crops, cultivation of millets, use of locally available nutri dense food crops, nutrition education, provision of affordable basic health care and effective extension delivery system will help in elevating the nutritional outcomes of farm families. Strategic implementation of Nutri Smart Agriculture (NSA) will facilitate success of national nutrition Campaign.

The Short Course entitled “Women friendly Nutri Smart interventions for alleviating malnutrition in rural areas” is being organized at ICAR-CIWA, Bhubaneswar

with objectives to sensitize and train entry and middle level scientists about women friendly nutri smart interventions for alleviating malnutrition in rural areas and enhance the competency of scientists for further refining the concept and develop research projects on NSA with gender perspective. The course highlighted issues and interventions like nutritional problems and possible solutions, designing effective nutrition sensitive agricultural interventions , collaboration and linkages for promoting Nutri Smart Agriculture, effective management of family resources, creating conducive environment through capacity building in nutri smart farming practices for livelihood of rural women, diversified sustainable Agriculture System , revamping traditional agri food system, promotion of millets and locally available nutritious foods, Govt. Schemes and programmes supporting NSA & digitalization needs , e-marketing and value chain for nutri foods, spatial analysis for planning and socio sectoral development for intervention in nutri smart rural agriculture and strengthening extension advisory system for nutrition sensitive agriculture

The support of Indian Council of Agricultural Research is duly acknowledged for sanctioning the Short Course. I am very grateful to Dr. Mridula Devi, Director, ICAR-CIWA for her wholehearted support, guidance and encouragement throughout the course. I am thankful to Dr Anil Kumar for his intellectual inputs in designing the course. The Short Course team members are highly indebted to all the experts and resource persons who shared their knowledge and experiences with the participants. The active participation of all the participants during the Short Course is greatly appreciated. I am also thankful to Co Course Director Dr.JyotiNayak and Dr. Tania Seth, Course Coordinator Dr.Neetish Kumar, and Sri Manoranjan Prusty, Er.Pragati Kishore Rout, Er.Subrat Kumar Das the technical team of Short Course for their constant support. All the scientific, technical, administrative and financial staff members of the institute are behind the success of the course.

Date: January, 2023

Place: Bhubaneswar

Laxmi Priya Sahoo

Course Director

Role of Agriculture in food and nutrition security: Addressing the gender concerns

Dr Mridula Devi, Director, ICAR-CIWA, Bhubaneswar

Food and Nutrition Security

Food security has several levels like, global food security, regional food security, national food security, and most importantly household and individual food security. Food security at the national level does not necessarily ensure food security at the household or individual level. *"A household is food secure when it has access to the food needed for a healthy life for all its members adequate in terms of quality, quantity and culturally acceptable, and when it is not at undue risk of losing such access"*. More specifically, food security is an essential part of the broader concept of nutrition security. A household can be said to be nutritionally secure if it is able to ensure a healthy life for all its members at all times. Moreover, there is both a short-term and long-term aspect of food security. The short-term problem, is also known as transitory food insecurity, may occur in any household as a result of crop failure, seasonal scarcities, temporary illness or unemployment among the productive members of the household or perhaps an emergency need for large cash expenditure. Those reasons may reduce a household's access to food to below the nutritionally adequate level. The long-term problem, which is also known as chronic food insecurity, occurs when a household is steadily unable to obtain the food requirements of its members over a long period of time marked by continuous, temporary blips of good and bad moments.



Understanding Food and nutrition security

Food security, an important input for improved nutrition outcomes, is concerned with physical and economic access to food of sufficient quality and quantity in a socially and culturally acceptable manner. Nutrition security is an outcome of good health, a healthy environment, and good caring practices, in addition to household-level food security. For example, a mother may have reliable access to the components of a healthy diet, but because of poor health or improper care, ignorance, or personal preferences, she may be unable or

may choose not to use the food in a nutritionally sound manner, thereby becoming nutritionally insecure. A household achieves nutrition security when secure access to food is coupled with a sanitary environment, adequate health services, and knowledgeable care to ensure a healthy life for all household members. A family may be food secure, yet have many individuals who are nutritionally insecure. Food security, therefore, is often a necessary but not sufficient condition for nutrition security.”

Problems in attaining household Food and nutrition security:

Problem of acquirement and utilization

Acquirement refers to the ability of a household and its members to acquire enough food through production, exchange or transfer. A household that has the capacity to acquire all the food it needs may not always have the ability to utilize that capacity to the fullest. For instance, farmwomen may not have time to prepare the best nutrition foods. In some cases, the reason would be inadequate of basic infrastructure facilities.

Components of Food and nutrition security

- Availability
- Access
- Utilization
- Stability

General and Gendered impacts of food and nutrition security factors

Factors	General impacts	Gendered impacts
Access	Access to food is likely to be influenced by complex secondary impacts of environmental change including conflict, human insecurity, migration.	Women are often more vulnerable than men in conflict situations and will thus be affected more than men when access to food is threatened. Both men and women migrate in order to secure income, but women tend to be less flexible in the distances they can travel from their homes. Men travel farther away while women stay closer to home.
Utilization	Lowers people’s capacity to utilize food effectively, which compromises their food security status.	With farming systems changing there is a risk that traditional crops for food will not be available. As women tend to be responsible for the households, food preparation and food security this is felt especially strongly by them.
Availability	Availability of food will vary geographically	Although availability has consequences for both men and women, each attaches importance to different issues. For example, men may focus on the availability of fodder for large livestock, while women focus on the availability of water for cooking for the family.
Stability	Weather extremes and climate variability are the main drivers of food production instability,	A shortage of water affects both men and women, but men tend to focus on there being less water for farming and production whereas women tend to focus more on lack of drinking water and its implications on the health of their families.

Determinants of Food and nutrition security with gender perspective:

Determinants can be examined as the ability to cope with shocks to acquirement and utilization. Hence, broadly, these determinants impact differentially men and women as access and control mechanisms vary greatly based on gender. Non equitable allocation of these components deter the desired nutritional outcomes, agriculture could impart and more and more feminization of agriculture sector due to massive male migration surfaces peculiar gender issues which warrants concerted efforts from all stakeholders.

Determinants (Components)	
1. Resource components	
I. Tangible resources	Land, animals, machinery, water resources, trees, forests, and common property resources
II. Intangible resources	Household's labor power and the rights attached to membership in a community
2. Production components	Technology of food production Quality of lands
3. Exchange components	Wage rate

Nutritional outcomes of agriculture-the Gender dimensions

Agricultural productivity growth has long been seen as a promising pathway towards reducing malnutrition, given its high incidence among predominantly cultivator families in rural India. Pursuing an agricultural growth strategy for addressing nutritional concerns, with a specific focus on women's malnutrition exceptionally for younger women, a demographic most at risk of being underweight,



and among whom fertility is largely concentrated is imperative. Among pathways considered, we find both own-production and market purchase of food to be associated with BMI increases but via different food groups. While women's BMI is positively associated with cereals produced and consumed at home, for more expensive and nutritious foods, the market plays an important role. Increasing agricultural incomes also empowers women within households to allocate expenses towards more nutritious purchases. This effects a more direct link between maternal health with child weight. Examining the effect of women's empowerment on child nutrition suggests strong inter-generational nutritional benefits of agricultural income.

The extent, to which the agricultural sector can influence individuals' nutritional status, is a function of the size of the sector and its economic importance at the household-level. In the context of diversifying rural economic activity and the growing importance of the rural nonfarm sector, the role of agriculture in poverty reduction and nutritional improvements, is not immediately obvious and requires detailed consideration. Looking at the sectoral composition of household incomes, investigation of the relative economic significance of farming activity is essential. Income from farming i.e. crop/agricultural income is the largest source of income for households and, on average, accounts for around a third of all income. In comparison, the share of earned non-agricultural income, while on an upward trend, is still small, relative to farming. The “unearned income” category comprises of rental income including rent from land, income from gifts and remittances and savings and deposits. Thus, the break-down of the sectoral composition of household incomes posits an important role of agricultural incomes as a source of income for purchases and production of food for self-consumption. Agricultural income, vis-a-vis non-agricultural income, is a relatively more important source of income for women. This is consistent with time series data for India which suggests that the country is witnessing a feminization of the agricultural workforce as men shift rapidly to non agricultural sectors. To the extent that women spend more time working in farming than in non-agriculture, increases in agricultural output can plausibly afford women control over a larger share of household economic production and hence greater bargaining power over the allocation of household resources.



Interventions for addressing gender issues for achieving nutritional security

Women being the primary food provider of the family suffer from various issues and constraints, which creates the biggest hindrance in the path of nutrition security. Not being the principal decision making individual in the farm household, farmwomen sometimes fail to get proper share in the farm income which hampers the investment in household health, nutrition and other welfare activities. Demand for more care giving time hampers engagement in alternate source of income reducing her purchasing power of nutritious food. Household structure and governance along with other extrinsic and intrinsic factors creates a wide gap in achieving nutrition security. Hence, interventions in those areas can go a long way for achieving the goal.

Interventions

1. Degree of diversification	Secondary (other) sources of income
2. Scope for consumption	Household asset base

smoothing	- Access to capital - social capital/ networks
3. Women's time constraints	Reproductive responsibility Access to basic infrastructure facility (water, electricity etc)
4. Storage facility	Refrigerator
5. External phenomenon	External health facilities health care facility (eg: child, old and, sick-care center)
6. Internal phenomenon	Women status within the household
7. Household structure	Number of female members in the household

Leveraging agriculture for food and nutrition security

Priority in developing countries is achieving food and nutritional security (FNS). A flexible global food system, and one of the critical routes to achieving better FNS, requires the reorganization of relevant policies. During the last decades, food and nutritional security (FNS) has developed greatly in practice. Current understanding on agriculture, food, and nutritional security reveals that factors beyond production and productivity need to be integrated for realizing the desirable output. This warrants a multi discipline and multi sectoral approach keeping the gender concerns in the forefront. Among them, policies and strategies related to the creation and adaptation of technologies, innovations, and their associated institutional adjustments are significant factors to counteract the complex and growing challenges of the global food system.

Nutri-sensitive agriculture (NSA)

Food is the core of nutritional security and agriculture is the main source of food production. Nutri-sensitive agriculture (NSA) is a concept for reorienting agricultural aspects in a well coordinated manner to achieve the goal through an effective extension delivery system capable of understanding the problems and intervening smartly.



Components of NSA

- Diversified farming
- Homestead nutrition garden
- Bio fortified crops and products
- Promotion of locally available fruits and vegetables
- Effective seed systems catering to both improved varieties and local landraces
- Bio-diversity conservation and their sustainable use

- Innovations in marketing, storage
- Sustainable soil management
- Pesticide free food
- Smart village

Conclusion

For realizing sustainable nutritional outcomes from agriculture, which will be able for making the farm household nutrition secure and livelihood enabling, relooking into the sectoral developments in agriculture with respect to women in agriculture is imperative. Intervening in the present farming practices for making it both remunerative and nutrition sensitive is the call which needs a well coordinated effort from multi-stakeholders and multi sectors. Standardized technologies catering to small and marginal holder women and women headed farm households will enable women empowerment. Informed decision making and benefit sharing combined with availing opportunities from government schemes and programmes can bring farmwomen to mainstream. Enhancing livelihood opportunities and formation of business groups will increase their bargaining power and ensure profits from farming. Hence, it can be inferred that, intervening in agriculture with a gender perspective can go a long way in achieving food and nutritional security of farm household and reduce malnutrition.

Addressing Gender Issues for realizing nutritional outcomes of Agricultural Development

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"Some historians believe that it was woman who first domesticated crop plants and thereby initiated the art and science of farming. While man went out hunting in search of food, women started gathering seeds from the native flora and began cultivating those of interest from the point of view of food, feed, fodder, fibre and fuel". -----

----- Dr. M. S. Swaminathan.

The Indian farm women perform triple roles. They devote 45 - 50% of their time to agricultural activities, 79% of women continue to be engaged in agriculture and allied activities as against only 63% of men (Courtesy: Gender Reference Manual, 2016, ICAR-CIWA). According to FAO (2016), the percentage of women in the fisheries workforce is 46 % globally and 72% in India. While considering participation in agriculture in rural areas, 89.5% of the total female employed is engaged in the agricultural and allied industrial sector and about 70% of farm work is performed by women. A study in Koraput district of Odisha by Mishra, Sabita and Dash, H. K. (2012) indicated that the tribal women play major role for purchasing or selling of own farm products as well as Non Timber Forest Products (NTFPs). However, women's multiple responsibilities mean that they may be unable to spare time from household and care responsibilities to participate in these activities ([Paul and Kumar, 2016](#)).

Agriculture Scenario in India:

- ❖ World's 2nd most populous country with Agro-Ecological Diversity.
- ❖ Agriculture: Largest source of Livelihood.
- ❖ About 70% of rural households depend primarily on Agriculture for their livelihood, with 82% of farmers being small and marginal.
- ❖ India: India has ranked first in Global milk production and contributes 23 per cent of global milk production (209.96mt, Ministry of Information and Broadcasting, 2021) and jute.

- ❖ India is the largest jute producing country in the world, with annual production 1.968 million tonnes.
- ❖ Second largest producer of Rice, Wheat, Sugarcane, Cotton, Groundnuts, Fruits & Vegetables in the world.
- ❖ Fruits and Vegetables accounting to 10.9% & 8.6% of World's Fruit & Vegetable production.
- ❖ World's largest Cattle Population (30% of the world's inventory).
- ❖ Leading producer of Spices, Fish, Poultry, Livestock & Plantation Crops.

Challenges of Indian Agriculture:

- ❖ Natural Calamity: (Farmers face number of Natural Calamities like: Cyclone, Flood, Drought, Insect Pest Disease Attack etc.)
- ❖ Environmental Sustainability: (Falling Ground Water Levels, Soil Erosion, Deforestation, Unstable, Erratic Rainfall)
- ❖ Poor Infrastructure: (India has 2nd largest Road Network in the world, but, only 2.7% of the entire road length is covered by National Highways)
- ❖ Logistic Challenges: (High cost of administrative delays, lengthy and time consuming transportation system etc.)
- ❖ Storage Facility: (India, one of the Biggest Food Wasters in the world wasting INR 440 Billion worth of Fruits, Vegetables & Grains. Annual loss for fruits and vegetables estimated to be 18% of the total production due to lack of Cold Storage).
- ❖ Frequent Changes of Land Ownership: (Breakdown of Joint Family System and subdivision of agriculture-land into smaller plots, resulting uneconomic with low productivity).
- ❖ Farming System: (Without Crop Rotation, Mono-Crop-System without integration, lack of irrigation (60% irrigated land), inadequate use of improved seeds and FYM etc).

Women in Agriculture: Agriculture is the prime source of women's livelihood for women. They are the backbone of agricultural work force and it is women who gave birth to art of farming. The contribution of women in agriculture is as follows:

78%	Of India's Employed Women work in Agriculture
70%	Of Farm-Work is led by Women
50%	Of Rural Women are Agricultural Labourers
60%	Of World Food volume is grown by Women

Women spend 291 min/day and men 32 min/day towards unpaid activities in rural areas whereas women spend 312 min/day and men 29 min/day towards unpaid activities in urban areas. Unpaid work done by Women across the globe is USD 10 trillion / year. It is 43 times more than the annual turnover of the world's biggest company Apple, (Oxfam, 2019). A female worker uses her fingertips on an average 522 times, her fingernails 144 times and her palms 55 times for every single kilogram of grain she produce. She has to put her fingers 1.2 lakh times into puddle field to transplant one acre of land. She needs to beat 33,000 times to thresh one acre of paddy.

Challenges of Farm Women: The women in India face a number of social dicriminations while compared to men in the field of nutritious food, costly education, proper health care, child marriage, dowry, divorce, abortion of female child, sexual harassment, maternal mortality, resource ownership, domestic violence, etc. A study by [Chander \(2020\)](#) shows that, agricultural extension services will be instrumental in providing timely and accurate information to farmers–women and men alike–towards enhancing productivity and ensuring food security. A study conducted by Mishra Sabita (2008) in Odisha was observed that due to work pressure, the women in peak time do hard work for 14-18 hours while in lean period it comes down to 14-16 hours and they feel little relaxation. Women belonging to marginalized communities are generally less educated, have lower access to financial resources and are thus, less likely to have access to assets and technology to avail information ([Kiran et al., 2012](#); [Sulaiman and Reddy, 2014](#)). The other challeges are:

- ❖ Male Migration
- ❖ Declining Interest of Youth towards Agriculture

- ❖ Male-Centric Technology Development
- ❖ Poor Access to Productive Resources
- ❖ Physical Drudgery
- ❖ No recognition
- ❖ Women perform 66% of world's work, produce 50% of food, earn 10% of world's income; but, own 1% property. They lag behind men in access to & control over resources.

Strategies for Gender Mainstreaming in Agriculture:

- ❖ Gender sensitization
- ❖ Providing equal status between women and men
- ❖ Providing fairness in women's and men's access to socio-economic resources
- ❖ Incorporating a gender perspective at all levels of the budgetary process
- ❖ Gender analysis
- ❖ Creation of GDD
- ❖ Gender impact analysis
- ❖ Gender sensitive extension

Several Indian states have experimented this type of model in agriculture with considerable success, including Kisan Sakhis in Bihar ([Munshi, 2016](#)), and Pashu Sakhis for livestock related extension in Rajasthan and Bihar ([Ghaswalla, 2015](#)).

Nutritional & Economic Outcomes through:

- ❖ Mushroom cultivation
- ❖ Backyard Poultry / Duckery rearing
- ❖ Backyard Nutrition Garden
- ❖ Homestead Fish cultivation
- ❖ Value addition
- ❖ Vegetable cultivation
- ❖ Green Leafy cultivation
- ❖ Growing Organic fruits/vegetables

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Prevalence and Challenges of Malnutrition in India

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According to the National Family Health Survey (NFHS)-5, India has unacceptably high levels of stunting, despite marginal improvement over the years. The number of children under 5 years who are stunted (less height-for-age) in India has come down from 38.4% to 35.5% and the number of children who are underweight (less weight-for-age) has come down from 35.8% to 32.1%. The NFHS-5 reported wasting (weight-for-height) in 19.3% children less than five years as compared to 21 per cent in NFHS-4.

So far as Odisha is concerned, there is noticeable improvement in figures relating to child malnutrition as compared to the national averages. Stunting in Odisha has come down significantly from 38.2% in NFHS-4 to 31% in NFHS-5. The percentage of underweight children has gone down from 34.4% to 29.7% and there has been a marginal improvement of 0.2% in the figures concerned with wasting. Though there is a long way to go to achieve top performing status, it seems that there is a good momentum on key essential nutrition actions.

To address the issue of malnutrition, especially in women and children, the Government of Odisha has been implementing the flagship centrally sponsored schemes such as the Integrated Child Development Services (ICDS), the Mid-Day Meals (MDM) scheme and the Central Government's food subsidy scheme called the Targeted Public Distribution System (TPDS). It has also seen good results in its schemes MAMATA and JananiSurakshaYojana targeting the overall well-being of pregnant, lactating women and their infants (including their nutritional needs). It aims to promote the thought of healthcare seeking behaviour amongst all echelons of the society.

According to the National Family Health Survey (NFHS) 2019-21, the 5th in the series India has seen no significant improvement in health and nutritional status among its population. The latest data shows, **7.7% of children are severely wasted, 19.3% are wasted and 35.5% are stunted.**

33 Lakh Children in India Malnourished, **Over 50% Cases Severe.**The bane of child and maternal malnutrition is responsible for 15 per cent of India's total disease burden.

There are 51 million wasted children in the world; India alone houses **20 million** - that's half of the world's severely wasted children. (CNNS 2016-18 and JME 2018 in India). Wasting, or low weight for height, is a strong predictor of mortality among children under five.

Recently, the Union Minister for Women and Child Development has informed RajyaSabha that there were **927,606 severely acute malnourished children in India**.

Child Malnutrition

- **Malnutrition**, in all its forms, includes **undernutrition** (wasting, stunting, and underweight), **inadequate vitamins or minerals**, **overweight**, **obesity**, and resulting diet-related noncommunicable diseases.
- The term malnutrition **addresses 3 broad groups of conditions**:
 - **Undernutrition**, which includes **wasting** (low weight-for-height), **stunting** (low height-for-age) and **underweight** (low weight-for-age)
 - Together, the stunted and wasted children are considered to be **underweight**, indicating a **lack of proper nutritional intake and inadequate care post-childbirth**.
 - **Micronutrient-related malnutrition**, which includes micronutrient deficiencies (a lack of important vitamins and minerals) or micronutrient excess; and
 - **Overweight, obesity and diet-related noncommunicable diseases** (such as heart disease, stroke, diabetes and some cancers).
- It is a **chronic problem** and a **longstanding challenge** for the public administration of India.

Causes

- **Agriculture Output**: The agriculture output from small and marginal holdings are either stagnant or declining due to reasons such as reduced soil fertility, fragmented lands or fluctuating market price of farm produce.
- **Low Income**: Relative income of one section of people has been on the decline.
 - This has adverse effects on their capacity to buy adequate food, especially when food prices have been on the rise.

- The kinds of work a section of people have been doing are less remunerative or there is less opportunity to get remunerative work.
- **Public Distribution System:** The public distribution system of the state is not functioning well or is not accessible to everyone.
- **Rural Unemployment:** The emaciated rural livelihoods sector and lack of income opportunities other than the farm sector have contributed heavily to the growing joblessness in rural areas.
 - The PLFS 2017-18 revealed that **rural unemployment** stood at a concerning **6.1 per cent**, which was the **highest since 1972-73**.

India's Malnutrition Profile

- The first **National Family Health Survey (NFHS)** in **1992-1993** found that India was **one of the worst performing countries** on child health indicators.
- There are about **189.2 million undernourished people** in India with a majority of who are women and children.
- According to government figures from the year **2015-2016**, **22.9 per cent** of **women** in the 15-29 age group are underweight, as compared to 20.2 per cent of men in the same age group.
 - Further, according to **The State of Food Security and Nutrition in the World 2020 report**, in 2016, nearly 51.4 per cent of women of reproductive age in India were suffering from anemia.
 - Almost 50 per cent of women are facing severe undernutrition and Anaemia.
- Around **60 million children**, which is roughly about half, of all children in India are **underweight**, about 45 per cent are stunted, 21 per cent are wasted, 57 per cent are vitamin A deficient and 75 per cent are anemic.
- Malnutrition has thus become the **major contributor to the under-five mortality rate in India**.
- These statistics indicate that **under nutrition in India is a gendered problem**.
 - The root cause for these male-female differentials can be found in native socio-cultural norms and mindsets.

- Such norms, rooted in patriarchy, would suggest that distribution of resources, including food, should be done in a hierarchical manner, with male members of the family typically at the top of the ladder.
- Malnutrition and the widespread prevalence of stunting, wasting and nutritional deficiencies among women and children are **well-recognized elements of India's profile** in the **Global Hunger Index**.
- The prevalence of malnutrition in India has notably declined over the last decade, and the **Comprehensive National Nutrition Survey 2016-18** revealed that major challenges remain.
 - According to the NFHS-4, the **percentage of wasted, stunted and malnourished** children in 2015-16 stood at **21, 38.4 and 35.7 respectively**.
 - As compared to NFHS-4 data, the **Comprehensive National Nutrition Survey (CNNS)** compiled in 2017-18 showed an **improvement of 4 per cent, 3.7 per cent and 2.3 per cent** in wasted, stunted and malnourished children **respectively**.

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
4. Minimum Support Price (MSP)
5. The role of women in agriculture
6. Efficient information dissemination
7. Linking farmers and farming households to institutional feeding programmes
8. Promote local agri-food value chains for nutrition.
9. Nutrition gardens of nutrient dense vegetables and fruits
10. Homestead production of animal source foods
11. Social and behavioural change
12. Nutrition sensitive agriculture

13. Farm Mechanization

Measures Taken to Tackle Malnutrition

- **PoshanAbhiyan**
 - It was approved in **2017** and launched in **2018**
 - It is a **multi-ministerial convergence mission** with the vision to ensure the attainment of malnutrition free India by **2022**.
 - The **Ministry of Women and Child Development (MWCD)** is implementing POSHAN Abhiyaan.
- **Integrated Child Development Services**
 - It was launched on **2nd October 1975** and it represents one of the world's largest and unique programmes for **early childhood care and development**.
 - The beneficiaries under the Scheme are children in the **age group of 0-6 years, pregnant women and lactating mothers**
 - **Ministry of Women and Child Development** is the implementing agency
- **MatritvaSahyogYojana**
 - Indira Gandhi MatritvaSahyogYojana (IGMSY) is a **Conditional Maternity Benefit (CMB) Scheme** launched in **2010**.
 - The scheme is being implemented by the **Ministry of Women and Child Development as the centrally sponsored scheme**.
 - It was launched for **pregnant and lactating women** to improve their health and nutrition status to better-enable the environment by providing cash incentives to pregnant and nursing mothers.
- **PradhanMantriMatruVandanaYojana**
 - The **centrally sponsored scheme** was launched in **2017**.
 - **Rs. 6,000** is transferred directly to the bank accounts of pregnant women and lactating mothers for availing better facilities for their delivery to compensate for wage loss and is eligible for the first child of the family.
 - Implementation of the scheme is closely **monitored** by the **central and state governments** through the **PradhanMantriMatruVandanaYojana-Common Application Software (PMMVY-CAS)**.
- **Mid-Day Meal Scheme**

- The Mid-day Meal Scheme is a **school meal programme** in India designed to better the nutritional standing of school-age children
- It covers all school students studying in **Classes 1 to 8** of government schools, government-aided schools, special training centres, including madrasas supported under SamagraShikshaAbhiyan.
- **National Food Security Mission**
 - It was launched in **2007-08** by the **Ministry of Agriculture and Farmers' Welfare** as a **Centrally Sponsored Scheme**.
 - It was based on the recommendations of the agriculture sub-committee of **the National Development Council (NDC)**.
 - It focuses on the sustainable increase in the production of targeted crops through area expansion and productivity enhancement.
- **National Nutrition Mission**
 - It is the government's **flagship programme to improve nutritional outcomes** for children, pregnant women and lactating mothers.
 - **Aim:** To reduce stunting and wasting by 2 per cent per year (total 6 per cent until 2022) among children and anemia by 3 per cent per year (total 9 per cent until 2022) among children, adolescent girls and pregnant women and lactating mothers.
 - The **Ministry of Women and Child Development** is the nodal ministry for implementation.
- **National Nutrition Strategy**
 - The Strategy aims to **reduce all forms of malnutrition by 2030**, with a focus on the most vulnerable and critical age groups.
 - The Strategy also aims to **assist in achieving the targets identified as part of the Sustainable Development Goals** related to nutrition and health.

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Strategic nutrition related interventions rolled out by government of India

Various community nutritional programmes are running in India to combat child malnutrition and to get nutrition on track. These are based on strategic nutrition related interventions. A few of them are discussed below.

Promotion of Infant and Young Child feeding practices (IYCF): exclusive breastfeeding for first 6 months, complementary feeding beginning at 6 months and appropriate infant and young child feeding practices (IYCF) are being promoted. Mother's Absolute Affection (MAA) programme was launched in 2016 to promote breastfeeding and infant feeding practices by building the capacity of frontline health workers and comprehensive IEC campaign.

Establishment of Nutritional Rehabilitation Centres (NRCs): NRCs have been set up at facility level to provide medical and nutritional care to Severe Acute Malnourished (SAM) children under 5 years of age who have medical complications. In addition, the mothers are also imparted skills on child care and feeding practices so that the child continues to receive adequate care at home.

AnaemiaMukt Bharat (AMB): to address anaemia, NIPI has been launched which includes provision of supervised bi-weekly Iron Folic Acid (IFA) supplementation by ASHA for all under-5 children, weekly IFA supplementation for 5–10 years old children and annual/biannual De-worming. The AMB strategy—Intensified Iron Plus Initiative—aims to strengthen the existing mechanisms and foster newer strategies of tackle anaemia, focused on

six target beneficiary groups, through six interventions and six institutional mechanisms; to achieve the envisaged target under the POSHAN Abhiyaan. The strategy focuses on testing & treatment of anaemia in school going adolescents and pregnant women using newer technologies, establishing institutional mechanisms for advanced research in anaemia, and a comprehensive communication strategy including mass/mid media communication material.

National De-worming Day (NDD): recognising worm infestation as an important cause of anaemia, National Deworming Day (NDD) is being observed annually on 10th February targeting all children in the age group of 1–19 years (both school enrolled and non-enrolled).

Biannual Vitamin A Supplementation is being done for all children below 5 years of age.

Village Health and Nutrition Days (VHNDs) are also being organized for imparting nutritional counselling to mothers and to improve child care practices.

Conclusion

The facts and discussion presented above, highlights the worrying unacceptably high prevalence and universality of malnutrition in all its forms in Indian communities, but it is both preventable and treatable. Beyond health, malnutrition is also impacting the social and economic development. In Indian context, poverty, maternal health illiteracy, LBW, diseases like diarrhoea, home environment, dietary practices, hand washing and poor hygiene practices are few important factors responsible for very high prevalence of malnutrition. Government of India has rolled out various community nutritional programmes to combat malnutrition and to get nutrition on track. Despite enormous challenges, India has made considerable progress in tackling hunger and under nutrition in the past two decades, yet this pace of change has been unacceptably slow, uneven and many have been left behind. But with sustained prioritization, increased resource allocation, adopting comprehensive, coordinated and holistic approach with good governance and help of civil society, India has the potential to end malnutrition in all its forms and turn the ambition of the Sustainable Development Goals into a reality for everyone.

Exploring Gender-Neutral Extension to Improve Nutritional Security

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Issues for discussion

1. Do women have less access to nutrition?
2. Is it because of the social bias or lack of property rights or education?
3. Does India's extension system ignore women? If so, how it can be targeted to women?
4. Can technology (bio-fortification) be a solution?
5. Does extension system require more women extension workers? Can IT be a solution?

Women farmers are one of the major stakeholders of the agriculture sector and play a predominant role in various on-farm and off-farm activities. They have abundant roles and responsibilities in the sector and can play instrumental in transforming the face of agriculture. Empowering and educating women has positive implications for children's health and nutritional status, which in turn influences the demographic dividend, and that is what India aims to harness in the medium to long run. Many experts consider women to be at the nexus of agriculture, health and nutrition, and thus gender and nutrition are increasingly being viewed as priority areas for research and extension.

Women often hold dual roles as consumers and food managers at home, influencing intra-household management of both food and nutrition security (Box 1), as recognized by India's National Food Security Act (NFSA). They also play a substantial role as producers, and contribute a significant share to farm labor all over the world. It is important to find ways to mainstream gender in nutrition into the field of agriculture, so as to create gender and nutrition linkages in the food systems.

According to (OXFAM 2018), the agriculture sector in India employs 80 per cent of all economically active women. In India, farm women comprise 33 per cent of agricultural labour force and 48 per cent of self-employed farmers. Nearly, 85 per cent of rural women are engaged in agriculture but on an average only 13 per cent of them own land. But, women centric agricultural policies, Research, and training and capacity building programs are often ignored.

The magnitude of women's work participation in agriculture is often **curtailed by prevailing socio-cultural taboos which create perceptible gender disparity**. The

traditional patriarchal customs, norms and taboos have relegated women to a secondary status within the household and workplace which has **resulted in a huge gender gap**.

The socially constructed gender roles of men and women interact with their respective biological roles which in turn affect the nutrition status of the entire family and also of each gender. In Indian rural milieu, women by and large have limited access to land, education, information, credit, technology, and also the decision making opportunity. In contrast, their primary responsibility covers mainly the child rearing, doing household chores and performing farm related operations of crops, livestock and others. As a result, they rely on developed social networks that act as an informal safety net for the family in times of crisis. On the other hand, even in formal employment rural women typically command lower remuneration rates than their male counterpart, despite they possess the same level of skills. The three pronged burden i.e., productive, reproductive, and social roles, women have less time to attend to their own needs, leisure related or otherwise including food and nutrition. The relatively poor nutrition level of female in their early life reduces learning potential, increases reproductive and maternal health risks, and lowers the productivity and efficiency. Indicators of the level of agricultural performance on income have established a strong and significant negative relationship with indices of under-nutrition, suggesting that improvement of agricultural productivity can be a powerful tool to reduce under-nutrition across vast majority of the population.

India slips to 112th Rank on Gender Gap Index...

- ❖ As a matter of concern, India despite of achieving high rates of economic growth in recent year was ranked at **135th positions among 146 countries in Global Gender Gap Index (World Economic Forum's Global Gender Gap Report, 2022)**. Its **global Gender Parity Score is 0.629**, which represents an ‘**extremely high**’ level of gender inequality thereby resulting in its poor performance on gender related assessments despite being a large geographical entity with enormous natural resources.

Identification of the Problem

- Agricultural interventions in India from the 1960s till the early 1990s were focused on **increasing food grain production and productivity to attain self-sufficiency** and address more important issues like food shortage and hunger.
- But however, self-sufficiency in food production has **not translated into nutritional security**, indicating missing link between agriculture production and nutritional security.

The 2 Big Questions ??

- 1. Why a Country like India which is having agriculture as the predominant occupation and surplus in food grains production, is having significant share of malnourished people?**
- 2. Why there are missing links between agriculture and nutrition?**

Conceptual Approach

- 1. Need to focus on the nexus between Agriculture, Nutrition and Gender.**

Agriculture-Nutrition-Women Continuum

Promotion of innovation in application of information & communication technology in agriculture and dissemination of knowledge plays a critical role in knowledge-based growth of Nutrition Sensitive Agriculture (NSA). Therefore, it is imperative to update the skills of female farmers in the latest knowledge and techniques of Nutrition Sensitive Agriculture (NSA) to bring about the desired qualitative improvement and necessary orientation to contemporary problems to make research and productivity more relevant. The basic objective in the competency framework is that female farmers not only have the required competencies for the professions but are also able to promote development and delivery of need based research and production programmes that would enhance the livelihood security and build up an easy, accessible and cost effective knowledge intensive information system. Learning progression of female farmers is also linked with periodic exposure to capacity building programmes. The capacity building in deficient areas of contemporary relevance and anticipated future is addressed by this framework. Training of the female farmers in the cutting edge areas of Nutrition Sensitive Agriculture (NSA) is required to meet capacity building demands in terms of production, storage & marketing. In order to augment agricultural extension and capacity building activities towards improved and gender inclusive dissemination of NSA based practices, capacity building centres should be established in already existing ICAR institutions all over the country.

Considering the significance of holistic development of agriculture, ensuring gender equality and equity is critically vital. Hence, it is imperative to identify and assess critical gender gap indicators which will serve as a fundamental basis on which gender-sensitive programs and approaches can be designed.

There are five core areas that run through the SDGs which nutrition can contribute to, and in turn, benefit from:

- 1. Sustainable Food Production**
- 2. Strong Systems of Infrastructure**
- 3. Health Systems**
- 4. Equity and Inclusion**
- 5. Peace and Stability**

The nutrition needs of a family are not often kept in mind in deciding the cropping pattern. If agriculture is to be integrated with nutrition, automatically multiple cropping, crop rotation, integrated farming system would emerge, which also provide solution for many of the farmers problem today.

Nutrition-sensitive agriculture is an approach that seeks to maximise agriculture's contribution to nutrition. It encompasses more than just cereal crop production—from horticulture to forestry and fisheries, agriculture should be seen not only a means but, it is an essential process for improving the quality of foods available to the community and ensuring healthy soils and ecosystems for farming in the future. Nutrition-sensitive agriculture also leads to targeting poor households, promoting gender equity, and providing nutrition education.

Gender Gap in Health and Nutrition

In the context of Health and nutrition security aspect, the dominant gender gap assessed was BMI (Body Mass Index) related issue, wherein the majority of farm women (92.5%) reported that the BMI (Body Mass Index) of a female is not at par with the recommended BMI, followed by higher nutritional deficiency-related problems among them.

One third of women of reproductive age in India are undernourished, with a body mass index (BMI) of less than 18.5 kg/m². In rural areas 40.6% women compared to 25% in urban areas are undernourished. The rates of under nutrition is three times higher in low income groups compared to high income groups.

Malnutrition has intergenerational consequences because undernourished women give birth to low-birth-weight babies. Such children can face cognitive and other limitations all their lives, making it difficult to escape from poverty. When women face food discrimination on a national scale, the human capital of the nation is put at risk.

In spite of vulnerability to malnutrition, women are in a unique position to improve nutrition in their households. They are often primarily responsible for growing, purchasing and preparing foods and child-rearing although they have limited access to nutrition information and the resources they need to improve food security, such as income, land, equipment, financial services and training. Despite these extensive roles, most developing countries' extension systems do not sufficiently address the needs of female farmers or rural workers.

The concept of nutrition-sensitive agriculture was initiated for promoting gender equity and providing nutrition education by targeting poor households. Introducing gender and nutrition as a new cross-cutting theme of Agricultural Extension helps to build more robust, gender-responsive and nutrition-sensitive institutions, projects and programmes to assist in considering and responding to the needs of both men and women of a community.

Recommendations suggested that to prevent malnutrition a family approach rather than a group or individual approach was required, along with more efforts to sensitize grassroots-level workers about nutrition; sensitization of more women and men Village Level Workers (VLWs) about gender and nutrition perspective.

We also know there are **three main pathways that potentially improve nutrition: agricultural production, agriculture-derived income, and women's empowerment.** Extension workers are often considered as a promising vehicle for the delivery of nutrition knowledge and practices to improve the nutritional health of rural communities because they reach and interact closely with farmers in different settings and act as significant service providers of crop, livestock, and forestry aspects of food security, consumption and production.

Leveraging Extension Services in empowering women and enhancing nutrition

Access to income and equal employment opportunities for women will enhance the household's access to food and nutrition. A fundamental step forward in that direction involves removing the constraints faced by women with regard to their access to information, dissemination, and extension facilities. Information asymmetries tend to limit the ability of women farmers to harness the potential of agriculture, as they often do not have access to the appropriate technological know-how and inputs, as well as information on weather patterns and best agronomic practices. In this context, the roles of extension services become significant. Extension agents often fail to reach out to women farmers due to structural

impediments such as staffing and funding shortages that make it difficult to reach resource-poor, remote farms (as women's barriers to credit and land titles usually leave them with marginal lands). Existing cultural and social barriers also discourage women farmers from interacting with male extension workers. Enhancing women's skills and knowledge through extension systems is a prerequisite for increasing their decision-making capacity and income, which lead to better nutritional outcomes.

Within agriculture extension services, agri-nutrition-related education and communication have a very critical and important role to play if we want food security to translate into nutritional security and gender empowerment. Extension has a facilitating role in multi-sectoral convergence for leveraging agriculture with regard to nutritional security and gender empowerment. Information and Communication Technology (ICT), together with traditional media, offer a platform for promoting extension for agri-nutrition. Although extension services in India have started integrating modern ICT tools to disseminate information, yet gender bias exists due to poor access of women to these resources.

Nutrition-sensitive information is still not a mandate for the extension system of India. It is necessary to deviate from just the conventional information about staple crops and agronomic practices and include information that incorporates a diversified production system. For example, to enhance household nutrition, it is important to promote labor-saving technologies and a variety of allied activities, such as kitchen gardening, wadi (orchard), livestock, poultry, and fisheries. This can help in creating gender-driven diversification of production activities.

Potential Approaches for Nutrition Smart India

- 1. Food-based approaches** can focus on cultivation and availability of nutrition-rich crops at the farm level, linking farmers to markets and value chains at the farm gate level, knowledge for preservation of nutrient content of food through cooking, storing, and processing at household level.
- 2. Non-food based approaches** such as providing women with the gender-friendly tools and technology to improve their own livelihoods and reduce their labour and time, generating income through raising livestock by improved husbandry practices, and by adopting sustainable agricultural practice which have a direct impact on nutrition and health.

Role of Extension in Addressing Malnutrition

The multi-agency extension service can address hunger and malnutrition through strengthening capacity of the public agency, supporting private sector in marketing extension through extensive use of media, internet and IT in information and technology

dissemination to the farm women. Farmers to farmer extension to India is very important mean for dissemination of knowledge with negligible time lag for diffusion of technology and innovations. This potential of social capital building can be harnessed for lessening the under nutrition and poverty.

We require improved knowledge on the agriculture-nutrition-health nexus and move beyond a pursuit of agricultural growth to focus on distribution and diversification. Important steps to build up this knowledge base include investments in research, evaluation and education systems capable of integrating information from all three sectors. As the National Commission on Farmers mentioned, there is a yield gap and knowledge gap of the prevailing technology, which can be bridged up using string of extension system for improving agricultural productivity. This demands that scope of extension become wider, covering all aspects of farming, from seeds to market. Farmers also need information about post-harvest tasks including processing, marketing, storage and handling.

Measures to augment agricultural extension and capacity building activities towards improved and gender inclusive dissemination of NSA based practices

- Innovative Practices to Promote Nutrition Sensitive Agriculture and Food Security
- Enabling Suitable Governance and Policy
- Value Chain and Village Trade Related Issues
- Improving Maternal and Child Nutrition
- Strategies to Improve Complementary Food and Feeding
- Nutrition Literacy
- Capacity Development of Women Institution/ SHGs/ FIGs/FPOs

ICAR-CIWA along with its AICRP (Women in Agriculture) has a greater responsibility for planning and implementation of such programmes

- i) **Gender Sensitive Extension Model:** The Gender Sensitive Extension Model was designed to promote gender friendliness to the existing extension services. The model focuses on Gender Sensitive Extension as the central core of any developmental programme considering the strength, weakness, opportunity and threat (SWOT analysis) of women farmers. The pillars of the model are ‘Women farmers & farming community, R & D Organizations in a convergence mode and Market/ Commercialization’. It is essential to link all the pillars for holistic development keeping in mind to meet the basic

needs viz. ‘Nutritional Security, Livelihood enhancement and Environmental Sustainability’.

- ii) **Gender Sensitive Agri-Nutri (GSAN) Farming System Model** including four components viz., Nutri-Farming System, Agri-Nutri Education, Skill-based Capacity Building and Institutional Convergence for developing Multi -Stakeholders Value Chain.
- iii) **Three-tier Approach for bridging Gender Gap and addressing Livelihood, Nutrition and Entrepreneurship**
- iv) **Nutrition Smart Village Programme: An Innovative Model” to strengthen the POSHAN Abhiyan:** This new initiative aims to reach out 75 villages in 23 districts across India through the network of AICRP on Women in Agriculture which is in operation at 13 centres in 12 States of India besides the coordinating institute located at Bhubaneswar.

Major Outputs

Sl. No.	Major Output	Practical Relevance
1.	Identified Critical Gender Gap Indicators in Health and Nutritional Security	<ul style="list-style-type: none"> • Implication for policy makers, researchers, academicians and extension workers
2.	Gender Sensitive Extension Model	<ul style="list-style-type: none"> • Relevant for achieving higher inclusive development
3.	Agri-Horticulture Model for addressing Livelihood, Nutrition and Entrepreneurship	<ul style="list-style-type: none"> • Gender sensitive farming system model of practical significance for addressing Livelihood, Nutrition and Entrepreneurship
4.	Family Farming Approach	<ul style="list-style-type: none"> • Part of the Solution to the Hunger Problem.
5.	Seventy Five Nutri-Smart villages will be developed focusing on the concept of nutri-village / nutri-food /nutri-diet/ nutri-thali etc. for strengthening the <i>POSHAN Abhiyan</i> .	<ul style="list-style-type: none"> • The Programme of Nutri smart villages proposed to be established with peoples’ partnership will assist in achieving the most cherished goal of a <i>KuposhanMukth Bharat</i>.

The efforts to improve women's nutrition status will be most powerful if undertaken in conjunction with public policies and programs that aim to improve the status of women and to address gender inequalities. Public policies that aim to improve women's status can promote gender neutrality either by creating a level playing field with a hope that women will catch up. Hence, there is a need to ensure that extension services and extension tools and materials are gender and nutrition inclusive. Enhancing women's skill and knowledge through a targeted extension system is a prerequisite for achieving the goal of improved decision making in the context of increased feminization of agriculture. Farmer-to-Farmer extension programs can be more focused on engaging women lead farmers, who can then reach out to other women farmers.



Strengthening Nutrition Security and Enhancing Income of Farm Families through Family Poultry Production

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Family poultry production is considered as a quickest way to ensure food security, generate employment and income, and promote women's empowerment at a relatively low investment (FAO, 2014). Poultry represent an important system to feed the fast growing human population of developing countries like India and to provide income to poor small farmers, especially women. Village poultry are generally owned and managed by women and children and are often essential elements of female-headed households. In spite of the rapid development of commercial poultry activities worldwide, it has been estimated that around 80 per cent of the global poultry population occurs in traditional family-based production systems and that the latter contribute up to 90 percent of the total poultry products in many countries. The total backyard poultry in India is 313.7 million in 2019 which has increased by 45.8% over previous census (DAHD, 2019) and contributing to 21% of total egg basket.

Nearly 70 % of India's population is living in rural areas. 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. Just 25% population living in urban areas consumes about 75-80 % of eggs and poultry meat (Panda et al., 2010). Non-availability of poultry products and low purchasing power of the rural people devoid them of access to the highly nutritious products like egg and meat, thereby, resulting in malnutrition. Free range and small scale semi-commercial poultry farming can be promoted in rural areas to increase the availability of eggs and enhancing the income of farm families. It can be used as a powerful tool for alleviation of rural poverty, eradication of malnutrition, creation of gainful employment and women empowerment in vast rural areas.

Nutritive value of poultry egg and meat

Poultry egg and meat are important animal protein sources and essential in providing balanced diets for nutrition and health. It is an excellent source of high quality protein, vitamins and trace minerals. Egg contains 44 out of the 45 essential nutrients for the human body. An egg supplies about 6.9g wholesome protein of the highest biological value (94). An egg provides about 6 g fat and is a rich source of linoleic acid, which is essential in human nutrition. Although, egg is a multifunctional food with superior nutritional quality, it is

available at a relatively lower price. Thus, egg is within the reach of poor people. Availability, lower cost, ease of preparation and good taste give eggs a deserved place in diets of humans. Poultry meat is well accepted, relatively cheaper natural food and a valuable source of nutrients for human being. Nutritionally poultry meat is a valuable source of proteins, vitamins and minerals and has relatively lower fat content. The protein content of chicken meat is about 22% with a biological value of 79.

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

Why Family Poultry?

The lack of basic infrastructure and limited resources of the poor people in rural areas creates a major hurdle to undertake commercial poultry farming using high yielding varieties of poultry. Adapting poultry farming in rural/tribal areas utilizing chicken varieties which demand low inputs in terms of nutrition and management and perform better is a potential tool to increase the availability of poultry products and economic status of the rural people. Free range and small scale poultry production can be promoted in rural areas to improve livelihood and nutritional status of farm families. Family poultry farming introgressing scientific practices can be used as a powerful tool for poverty alleviation, eradication of malnutrition and creation of gainful employment, and gender equity in vast rural areas (Sharma and Chatterjee, 2009; Rajkumar et al., 2010, Panda et al., 2020;).

Advantages

- ❖ It needs minimal use of land, labour and capital.
- ❖ It is easy to manage and handle.

- ❖ It needs little intervention in rearing,
- ❖ It can easily integrate with other agriculture, aquaculture and livestock farming.
- ❖ It can contribute to the village economy.
- ❖ There is higher demand and better price for eggs and birds of native fowl.
- ❖ Women in rural areas can operate family poultry with maximum involvement.
- ❖ Has a potential to fight poverty and malnutrition and provide scope for high employment generation and solving gender issues in employment

Family Poultry for Gender Equity

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. Gender relations affect household security, family well-being, planning, production and many other aspects of life (Bravo-Baumann, 2000). The role of backyard poultry in poverty alleviation, food security and the promotion of gender equality in developing countries are well documented. Backyard 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. 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. Understanding and considering the gender roles in family poultry production is crucial to identifying the most appropriate approach when designing and implementing development activities (Panda, 2016).

Family Poultry for Nutrition Security

Malnutrition, especially under-nutrition remains a major public health challenge in India contributing to over 69 per cent of deaths of children below the age of five. Traditional Indian diets are based on cereals (adequate in energy) but deficit in protein. Poultry eggs and meat can provide high-quality protein and micronutrients in bioavailable forms which, even

in small quantities, substantially increase the nutrient adequacy of traditional cereal based diets. Women play major role in backyard poultry production and they are who are responsible for the day to day care of the birds, selling of eggs and chickens and, are often responsible for decision making on issues related to chicken production. This resulted in an overall positive impact on the welfare of the household.

The contribution of family poultry production (FPP) to achieve food and nutrition security can be achieved only when the constraints associated with BPP is properly addressed. The major constraints include low production potential of the birds, high mortality due to disease incidence, predation in the extensive system, lack of supplementary feeding practices (inadequate nutrition), improper housing, lack of proper extension and veterinary services. The need of the hour is to successfully address these barriers, assessing the management practices for local sustainability and cost effectiveness and the greater involvement of women. Some of the focus points which need urgent attentions are

- **Rearing of Chicken varieties suitable for family poultry farming** – The production potential of the native chickens are very low. A need was thus felt to develop suitable germplasm for rural / backyard production with improvements in their economic traits in the existing native breeds or the development of new stock with infusion of native blood. Several chicken varieties such as Giriraja, Vanaraja, Gramapriya, Swarnadhara, Narmadanisdhi, Srinidhi have been developed for rural poultry farming. However, they are unable to cater the need of the country. There is a need to develop more such varieties giving emphasis on agro-ecology (Location specific) to meet the growing demand.
- **Utilization of locally available feed resources** - It is difficult to know the activity of the birds for their picking up habits and availability of feed ingredients in the backyard poultry keeping. It is therefore suggested to provide some supplementary feed to meet their nutrient requirements to realize optimum production. There is a need to identify the feed resources available locally, evaluate their nutritional value and formulate low cost feed for economic efficiency.
- **Disease control** - The most common cause of the high mortality observed in FPP in India is Ranikhet Disease (RD). It is highly infectious among chickens, and virulent strains can cause up to 100% 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. Women should receive training in

husbandry practices and gain access to poultry health services as community vaccinator for mass vaccination and health care.

- **Training of farmwomen-** Many times failure in backyard poultry rearing is observed due to lack of knowledge, experience and sufficient exposure to poultry rearing. Training programs at village level targeting the stakeholders, women and youth should be organized for effective implementation of the farming is the need of hour. Providing extension services including management, vaccination, disease diagnosis, market information and other inputs like supply of chicks, quality feed etc. is a major challenge for the system to be successful.
- **Proper marketing system-** The birds in the rural areas are sold live or slaughtered at the place of sale. Similarly eggs are sold in open without consideration for preservation of their quality. Development of reliable and stable market chain round the year is a must for effectively absorbing the rural surplus production. Also facilities for hygienic slaughter and preservation of eggs should be made available at market places in rural areas. Formation of women producer co-operatives/ Associations and Rural market yards will help in proper marketing.
- **Government Policy** - Women are considered as key players in backyard poultry production systems. It has been found that agricultural interventions which target women are more likely to lead to positive nutritional outcomes. There is a need for the development of policy aimed to increase the productivity of family poultry systems, through effective extension services and disease control programmes, to form part of a multi-disciplinary approach to address malnutrition. This needs a multi-disciplinary research approach, multi-sectoral involvement within government institutions and the implementation of policies targeting farmwomen to realize the potential impact of improvements to family poultry systems on food and nutritional security.

Conclusions

Human under-nutrition remains a major public health challenge across the world, contributing to more than 3 million preventable maternal and child deaths every year. Poultry eggs and meat provide high-quality protein and micronutrients in bioavailable forms for nutrition and health. Family poultry keeping also represents an appropriate system to contribute to feeding the fast growing human population and to provide income to poor small farmers, especially women. As women constitute half of the population, can be a great

resource in the development process, if they are properly mobilized and organized. Rural/backyard/Family poultry production has been recognized globally to alleviate poverty, hunger and malnutrition in developing countries. With increasing demand for chicken egg and meat, the poultry production in India foresees further expansion and industrialization. There is a need for coexistence of rural and commercial poultry farming for sustaining the growth in poultry production in the country to bridge the gaps in the supply chain of poultry products between rural and urban areas. Adoption of small scale poultry farming in backyards of rural households will enhance the nutritional and economic status of the rural people.

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Strengthening farmwomen perspectives in Nutri smart village development through homestead aquaculture

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Introduction

The health and nutritional status of women and children is a strong indicator of social and economic well-being of a country as they are the most vulnerable sections of the society from the point of view of nutritional stress. When children are concerned, about 38% of them below the age of five are stunted, 21% are wasted, 36% are underweight and an alarming 59% are anaemic. As a matter of fact, today India is home to the largest number of stunted and wasted children (25.5 million) in the world. In case of women, 23 % of them in the reproductive age are underweight. About 53% of them in general and 50 % of pregnant women are anaemic (NFHS-4). This will have lasting effects on their future pregnancies and children. It also creates a vicious circle of malnutrition wherein malnourished mothers give birth to low weight infants. Women's health also affects the economic well-being of a family as women with poor health are less productive. Malnutrition is linked not just to lack of calories but also to a lack of diversity in diet, poor maternal health and inadequate sanitation. In India, the rural diet is predominated by cereals. It is qualitatively deficient in micronutrients particularly iron, calcium, vitamin A, riboflavin and folic acid due to low intake of income-elastic foods such as pulses, vegetables particularly green leafy vegetables (GLV), fruits, and foods of animal origin. The intake of micronutrients in daily diet is far from satisfactory and largely less than 50% RDA is consumed by over 70% of the Indian population. Micro nutrient deficiency is referred to as the hidden hunger as it is not a conspicuous killer orcrippler, but extracts heavy human and economic cost. Iron deficiency anaemia is the most common manifestation of micronutrient deficiency in India. Milder clinical manifestations of blindness due to vitamin A deficiency and rickets due to vitamin D are also common in India. Osteoporosis in adults, particularly women after menopause due to calcium and vitamin D deficiency is also very common in our country. Productivity losses due to poor nutrition are estimated to be more than 10% of lifetime earnings for individuals, and 2-3 % of GDP to the nation. Cost of treating malnutrition is 27 times more than the investment required for its prevention (Horton *et al.*, 2010). Adopting dietary diversity is one of the most important preventive steps for malnutrition. Nutri-smart village concept should

imperatively encompass inclusion of fish farming in homestead ponds along with homestead nutri-garden comprising of bio fortified crops and micronutrient dense vegetable varieties, backyard poultry, dairy, mushroom etc.

Fish protein is one of the easily digestible proteins after milk and egg and fish carries all the essential vitamins, amino acids, minerals and fatty acids. The per capita average annual consumption of fish and fish products in India is around 6.4kg which contributes to around 13% of animal protein (Jayan, 2021). The Second International Conference on Nutrition (ICN2), held in Rome in November 2014, confirmed the importance of fish and seafood as a source of nutrition and health for many coastal communities that depend on fish for their proteins and essential micronutrients, in particular for women of child-bearing age and young children. Owing to the growing demand of fish, the world per capita fish consumption has increased from an average of 9.9 kg in the 1960s to 20.4 kg in 2019. It is further estimated to increase beyond 21.4 kg by 2029.

Aquaculture is an important source of food, nutrition, income and livelihoods for millions of the world's population. It is predicted that by 2030, aquaculture is expected to provide 57% of the fish for human consumption. Aquaculture can provide food and nutrition security to the entire household, as well as the much needed micronutrients for women and children. Aquaculture will also help in reducing seasonal vulnerability of the rural poor by extending availability of income and fish as food to the lean season. India is blessed with abundant water resources, both inland and marine. Of late, the production of fish from marine sources has become stagnant and the contribution of aquaculture towards total fish production in the country is increasing year by year. Our country has 9.2 mHa of ponds and tanks, 4.03 mHa of reservoirs, 2.52 lakh km of rivers and canals and 1.06 mHa of brackish water area (DoF, 2020).

Women have been contributing to the rapid growth of aquaculture around the world with their participation along the aquaculture value chains. Active participation in aquaculture can empower women, notably by facilitating women's decision-making on the consumption and provision of nutritious food to their families. The scope and magnitude of women's participation in aquaculture production 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. Although women of Manipur, Assam and West Bengal do participate in sustainable aquaculture, by engaging in pond fertilization, nursery

rearing, fish feeding and harvesting, they are excluded or are not participating in skill involving practices like feed formulation, water quality management, disease management etc. (Meeteiet *al.*, 2017). It is reported that in northern India only 13 per cent 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, social taboos, priorities for household chores, food consumption pattern, lack of ownership of and access to pond and lower access to credit as well as technical knowhow and lack of women friendly technologies.

Coastal states and northeastern states are characterized by predominance of homestead ponds. These ponds are usually less than 1 ha in size, to which women can have an easy access. The integration of gender transformative strategies with technical capacity development will help in overcoming the existing barriers to enable women to better engage in aquaculture and to provide a sustainable economic and nutritional security to their family. Reports on the use of a gender-responsive family approach in aquaculture programs suggest that women can acquire new skills in aquaculture management practices and as a consequence, their mobility increases and their status improves (Debashishet *al.*, 2001). Women usually lack scientific knowledge on the aquaculture management practices. It is necessary to conduct hands on skill development programmes to make women capable of handling all the activities in aquaculture starting from preparation of pond, stocking of fish, water quality management, farm made feed preparation, feed calculation, sampling of fish, identification of diseases and parasites, feeding of fish, diversification by addition of unconventional species, and harvesting of fish. The popularization of polyculture of small indigenous fishes along with Indian Major Carps will ensure continuous availability of fish to rural families. These fishes being auto breeders will continuously replenish themselves in the village ponds. The small size of fish favours frequent consumption by and nutrition of the rural poor, some of the most important cultivable small indigenous fresh water fishes are *Amblypharyngodonmola*, *Esomusdanricus*, *Puntiusspp*, *Osteobramaspp* etc. These fishes contain huge amount of vitamin-A and vitamin-D which are very good for human bones, teeth, skin, and eyes. For eg: *Amblypharyngodonmola*, locally called as mahurali has a Vit A content of more than 2000 µg Retinol activity equivalent/100g (Anderson *et al.*, 2016) which is fifteen times higher than that in rohu. It has been reported that one kilogram of small fish

provides minerals and vitamins equivalent to those in 40 kilograms of big fish. It is also necessary that women friendly harvesting gears or devices need to be popularized so that women can engage in fish harvesting activities without their dependence on their spouses or external labour.

Conclusion

Strengthening the perspective of women about mitigating malnutrition through adoption of homestead aquaculture will go a long way in attaining the goal of emancipation of rural families from the grips of malnutrition. This can be achieved through awareness creation, technological backstopping, increasing their access to and benefits from economic resources, improving their decision making ability and leadership. These will ultimately help our country to march towards the SDG 5 of Gender equality. Homestead aquaculture with the participation of women will make fish and aquaculture more accessible and affordable through increasing production productivity and income.

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Implementation of Digitalization in Agrifood System

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The digital technology has the potential to be a very powerful instrument in the agri-food system. It can be helpful throughout the entire food production process, including harvesting, processing, marketing, etc. At each level, a variety of factors have an impact on agriculture and the agri-food system. It can reduce the gap of access of information for underprivileged farmers. Through digital technologies different types of advisories may be timely given to farmers. It is known for its efficiency, timeliness, etc. By including information technology in agriculture, the target to feed the world may be achieved in spite of various hindrance . The livestock and horticulture sectors have also witnessed the emergence of digital agriculture applications.

Why Digital Technologies?

- Communication Speeds.

Digital technologies are known for its fast communication speed, execution speed and data accuracy with less human involvement required.

- Versatile Working.

Digital devices are of versatile in nature and can be used in almost every activities of agriculture.

- Accuracy in prediction based on data

In spite of less human intervention the accuracy of data prediction is quite good. The data predicted from temperature sensor, soil sensor gives satisfactory results for performing farming activities.



Figure 1. Agriculture Minister Signing 5 MoU for Digital agriculture (Source: PIB, Delhi)

Recently, MOA&FW have signed MoU with 5 private partners towards the digitalization of agriculture. It has full potential to bring the 2nd wave of green revolution.

ICT Applications for Agrifood system:

To support the Digital India Initiatives various online portals have been developed to help farmers. Some are as follows:

e-NAM portal: The e-NAM Portal provides a single window service for all APMC related information and services. This includes commodity arrivals and prices, buy and sell trade offers and provision to respond to trade offers, among other services. While material flow (agriculture produce) continues to happen through mandis, an online market reduces transaction costs and information asymmetry.

FARMER PORTAL: Farmers' Portal is an endeavour in this direction to create one-stop-shop for meeting all informational needs relating to Agriculture, Animal Husbandry and Fisheries sectors production, sale/storage of an Indian farmer

IT enabling policies:

The Digital India scheme is one of the basic policies for making India digitally empowered society and knowledge economy. There are various other government schemes through which the rural India are being kept under the umbrella of high speed internet. Internet became ubiquitous for accessing any type of information. BHARATNET programme is started with the aim to provide high speed internet to rural India in affordable price. Other scheme like PMGDISHA (Pradhanmantri Gramin Digital Saksharta Abhiyan) is aimed for make 6 crores persons in rural areas, across States/UTs, digitally literate. It specially targets the marginal section of society.

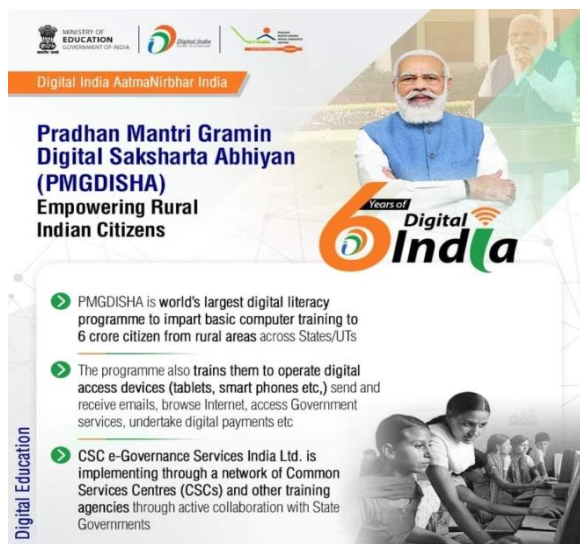


Figure 2 (a) BharatNet programme for Internet connectivity in rural India (b) PMGDISHA scheme for digital literacy among rural youths.

Gender mainstreaming in IT.

The active IT users in farm community is not gender balanced. The no of smart phones used by male farmers are more than the female farmers. More mobile apps, portals related to agriculture are searched by male farmers comparatively with female farmers.

Different mobile applications: A large no of user friendly mobile applications have been developed for farmers that provides advisories and information on finger tip related to crops,



fisheries, animal science, etc.

Figure 3: Smart agriculture using the mobile application

Online meeting platform like zoom, google meet etc:

Online meeting platforms are very important for farm women, as their mobility get restricted because of unpaid house hold work too. Women farmers can meet with each other on online meeting platform like google meet, Zoom etc. They can also get scientific advisories over it. These platforms may save time and money of farm women.

Digital transaction in purchase of agricultural inputs:

It is the government policies to promote cashless economy to bring transparency. The government is also sending money to the beneficiaries through DBT mode in order to reduce corruption and non-involvement of middle men. To bring transparency in whole agrifood system the transaction should be done in cashless mode only.



Figure 4. e-RUPI Digital payment solution

4. Challenges:

Fast growing digital technologies has shown unexpected reach in agricultural scenario. It had already proved its efficiency in industrial sector where production, inspection, quality control everything is done with robotics, IoT, artificial intelligence. In Indian agriculture scenario there are some hurdles for implementing it and Digital literacy is one of them. According to the NFHS data more than 50% of population still not have smart phone and internet services. Digital learning policies should be strengthened for making digital farming a great success in Indian scenario.

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Promotion of locally grown vegetable crops for nutritional security

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Introduction

Nutrition has captured the international spotlight in an unprecedented way as persistent global hunger and under nutrition has underscored the need for urgent action. One in eight people around the world still suffer from hunger and more than double that number are victims of hidden hunger. India also faces challenges of nutritional security at household levels due to nutrient deficiencies such as vitamin A, iron, zinc, and calcium. India represents rich biodiversity of vegetables; about eighty species of major and minor vegetables are reported to have originated in India. The locally grown vegetables are important source of vitamins, minerals and other phytochemicals which help to reduce non-communicable diseases like cancer, cardiovascular disease and other age related disorders (Sreenivasa, 2017). These vegetables make an important contribution to nutritional and livelihood security for the rural resource constraint women farmers. Locally grown vegetables are considered to be “women’s crops” because they are mostly grown by women (Howard, 2003) for both household consumption and sometimes providing the only cash resource for women to use for the welfare of their families (AVRDC, 2011). Women’s indigenous knowledge about these vegetables was significantly higher than that of men’s because of their key role in collecting, processing and utilizing them. They have knowledge about each and every plant regarding its location, availability, factors influencing palatability, nutritional value and so on.

Benefits of locally grown vegetables

- Contribution to healthy diets
- Diversifying agricultural production systems
- Contributing to sustainable food production
- Contributing to climate change adaptation
- Contributing to improving smallholder income by production, processing and marketing

Nutritional benefit

Locally grown vegetables are blessed with tremendous nutritional and medicinal properties. They are rich sources of minerals, vitamins, essential amino acids, antioxidants, phytochemicals) and dietary fibre which are beneficial for the maintenance of good health. They play a significant role in addressing malnutrition problems, sustainable food production, household nutrition, maintaining biodiversity and ensuring incomes for poor farmers. Leafy vegetables are the main source of iron, folic acid and vitamin C of in the rural and tribal communities where pregnant women are fulfil their requirement of folic acid during pregnancy.

Local vegetables associated with local culture and heritage

In India, many locally grown green leafy vegetables are related to social and cultural heritage. During various local festivals there are rituals of cooking some special dish with specific leafy vegetables for offering worship to God. The leafy vegetable, purslane (*Portulacaoleracea*) used in Bihar during *Jivitputrica* festival. A famous traditional dish of Bengal 'Chauddo Shaak' is prepared using different 14 local leafy vegetables. In Andhra Pradesh, a famous curry of basella and yam is popularly known as Kanda Bachali Kooru. In Maharashtra, the demand for green leaves in *Rishi Panchami* festival, just before *Ganesh Chaturthi* to show respect to the sages of Hindu mythology lived in the forests. The conservation of biodiversity of these local vegetables can be done through respecting these traditions and cultures.

Conservation attempt by women

Women are preservers of indigenous knowledge on multiple uses of plant resources. As the women are responsible for supplying their families with food and care, they generally have a special knowledge of the value and diverse uses of plants for nutrition, health and income. They play a great role in collection, conservation and utilization of these local vegetables. They collect the useful vegetables from their immediate surroundings without any investment. During rainy and summer season, rural women collect various species of edible weeds from their agricultural and non-agricultural fields as well as from forestlands to supplement their staple food. Despite the importance of women's knowledge about the conservation of plant genetic resources and expertise in biodiversity conservation their role is ignored by development planners.

Seed Production

Lack of structured seed production and sustainable supply of quality seeds are the main bottleneck in the development of locally grown vegetables. Farmers specially women farmers are the sole reservoir of seeds of these vegetables. More than 75% of seeds of locally grown vegetables are supplied through informal sources. Seeds of these vegetables mostly green leafy and gourd vegetables even can be produced in the kitchen garden for year-round production. Community seed production and storage system facility at the villages can be a viable option for large scale seed production of these crops. Farmers can be trained to produce genetically pure seed to store the seeds in low relative humidity conditions after drying. Training of farmers regarding seed multiplication, harvesting, seed extraction and seed marketing can overcome the present poor and irregular seed supply of these vegetables.







Market access







Marketing of locally grown vegetables depends on improving access to markets, adding value and stimulating demand. Innovative solutions to simplify processing, produce new products and establish multi-stakeholder platforms for locally grown vegetables value chains is of urgent need. Use of locally grown vegetables in several recipes of popular restaurants and food retailers can play a leading role in popularization of the locally grown vegetables.


Geographical indications of locally grown vegetables in India

Protection of intellectual property rights through Geographical indications (GI) is an important instrument in promotion of cultivation and conservation of locally grown vegetables by the local community within a geographic region. Government of India takes an initiative regarding 'One Product One District' (OPOD) for recognizing the traditional knowledge of the rural community about the local products. GI products of vegetables have huge economic potential to reach global market and earn higher foreign exchange. Among 86 horticultural products, vegetables cover 15% share to the total number of GI's. At present, 13 vegetables have been registered including crops like tomato(1), chilli(6), brinjal(2), onion (2), garlic(1) and French bean(1).

Table 1: Details of GI registered local vegetables

Vegetables and GI Tag	Scientific name	Area	Unique Characteristics	Photograph
Naga Tree Tomato (GI tag. 374)	<i>Solanum betaceum</i>	Kohima, Wokha, Zunheboto, Kiphiri, Tuensang, Mon and Phek region, Nagaland	The Naga tree tomatoes are locally known as seibangenuo. The fruit looks like tomato with oval or egg shape which is a 'traditional food item of the Naga people'. The fruit is rich in vitamin A and C as well as an excellent source of calcium, iron, potassium, phosphorous and magnesium. Naturally, it helps in controlling high blood pressure and to bring down cholesterol levels	
Byadagi Chilli (GI tag. 129)	<i>Capsicum annum</i>	Byadagi region of Haveri, Karnataka	Chilli is known for its deep red colour and got the highest colour value of 1,50,000 - 2,50,000 CU. It is not very pungent and is used in many food preparations in India. This chilli is characterized by wrinkles on the pods, low pungency and sweet flavour. The two main types are ByadagiKaddi and ByadagiDabbi	
Guntur Sannam Chilli (GI tag. 143)	<i>Capsicum annum var. longum</i>	Guntur, Prakasam, Khammam, Andhra Pradesh	It has long fruits (5 to 15 cm in length) and diameter range from 0.5 to 1.5 cms. It has thick skin. The chilli is hot and pungent with average pungency of 35,000 to 40,000 SHU. The content of Capsaicin is about 0.2260/0. This chilli is rich in Vitamin C (185 mg/100g) and Protein (11.98g/100g)	
Mizo chilli/ Mizoram's Bird Eye Chilli (GI tag. 377)	<i>Capsicum frutescence</i>	Mizoram	Fruit is small sized pods and very high pungency. Colour of mature fruit is blood red. Fruit size is not more the 4.5 cm. It is one of the hottest chillies in the world. (SHU- 50000 to 100000)	
Bhiwapur Chilli (Doda chilli) (GI tag. 473)	<i>Capsicum annum</i>	Bhiwapur, Umred and Kuhi taluquas of Nagpur, Maharashtra	Bhiwapur Chilli is known for its pungency. The colour is dark red. Outer covering is thick hence less chances of breakage and long shelf life. It length approximately measures 1.5 inch which describes its short size. The red colour of Bhiwapur chilli is darker than other Chillies like Guntur chillies. It is main ingredient in popular 'VarhadiThecha' (spicy red chilli chutney)	
Khola Chilli / KholchiMirchi (GI tag. 618)	<i>Capsicum annum</i>	Canacona region, Goa	Chil l i is characterized by attractive red in colour with long in length and having medium pungent taste and thus is widely used in making papad. 'Khola/Canacona' chillies have been cultivated in Khola village during <i>Kharif</i> entire village community is involved in their conservation	

Naga Mircha (GI tag. 109)	<i>Capsicum chinense</i>	Manipur, Arunachal Pradesh, Assam, Mayanmar, Nagaland	Commonly known as the Ghost Chilli (BhutJolokiaMirchi). Naga Chilli is the World's hottest chilli ever found on this earth. It is 110 times hotter than the Hottest Guntur Chilli and 400 times hotter than the mildest Chilli's. Finely wrinkled skin with thin flesh. Fruity aroma and distinctive pungency. Exquisite unique taste. It has vitamins which prevents cardiac arrest. Acts as antibiotic. Used as pain killer, insect and pest repellent and anti-venom	
JalgaonBharit Brinjal (GI tag. 501)	<i>Solanum melongena</i>	Jalgaon, Maharashtra	The golden-brown colour and tempting taste after roasting the brinjals make this variety popular among people. JalgaonBrinjal is specifically used for making traditional spicy dish 'Khandeshibharit'	
UdupiMattu Gulla Brinjal (GI tag. 199)	<i>Solanum melongena</i>	Udupi region, Karnataka	It has very thin skin and small spines on the fruit surface. It has unique taste and virtually gets dissolved while cooking and also less astringent and less bitter when compared to other variety of Brinjal	
Lasalgaon Onion (GI tag. 491)	<i>Allium cepa</i>	Nashik, Lasalgaon region, Maharashtra	Lasalgaon light red onion variety is popular due to its colour, pungent taste, long shelf life and bigger size	
Bangalore Rose Onion/ gulabi eerulli (GI tag. 212)	<i>Allium cepa</i>	Districts of Bangalore Urban, Bangalore Rural, Chikkaballapur and Kolar, Karnataka	Grown mainly for export purpose. It has scarlet red colour, anthocyanin, phenols and high pungency. The pungent property of these onions makes them suitable to be used in pickles	
Kodaikanal Malai Poondu Syn. Kodaikanal Hill Garlic (GI tag. 616)	<i>Allium sativum</i>	Dindigul district	KodaikanalMalaiPoondu is known for its medicinal and preservative properties. It has anti-oxidant and anti-microbial potential. It has a presence of higher amount of organosulfur compounds, phenols and flavonoids compared to other garlic varieties. It's usually white or pale yellow and each bulb weighs 20-30g on an average	

WaghyaGhevada (GI tag. 476)	<i>Phaseolus vulgaris</i>	Koregaon, Khatav Tehsils, District Satara	Faint pink colour having red lines on it which resembles tiger skin. High nutritional content—rich in carbohydrates and protein. Tastes sweeter as compared to other Rajama varieties. Ghevda beans also contain protein, calcium, dietary fiber, iron and several other essential nutrients. These beans have impressive amount of antioxidants and even provide cardiovascular benefits	
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Source: Hiremath et al., 2020

Strategies to improve livelihood and income of farmwomen

- Cultivation of local vegetables in homestead garden
- Nutrition education and popularization of healthy cooking methods
- Popularization of community composting
- Popularization of community seed production
- Seed banks for conservation and sharing of local vegetables within the community
- Formation of business group and tapping the niche market
- Branding and e-marketing of locally grown vegetables and their products
- Development of nutri-products from locally grown vegetables
- Minimal processing for increasing the shelf life
- Innovations in packaging, and short term storage

Future scope

In spite of the great medicinal and nutritional values of locally grown vegetables, they were ignored by commercial farming, research and development. They were not popularized among the urban community, gradually losing their diversity and the associated traditional knowledge. Huge potential exists for identification, domestication and commercialization of these unique vegetables in the biodiversity rich regions. Locally grown vegetable cultivation provide assistance to farmers from socially disadvantaged groups, such as minority, women and Native growers, who may lack the experience, networking connections and capital to access large markets to remain on the land, keep their traditional cultures and build their financial security. These vegetables have huge biodiversity, adapted to marginal soil and climatic conditions and can easily be grown with minimal external inputs. Increasing use of these vegetables will lead to diversification in agricultural production system and increase crop heterogeneity which ultimately will result into better crop resilience against biotic and abiotic stresses under the changing climatic scenario. They serve an immediate solution to the continuing struggle for alleviating hunger, malnutrition and

improving health. To understand the potential opportunities and perceived constraints faced by poor smallholder farmers in cultivating these vegetables scientific research is urgently required to develop adoption and dissemination strategies. Identification of nutraceutical rich promising locally grown vegetables, development of high yielding and stress tolerant varieties, agronomical packages of practices and seed chain system are the primary requirement for bringing these vegetables in to mainstream cultivation. To enhance food diversity and quality diets with local nutritious vegetables, a two-pronged approach of increasing nutrition awareness and consumer demand along with interventions to increase agricultural production and year round supplies is required.

Conservation of local land races and their sustainable use for nutrition and livelihood of tribal families

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Traditional and indigenous food systems are biologically and culturally diverse and can be greatly useful to improve nutritional status among populations. Protecting and leveraging agro-biodiversity can greatly help in ensuring dietary diversity for food and nutritional security among communities.



Agri-food system and nutritional security: The tribal linkage

While food systems globally are struggling to meet the nutritional needs of the growing populations, these have put a strain on land, water, soil, resources leading to a

renewed interest in sustainable food systems. These, derived from sustainable cultures and ecosystems are often known to be accessible, affordable, safe, healthy and promote environmental stability. Indigenous foods (IFs), consumed by indigenous people throughout the world, are known to be derived from natural ecosystems, and perceived to be sustainable and of high nutritional quality. *However, indigenous people, guardians of 80 percent of global species diversity, are often marginalized, nutritionally vulnerable and experience significant disparities in health outcomes; this is because the potential of traditional food systems in providing sustainable solutions to the existing nutrition insecurity within the population continues to be unrecognized.*

As India struggles to tackle malnutrition among women and children in the country as the NFHS data reveals, it is increasingly becoming clear that agro-biodiversity has an important role to play in ensuring sustainable and diverse diets and enhance health and nutrition, and may help manage effects of climate change. However the food systems in India continue to be dominated by rice and wheat which impacts dietary quality adversely. Protecting and leveraging agro-biodiversity can greatly help in ensuring dietary diversity for food and nutritional security among communities. Traditional and indigenous food systems are biologically and culturally diverse and can be greatly useful to improve food security and nutrition among populations. Agricultural biodiversity was measured by the variety of food crops grown, animals reared for food and food items obtained from natural habitats by hunting, gathering and trapping by household members.

Indigenous food systems for coping with malnutrition in tribal areas

The species diversity of the food groups

Case of Munda Tribe

Jharkhand, a central eastern Indian state known for its rich bio-diverse agro-forestry is home to several indigenous tribal communities that constitute 26 percent of the state's population. Mundas, the third most populous tribal community of Jharkhand, are the inhabitants of Chota Nagpur region in the state. This community lives in geographical locations that are surrounded by natural resources and have largely retained their traditional ecological knowledge (TEK) of gathering and preparing foods from the natural sources in traditional ways. Despite access to a rich agroforestry, studies show that malnutrition among women and children is very high. This paper discusses the findings of a study that explores the range of traditional foods that the Mundas consume, the nutritional value and the factors that influence their consumption. The study was conducted in Khunti district of Jharkhand,

India in Murhu and Torpa blocks of the district. The Mundas consume a two to three main meals a day, which consist of rice along with sautéed or curried green leafy vegetables (GLVs) or roots and tubers or sometimes pulses and flesh foods (meat, poultry, egg, or fish). Both indigenous as well as non-indigenous varieties of foods are consumed, which comprise of different varieties of rice, pulses, fruits, GLVs, roots and tubers, vegetables, and flesh foods. Milk and milk products are rarely consumed by the community. The community accesses foods from cultivated agricultural lands, backyard gardens and raising livestock, from the wild such as surrounding forests, pastures, roadsides, wastelands and local water bodies, and built food environments such as local informal markets and food entitlements under government's food security programmes. The agro-forestry and livestock produce is mainly utilized for household consumption, while the surplus is sold in local markets for income generation.

The Munda tribes depend on forests, water bodies and fields and pastures for gathering foods as well as firewood. Different varieties of indigenous leafy vegetables, fruits, roots and tubers, and mushrooms are collected for household consumption and sale in local markets and firewood is used as fuel for household cooking. Men in the village gather once in a year and collectively hunt wild animals for consumption. Local rivers, lakes and ponds are used during monsoons, to catch fish, crabs, and snails. Weeds grown in the fields, pastures and wastelands are collected for consumption. *The traditional diets of the Munda tribes include a diverse list of 194 indigenous foods (IFs) ranging from 34 cereals (17.5 percent), 7 pulses (3.6 percent), 57 green leafy vegetables (29.2 percent), 11 other vegetables (5.7 percent), 9 roots and tubers (4.7 percent), 15 fruits (7.8 percent), 23 mushrooms (12 percent), 37 flesh foods (19 percent), and honey. Out of 194 IFs listed, 87 (45 percent) were identified as commonly consumed and 107 IFs (55 percent) as little used or historically consumed.*

Case of Parajas and Kandhas of Odisha

In Odisha tribal communities use at least 20 forest based produces during Nuakai, Chaitiparab etc. Roots, vines, tubers, seasonal fruits, vegetables and leafy vegetables are among the collected and gathered foods. Protection of forest lands and products from them, and traditional practices can greatly help to ensure dietary diversity, better nutritional outcomes, sustainability and food security, and health among populations.

Case of Garo Tribe

Garo tribal farming involves the simultaneous cultivation of 15–20 mixed crops in the same field and includes traditional varieties of crops that are selected and preserved by farmers for many years. Many of these wild and locally cultivated edible plants and fruits are significant in the life and traditional culture of the indigenous tribes of India and provide the essential nutrients to maintain health of the communities. Despite the importance of local foods to local people and their diets, the important role of such foods in nutritional security is seldom acknowledged in large-scale hunger eradication or nutrition promotion/livelihood improvement programmes. There is also very little information available on local food systems of indigenous communities and its impact on their diet quality and food security. In most of the tribal areas Jhum farming, mixed farming, terrace farming system is being practiced. The jhum farming system is an ancient system practiced among the tribal communities, in which crops and livestock are the primary components. Crops are grown on some parts of the landscape, while some pockets are kept fallow for different durations, secondary forests on some fallow lands, and the original vegetation on other lands. A small patch of the forest is cleared by cutting and burning of trees, leaving out the larger trees as they provide edible fruit. Jhum is practiced on community lands, which are controlled by the village chief. Each participant is given land that cannot be sold or used for any other purpose than farming. The land is prepared during February–March, and seeds are sown in April.

The foods obtained from tribal cultivation could be classified into five groups – cereals and legumes, vegetables, fruits, spices, and meat. Each of the five food groups was dominated by at least two species of crops or livestock, showing the diversity inherent in traditional farming. This helps to cope against risks and enhanced food and nutritional security by ensuring supply of food around the year. It was found that 26 landraces (a local variety of a species of plant or animal that has distinctive characteristics arising from development and adaptation over time) of four crop species enriched the food basket and helped mitigate environmental stress. Landraces have rich gene pool and can help in strengthening biodiversity while maintaining strong cultural ties. However, traditional mixed cultivation is disappearing rapidly due to land use changes and its place is gradually being taken by intensive agriculture that mostly involves monoculture, which can be a growing threat to local food security.

Wild edible plants in the food basket

As high as 90 percent of the total tribal diets were from the wild, which are nutritionally rich and also culturally important. Fresh shoots of bamboo were most commonly consumed - fresh during the season (May to October) or dried, fermented, or pickled for off-season consumption. Some households also consumed wild edible fruits and vegetables, mushrooms, and medicinal plants. A range of plants were also consumed by the tribes from the wild as vegetables. In north eastern states, they consume diverse (as many as 23) sources of food by exploiting the available biodiversity. three major products from glutinous rice, namely menilpita, menilrita, and chubitchi were prepared and consumed mainly during '*wangala*', the most important festival, and also on other festive occasions such as '*rongchugala*' (thanksgiving), '*do.si dodoka*' (a traditional wedding), '*a.galmaka*' (offerings after afield is cleared for *jhum*), and '*nokkingpina*' (construction of new traditional home). Majority of the households had average levels of dietary diversity, seven percent had very high dietary diversity while twenty three percent had low dietary diversity. It greatly helped in maintaining the dietary diversity of majority of the tribal populations.

Many of the indigenous foods are found to be highly nutritious, but their consumption is now declining. The commonly consumed foods include rice, maize, finger millet, pearl millet, sorghum and little millet. About 29 varieties of indigenous rice exist, but only 14 are routinely consumed. Millets are seldom consumed nowadays, only half of the known green leafy vegetables are now consumed. While twenty three varieties of mushrooms are known to the Mundas, only 12 varieties are routinely consumed. Similarly, only about 50 percent of roots and tubers and fruits are routinely consumed at present. Only a third of the reported 37 animal foods are included in the routine diets.

Indigenous foods continue to be consumed because of their desirable taste, perceived nutritional benefits, adaptability and resilience to climatic variability resulting in improved productivity and availability, the traditional practices of preservation and conservation which promote their incorporation in daily diets, and the cultural importance associated with the foods which facilitates their use on special occasions.

Barriers leading to decrease in production and consumption of traditional foods

However, a number of barriers were found to lead to decreasing production and use of traditional foods

1. Local climate variability leading to erratic rainfall patterns and short rainy season followed by long periods of dry season

Agriculture in the hilly region is rain-fed. Due to low rainfall, water scarcity has become a major crisis in these regions leading to acute water shortage for crop irrigation. This has negatively affected both farm and kitchen garden produce. Insufficient marketing facilities and non-remunerative price for the produce makes ethnic farming non profitable and non-livelihood sustaining.

2. Easy access to non-indigenous foods from markets and food security schemes:

As farm and forest produce is declining due to climate impacts, the tribals have started exploring alternative sources of livelihoods such as daily wage labour, working in factories, shops, hotels etc. The income generated is used for purchasing non indigenous foods from local markets, such as green gram and lentils, vegetables like brinjal, cabbage, cauliflower, tomato, onion, GLVs like spinach and bathua leaves and roots and tubers like potato.

3. Access to food distributed under PDS:

Public distribution system supplies them with non-indigenous rice and wheat, sugar and salt at highly subsidized rates. This has led in reduction in inclusion of IFs in the daily food basket.

4. Increasing Exposure to Hybrid Crop Varieties:

The low crop yields associated with indigenous seeds and increased emphasis over modern farming methods that use high yielding seeds and chemical fertilizers by the local agricultural organizations has led to changes in the traditional farming practices of tribal community.

5. Predominant cultivation and consumption of rice as a staple in the villages

Predominant cultivation and consumption of rice as a staple in the villages inhabited by tribals is being reported. Loss of coarse cereals like millets and indigenous vegetables from the habitual Indian diet have led to reduced iron intake in the populations is one of the important indicators of malnutrition in the country.

Challenges in conservation of local land races and changing role of tribal women

“Upon this handful of soil our survival depends. Care for it, and it will grow our food, our fuel, our shelter and surround us with beauty. Abuse it and the soil will collapse and die, taking humanity with it.”
Ancient Veda

The two great ecological challenges of our times are biodiversity erosion and climate

change. And both are interconnected, in their causes and their solutions. Industrial agriculture is the biggest contributor to biodiversity erosion, as well as to climate change. According to the United Nations, 93 percentage of all plant variety has disappeared over the last 80 years. Monocultures based on chemical inputs do not merely destroy plant biodiversity; they have destroyed soil biodiversity, which leads to the emergence of pathogens, new diseases, and more chemical use. In many regions with intensive use of pesticides and GMOs, bees and butterflies are disappearing. There are no pollinators on plants, whereas the population of pollinators in the biodiversity conservation farms is many times more than commercial farms. The UNEP has calculated the contribution of pollinators to be \$200 billion annually. Monocultures undermine nutrition by displacing the biodiversity that provides nourishment and the diversity of nutrients our body needs. Indigenous bio-diverse varieties of food grown by women provide far more nutrition than the commodities produced by industrial agriculture. Bio-diverse ecological agriculture in women's hands is a solution not just to the malnutrition crisis, but also the climate crisis.

Strategies for inclusion of local land races in the agri-food system with participation of tribal women

Identifying gender issues in conservation of local land races

Women provide close to 80% of the total wild vegetable food collected in 135 different subsistence-based societies. Women often have specialized knowledge about “neglected” species. The majority of plant biodiversity research is not gender sensitive. This has led to incomplete or erroneous scientific results with respect to the diversity, characteristics and uses of plants, and the causes and potential responses to genetic erosion. Integrating women's traditional knowledge into botanical and ethno-botanical research, and protecting all informants' rights, are critical for improved knowledge and management. The language used by the Convention on Biological Diversity and the Bonn Guidelines to address subjects related to indigenous and local communities is not gender-sensitive. In spite of the fact that an increasing number of experiences are highlighting the sustainable manner in which women use biological diversity, it is often true that women do so without equitable participation in the access and control of such resources. There is a tendency to ignore the natural spaces predominantly used by women in favor of those used by men, and to undervalue non-commercial (mostly female) production spaces in favor of commercial (mostly male) production spaces.

Therefore, it is necessary to make visible the gender-differentiated practices and knowledge of women and men in their relations with biodiversity resources. Despite considerable efforts over the past fifteen years at national and international fora, such as the Convention on Biological Diversity, very little progress has been made in understanding the fundamental roles that women play in managing and conserving biodiversity. It is essential to recognize that women and men have particular needs, interests and aspirations, and that they make different contributions to the conservation and sustainable management of biodiversity. Making visible the various roles women play in biodiversity conservation, sustainable use of resources and survival of the human species is only the beginning. Ethnic festivals are a potential conserver of local food crops.

Traditional festivals and their Prominence in Andhra Pradesh

Festival Name	Celebrated Month	Associated Prominent Seed/crop varieties
Soyathpurabh	April	Pulses, Tubers
Gotnakiya	May	Tubers, Millets
Liyakiya	May	Finger millet, Sorghum
Jathara	July	Paddy , Ragi
Nuyakiya	August	Fox tail millet, Barnyard Millet, Pumpkin
VarshPurabh	October	Black eyed Pea, Paddy, Colocasia, Bottle guard
Pond purabh	November /December	Beans, Pulses
Push Purobh	January	Paddy, Black eyed pea, Beans, Pulses,Tubers

Sustainable use and benefit sharing

Large scale cultivation in the locality not only conserves the cultivars but also helps in sustainable farming by making seeds available for cultivation. Organic produces of the local land races will have demand in the locality and beyond. However involving groups of tribal women in organized way will ensure its sustainable use and benefit sharing. Revamping the gene fund by registering the local land races will help in supporting the community in their conservation endeavor.

Establishment of value chain and seed network

Use of the local landraces for development of products of value and establishing a value chain involving different stakeholders is an effective way for ensuring the livelihood of tribal women. At present, the demand for local produce and non chemical products are increasing. By tapping the market, production of local produce will receive a boost and tribal

women can increase diversity in their food basket. For popularizing these local produce a robust seed network for these local cultivars is essential. The seed network will ensure genetic purity, physical purity, viability and health of the seeds and will make it available in the areas of their production and beyond.

Facilitation, Linkage and capacity building for participation in Nutri smart agriculture

Capacity building of all the stakeholders involved in the value chain and seed network is essential with respect to quality, standard and regulatory parameters of products and seeds, Government schemes and programmes, production/manufacturing, quality control, packaging, market structure, composition, trading etc. Strengthening of institutional mechanism and farmers producer groups with forward and backward linkage is essential. Cropping diversity combined with nutrition education, regular health monitoring, arrangement of health camps, and inculcation of healthy eating habits will enhance nutritional well being of the tribal community.

Development of Nutri smart tribal villages

Establishing model nutri smart villages in every block by intervening in all aspects of NSA will be helpful in achieving the goal. Nutri smart village programme of ICAR-CIWA is working in this direction to realize the NSA.

Conclusion

The experience with the recent disruptions triggered by the COVID-19 pandemic, have raised a number of challenges for food security and health, and highlighted the importance of agro-biodiversity and the role that local practices can play to increase resilience in informal food chains and help enhance nutrition security, strengthen adaptive capacity and reduce vulnerability. Reinforcement of traditional ecological knowledge and informal food literacy, along with promotion of climate resilient attributes of **Indigenous Foods**, needs to be encouraged and can greatly contribute to sustainable foods and better nutritional outcomes among the tribal community as well as other indigenous populations in India.

Enhancing nutrition and income of rural women through improved goat rearing

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India has a rich diversity of small ruminant genetic resources having 223.14 million (148.88 million goats and 74.26 million sheep) (20th livestock census, 2019). About 75 % of rural households are small and marginal farmers, who own 62% of small ruminants contributing 4.8 and 3.4% of total world meat and milk production (Karim and Sahoo, 2012). Women form the backbone of agriculture and play a significant role in goat farming. Despite the fact that women in India do most of the work in animal production, their work remains mostly invisible. Gender divisions in agriculture are stark, with all activities involving manual labour assigned to women, while all operations involving machinery and drought animals are generally performed by men. Various schemes and programmes from Govt, and NGOs are being implemented to empower small ruminant owners. But, most of them are illiterate women, who were neglected and excluded from the mainstream development programme. Generating awareness, motivating and mentoring through skill based capacity development programme are most essential for ensuring their participation in the development programme. Special attention needs to be oriented towards the role of women and enhancing their income through suitable community based technological interventions to empower farm women making self-sufficient, independent decision making, better purchasing power with better socio-economic status.

The productivity of animals under the prevailing traditional production system is very low as they are maintained under the extensive system on natural vegetation. The adoption of improved production technologies/ management practices in the farmers' flock is very low. Therefore, rearing of small ruminants under intensive and semi-intensive system using improved technologies for commercial production has become imperative not only for realizing their full potential but also to meet the increasing demand of meat in the domestic as well as international markets. The animal production system in India has been slowly moving from extensive to intensive system of management for commercial production and entrepreneurship development by farm women. However, inadequate availability and poor quality of feed and fodder, high incidence of diseases and inadequate knowledge on appropriate management of livestock were identified as the major problems in small ruminant production system. A favorable policy environment in terms of access to micro-credit, assured market and veterinary services should be provided to make farm women socio-

economically sound through livestock development programme.

Importance of Goat Meat

The importance of meat and other animal proteins to the human diet is well established. Meat is a very good source of protein, B vitamins, certain minerals and essential fatty acids. It contains only a limited amount of carbohydrates. Meat also provides a high quality protein; skeletal muscle is a good source of essential amino acids, namely leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Goat meat on average consists of 72.3% moisture, 21.0% protein, 4.7% fat and 1.1% ash per 100 g of fresh meat. In fact, goat meat contains more arginine, leucine and isoleucine compared to mutton and beef, thereby indicating that goat meat is comparable to other types of red meats in terms of the quality of protein. The caloric value of lipids in muscle tissue is derived from the fatty acids in triacylglycerol's and phospholipids, of which TAGs constitute the bulk. Similar to other meat animals, the most common fatty acids found in the TAGs of goat meat are saturated palmitic (16:0) and stearic acids (18:0), monounsaturated oleic acid (18:1) and polyunsaturated linoleic (18:2,) and α -linolenic acids (18:3) (Hoffman et al., 2002). Comparisons of the fatty acid composition of goat muscle and fat depots with those of beef and lamb indicated that the ratio of polyunsaturated to saturated fatty acids (P:S) was higher in goats. The P:S ratio reported for beef and lamb was 0.11 and 0.15, respectively, whereas it was 0.33 for goat meat (Rhee et al., 2000). Higher values for the P:S ratio indicate that meat is healthy especially in relation to cardiovascular disease, this can be a positive marketing asset for goat meat.

Constraints in goat farming

Now a days commercial goat farming in entrepreneurship mode is being adopted which help in increasing the productivity of goat farming. However, use of improved technologies, particularly prophylaxis, superior germ plasm, low cost feeds and fodders, and innovative marketing of the produce would be the pre-conditions for successful commercial production. The producers use them to diversify their livestock management portfolio and to decrease their risk in case of adverse weather conditions such as drought. Under crop-livestock production system goats compete for the available resources with the other farm enterprises. Lack of improvement in the productivity of goats is often attributed to the lack of skilled labour. In many places women not only take care of the animals but also own them and market them. As production systems become more sophisticated, so do management skills. This is one of the most serious constraints in achieving higher production rates.

Training and technology transfer, adapted to women's schedules covering all aspects of production management may solve the problem.

During the initial phases of the animal farming, high mortality in sheep/goats due to PPR, diarrhoea, pneumonia, tetanus, etc. is a major concern of the farmers due to lack of knowledge about package of practices of improved goat farming, poor prophylaxis, non-availability of vaccines, etc., poor preparedness of the farmers, lack of personal attention of the entrepreneurs and poor access to veterinary doctor with experience of small ruminants. Difficulty in getting good quality breeding animals is also a major constraint. The best male animals from the traditional flocks were sold for slaughtering to traders resulting in scarcity of good quality breeding animals. Lack of organized efforts for breed improvement has been compounding this problem. Since large flocks of different breeds under commercial production are only few, the entrepreneurs had to select the breeding animals from the available traditional flocks mostly through middlemen. Therefore it takes a long time to establish a good flock. Non-availability of vaccines, especially PPR, was another major constraint. The trade of live animals which is unorganized and is in the hands of a large number of middlemen, traders and butchers, does not favour farmers. The live animals were sold not on the basis of their body weight in the livestock markets resulting in under-estimation of the value of live animals. The availability of institutional credit was relatively easy for large projects, but was another constraint for the small entrepreneurs with projects of 50-100 goats and had limited capital for collateral security.

Strategy for enhancing productivity and income of farm women

Goats are widely distributed and are of great importance as a major source of livelihood of rural communities. Age at first parturition, parturition interval and litter size determine lifetime production as well as efficiency of production which can be improved because they are under the influence of environmental and ecological factors. These effects are clearly related to nutrition, health and management. For starting and maintaining a profitable and successful small ruminant farming, strategic planning is required.

Selection of Breed: Breed selection is the main assets which give farmer's business a boom and a good uplift. Based on the region and climate purebreed (**Sirohi, Jamnapari, Barbari, Beetal, Black Bengal**) and cross breed (**sirohi and black bengal, jamnapari and sirohi, beetal buck and black bengal**) are best suited. Local climate resilient breeds of moderate productivity should be promoted over susceptible crossbreds. To increase the sustainability of

estrus synchronization, artificial insemination may be done in the flocks avoiding the lean period for kidding can improve the production of the flock.

Housing/ Shelter Management: The site having great source of fresh and clean water supply, availability of all types of equipment, easily available food source, fertile field for crop, grasses and other green plant production should be selected. House should be neat, clean, dry with proper ventilation and drainage system inside facilities with good transportation and veterinary service along with proper marketing facility. Goats do not thrive on marshy or swampy ground. Goats should be provided with a dry, comfortable, safe and secure place, free from worms and affording protection from excessive heat and inclement weather. Housing in tropical and semitropical regions should be kept to a minimum. In the arid tropics, no protection other than natural shade is required. The orientation of the long axis of the shed should be in east west direction in plain region and should be north south in high altitude areas having high humidity. Provision of elongated eaves or overhang will provide shade as well as prevent rain water from entering the sheds. The house should be well ventilated and wind flow at a speed of 5 km/h is ideal. Overcrowding in the animal sheds must be minimized. Floor should be cleaned regularly and kept dry by proper cleaning of waste materials and adequate sun light exposure.

Feed resource and feeding: Feeding is very essential for commercial goat farming. The natural ability of goat to eat a wide variety of vegetation and waste has been, in fact, a big motivating factor for small, marginal and landless laborers to rear small number of goats. Stall-feeding in goats was very limited. So an integration of forage legumes into the cropping system of small stock owners would go a long way to improve the productivity of their animals (Shalander and Upadhyay, 2009). By introduction of legumes like Siratro (*Macroptelium atropurpureum*), *Stylosanthes hamata*, *S. scabra*, *Glycine javanica*, *Dolichos auxilaris*, *Desmodium spp* and *Centrosema pubescens* etc., the quantity as well as quality of herbage production can be substantially increased. Indigenous legumes such as clovers (*Trifolium pratense*, *T. repens*), *Medicago denticulata*, *Melilotus alba*, white clover, red clover have proved successful apart from Lucerne and berseem. *Leucaena leucocephala* and even perennial pigeon pea etc. are pruned frequently to provide leaf fodder to get better crop production. For augmenting fodder availability, emphasis needs to be given to cultivated fodder crops on large area. Foliage of fodder trees could be fed to the livestock in mixture with crop residues and hay to improve their palatability and nutritive value. Propagation of

fodder and legume trees in wasteland and community pastures and its judicious utilization can be taken up to mitigate scarcity of fodder. Intercropping with twin objective, using seed for human and leaves for animals, short duration and quick growing leguminous forage crops should be promoted. The degraded grazing lands and community pasture land should be converted in to productive system like silvi-pastoral. Drought tolerant grasses, shrubs and fodder trees need to be promoted on field bunds. Improvement in the natural rangelands by reseeded with perennial grasses, intercropping of legumes, plantation of fodder trees and most importantly judicious utilization of natural resources. Agroforestry should be popularized among farmers.

She goats are given kitchen waste and the males are given inferior quality grains and grams for fattening purposes. Goats eat 4-5 times that of their body weight. They eat more of tree fodder and hence 40-50% of green fodder should contain tree leaf fodder in roughages. Goats should be fed with concentrate mixture consisting of maize, wheat, horsegram, groundnut cake, fish meal and wheat bran. Proteins may be supplied through concentrate such as groundnut cake, sesame cake or safflower cake when the pastures are poor in legumes or when scarcity conditions prevail. Normally 110-225 g of cake is sufficient to maintain an average sheep in good condition. Feeding a mixture of common salt, ground limestone and sterilized bone meal in equal parts is required to alleviate deficiency of minerals in the feed. Abundant clean fresh water should be made available to goats. Water should be changed every morning and evening. The mineral mixture may be included in the concentrate ration at the rate of 2 per cent. Lumps of rock salt are should be hung up in some suitable place where sheep and goats can easily get at them, or else they may be kept in the manger. The provision of salt licks and supplementation of vitamins A, D and E is also essential for optimum production.

Breeding and management:In goat farming, indiscriminate breeding is prevalent. No efforts seem to have made to improve the stock through selective breeding or by introducing high potential breeds. Male goats are taken better care than the female ones as these fetch good price to the owners. Many do not like goat milk; hence, less priority is attached to milk traits of the goats. Genetic improvement and or efficiency of production can be more easily ameliorated in small ruminants because they have a faster population turnover rate. Such progress would be achieved if increased selection pressure is effectively applied. Use of same buck for mating with numerous does at same day should be avoided and artificial

insemination should be encouraged providing door-to-door service and to serve as a training centre to promote entrepreneurship among the unemployed youths. For effective health, animals should not be provided contaminated food or polluted water. For commercial production, arrangement of separate housing of kids, bucks and does and extra care to the breeding bucks, kids and pregnant does should be provided. Only the improvement of management practices could earn 250–300% higher income, due to birth of healthy kids of elite breeds, proper care of selected male kids after weaning to make suitable buck, low mortality, high growth rate, good health, early maturity, sale of animals on weight and as breeding bucks. Motivation and popularization of package of improved management practices for small ruminant system is very essential. Animal owners should be made aware for improved management practices such as breeding calendar (optimum age and weight of breeding at first time, seasons/months of breeding to obtain maximum survival, production and profit, health calendar, low cost houses and taking hygienic measures of shed, better strategic feeding (timely colostrum feeding, supplementary concentrate feeding at advance pregnancy, first 60 to 90 days of lactation, 3-9 months of age during kids growth, efficient use of feed and fodder) and smart marketing and value addition of products.

Prevention and control of diseases: Since goat production is only a fringe activity for most of the farmers, the health problems of goats were hardly paid any attention. However, goats suffered mainly from worm load, mange, mineral deficiency, anorexia, contagious eczema, diarrhea, mastitis etc. Various types of viral diseases like PPR, goat pox, foot and mouth diseases and bacterial diseases like anthrax, brucellosis etc. are very harmful for goats. Proper scheduled vaccination is a must to prevent this type of diseases to overcome the mortality rate in goats. The does which was not vaccinated PPR, goat pox, brucellosis vaccines previously should be vaccinated in time. Kids should be vaccinated with PPR vaccine at 5 months of age. Before vaccination, deworming is compulsory to get better results. Helminthiasis and ectoparasitosis are widespread in tropical countries and both seriously affect the productivity of animals. Helminthiasis is a serious problem towards the end of the rainy season while ectoparasitosis inflicts heavy damage during the rains to early dry season. Vaccination programme would be even more viable in the pastoral and agro-pastoral regions. An efficient, well-planned animal health service is a pre-requisite for increasing goat production. Any improvement in animal health services must go hand in hand with an adequate improvement in the provision of feed to achieve expected improvements in productivity.

Marketing:Marketing is the most important but easiest step of small ruminant farming business. Commercial producers can target the international market and export the products in foreign countries. Total expenditure and profit from goat farming business depends on the farming system, location, breeds, feeding cost and some other factors. By good planning and proper management farming business can be profitable. Small scale farming requires less investment and profit can contribute regular income. Small ruminant especially goats offer a strong opportunity to development agencies for suitable interventions including micro credit, extension, technical and marketing support especially to women farmers.

Scope for enhancing income of farm women through improved goat farming

Promoting semi-intensive feeding management system: Goat keepers (>95%) rear their goat on zero input and earn average profit of Rs. 12,500/year from a unit of five adult females. The profit from five goats becomes double or more than that i.e. Rs.25,000/year by shifting goat management from extensive to semi intensive system. Farmers may be charged cost of inputs and many farmers (>50%) are ready to pay if profit message spread horizontally remaining farmers also become ready to pay cost that incurred on vaccination, deworming, feed-mineral mixture and service from high potential buck.

Up gradation of genetic stock through high potential pure-bred bucks: Farmers need to be encouraged to breed local non-descript goat with improved breed suitable for that particular agro-climatic conditions. Progenies born out from superior bucks yield 40-75% more production and also fetched 25-40% higher price in market as breed premium.

Promotion of prophylactic measures (goat health calendar):Goat keepers (>75%) were neither aware and nor adopted vaccination against infectious diseases such as Peste des petits ruminants (PPR), goat pox, enterotoxaemia and Foot-and-Mouth Disease (FMD) which are responsible for high economic losses (30 to 60% goat mortality). It was observed that vaccination and deworming of goats have reduced the mortality (<10%) increasing the survival of goat and net income of 3,500 to 4,500/year with a unit of five goats.

Strengthening support services and extension network: Credit is an important asset for goat keepers to access technological interventions such as improved housing, purchase of concentrate, quality animals, value-added products etc. It will encourage goat keepers to

switch their goat from extensive (zero-input) to semi-intensive management system and up-scaling the introduced innovations.

Motivation and popularization of complete package of practice: Awareness should be created for improved management practices such as breeding calendar (optimum age and weight of breeding at first time, seasons/months of breeding to obtain maximum survival, production and profit from goats, health calendar, strategic feeding and smart marketing and value addition of products. Avoid overcrowding of goats especially in growing kids. Floor should be cleaned regularly and kept dry alongwith adequate sun light exposure.

Formulation of farmer's groups, SHGs cooperative, societies for transfer of technology: Such groups should be periodically empowered (credit access, knowledge and incentives).

Value addition of goat products increases income and nutrition : Value-added products of goats have great potential. Processing of goat products to value-added products can contribute to sustained demand for meat and milk and efficient marketing of these products to earn reasonable returns by farmers. Such added value can be obtained in shelf-stability, improved technological functions, better sensory quality or even more convenience. Value addition of goat products may help farmers to increase their products sale and to get more net return. By following improved method of goat rearing and smart marketing the productivity of goats could be increased by 90 to 160%.

Enhancing social and financial security of farm women through goat farming

The importance of goat farming in income generation and nutritional security are well established. Higher the educational status and the higher the flock size of respondents, the higher the income realised. The enhanced income is assumed to be a precursor of being able to meet household financial obligations. Small ruminants described as the 'village bank' are of economic importance to small-holder farmers and especially women. Women are better managers of household resources than men. Goat-based integrated livelihood models can be propagated in entrepreneurship mode to establish profitable business. Model recommended by CIRG, Makhdoom revealed that a landless / marginal household having 15 adult female goats and 25 poultry birds may yield Rs. 82,727/year. Similarly, a landless/ marginal- and small-household with 10 adult goats, 2 cows and 50 chicks and 1 ha rainfed land may earn Rs. 100,634/year. Productivity of goats is low (75-100% of their potential) and

mortality is high (35-50%) because goats in India (>85%) are kept under sub-optimal production conditions (zero inputs). The net income of majority of goat farmers (with zero-input) ranges from Rs. 2,000 to 3,000/adult female goat/ year. The ratio of profit: cost mostly ranged from 1.5 to 2:1. However, by providing critical inputs, rearing good potential goats, following improved management practices and smart marketing the productivity of goats could be increased by 90 to 160%. Thus goat keepers of India may double their income within one year by adopting improved management practices, low cost innovative technologies and smartly marketing of goat and their products (Singh *et al*, 2018). Thus, an improvement in the financial security of rural women through rearing small ruminants would inevitably translate to better living conditions for households. Effort should be intensified at building capacity of rural farm women through education which can enhance their productivity through better adoption of technology that will invariably enhance output and increase revenue. Women should be encouraged to engage in cooperative activities by providing the initial take-off capital needed and fostering an enabling environment for cooperative activities to thrive. Government efforts should also be intensified at making more extension agents available and accessible to these women through employing more hands to complement available personnel and giving them all necessary incentives. Village based institutions should be enabled to handle the term loans for livestock production. The women selfhelp groups as institutions for cash/micro credit for livestock production should be promoted as a part of livestock schemes under rural development programmes. Extension approach should be need-based with problem-solving dimensions and participatory in nature. The exposure visits and training were essentially aimed at strengthening the human capital of the individuals i.e ethno-veterinary training provided to traditional healers to upgrade their skill and capacity; groups with specific needs for training on fodder production be imparted fodder technology. A massive campaign is required to launch capacity building and empowerment of village communities that will act as the harbinger of change and technology adoption and to establish the foundation for a farmer-to-farmer livestock extension mechanism and need for the Government to continue to protect the interests of livestock producers. Management of scientific lines should be encouraged to become the centres of production of superior quality breeding animals. Some large industrial houses such as Hind Agro Industries (a major meat exporter of the country) are entering into goat farming business, especially for the export market. However, for availing the benefits of lucrative export market, food safety standards will have to be developed. In the longrun, vertical and

horizontal integrations would have to be evolved for achieving sustainability of commercial production and remaining competitive in the global market. Service centres will have to be established to provide technical knowledge, recommended inputs and market information. Small size modern slaughterhouses need to be established near the production centres to maintain commercialization of goat farming. The private sector may be encouraged to create such infrastructures through appropriate policy support and incentives to enable the farmers to enhance their productivity and reduce cost of their production.

Conclusion

Goat farming as a source of supplementing household income is getting increasing attention especially among the landless agricultural laborers and small and marginal farmers. Women are increasingly finding it as a potential source of earning cash income to meet their personal requirements. The tradition bound communities currently not rearing goat though economically poor should be motivated through educational and incentive based developmental interventions to take up goat husbandry in entrepreneurship mode for their upliftment. Education through training on improved practices of goat farming may develop access to resources, skill and marketing channel, improve decision making ability and women empowerment which in turn improve socio economic status, self sufficiency, welfare of the rural farm women.

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Managing drudgery and occupational health hazards and women friendly farm tools and implements with emphasis on NSA

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Agriculture in India employs 263 million human workforces, 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 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 are such as sowing behind the plough, transplanting, weeding, interculture, harvesting and threshing. Argo-processing activities like cleaning / grading, drying, parboiling, 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

Livestock (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 in-charge 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 to 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 resources and imposes sexual division of labour (traditional gender roles). Poor purchasing capacity. Lack of awareness. Non-availability of tools, equipments and their maintenance facilities in women’s vicinity. Manufacturers often show little 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 equipment:

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 works 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 equipment. Proper design methodology, extension practices and attitudinal change can lead to better adoption of women friendly farm tools and equipment, 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. GopalKhore
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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Value addition of agricultural produce for entrepreneurship among farm women

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Agriculture sector employs 80% of all economically active women in India; they comprise 33% of the agriculture labour force and 48% of the self-employed farmers. 75 per cent of full-time farm workers are women and contribute 60 to 80 per cent of the country's annual yield. 75% of women are working as agricultural labour force and are active agents of the primary sector. Women constituted 38% of the agricultural labour force and employ two-third of the female workforce in India. Women and girls engage in a number of agro-oriented activities ranging from sowing, applying manure, seed selection and seedling production, weeding, transplanting, threshing, winnowing and harvesting etc to a series of post-harvest crop processing activities like cleaning and drying of vegetables, fruits and nuts for domestic use and for marketing etc. In rural India, out of 89.5% of the labour force, about 80% are working to be agricultural workers. Among them, 50 percent of the labourers had an only primary level of education and 19.2 percent labourers are illiterate. Women farmers, until now, were working in the shadows of our food systems. But they have ability to manage details, dedication to the work they take up, tolerance and kindness towards people. Women's issues are developmental issues and bypassing them in development programmes means leaving almost half of human resources outside development intervention.

According to NSSO data, out of 405.9 m rural female, only 9.4% are self-employed, 12.2 % are regular waged/salaried and casual labourers besides 42.2 % attains domestic duties. About 39 % of rural female are agricultural worker (228.7 m). There are 30.8 m (7.6 % of rural female) self-employed (cultivators) as against 44.7 m (11.0 %) casual labours in agriculture (*Kumar, A et al.*, 2021). The unemployment Rate (UR) for rural female is 29 %. In addition to work-in-hand with male, rural women those engaged in agriculture only 3% of women devoted about 118 min/day in marketing, processing of food products, beverages for their own final consumption (*Time Use Survey data-2019; Ministry of Statistics and Programme Implementation*). Also, there are community-based differences regarding women's participation in agriculture, therefore location, cropping patterns, ethnic affiliation and economic and educational background also have implications for the specific division of labour within a given family unit. In our society, the mother is the complete manager, as she

plans budgets, executes and shows results in the day to day life. Therefore, to raise the status of rural women it is important to empower them by increasing income level. In this context, the Income generation and women empowerment through development of value added products may be the potent tool for upliftment of the rural women towards entrepreneurship development.

1.0 Post harvest losses

Post-harvest huge losses of fruits and vegetables are a matter of grave concern for India's agriculture sector. But this is a general phenomenon and it is happening in almost every developing countries and this also used to happen in developed country as well. Quantitative post-harvest losses in India estimated by different committees ranged between 25-33% depending upon the crop by some authors. Insufficient knowledge of pre and post-harvest operations and lack of proper facilities for handling like pre-cooling, grading, packaging, transport, storage, processing and marketing all together compound the post-harvest losses and wastage which in value terms accounts for more than Rs 93,000 crores (2019-20). According to national level study conducted under AICRP on PHT, ICAR, post harvest losses are ranging from 4-10 % in cereals, pulses and oilseeds, and around 6 to 18 % in fruits and vegetables. But still the report is debated and no clear comprehensive value is documented till now. Out of three bananas one is going to be wasted means 33 % waste according to Institute of Engineers (India). Contrary to the [popular perception of loss of about one-third of agricultural and horticultural production](#), the ICAR-CIPHET study of 2012-13 found that the overall losses are much lower (6-18 %). This results in a considerable gap between gross food production and net availability.

Food and Agriculture Organization of U.N. predicts that about 1.3 billion tons of food are globally wasted or lost per year. Food losses at the post-harvest stage are not only a threat to human consumption and returns to the farmers, but it can also harm the environment in various ways. Food loss is estimated to be equivalent to 6- 10 percent of human-generated greenhouse gas emissions. A significant contributor of this problem is through methane gas generation in landfills where food waste decomposes anaerobically. On the basis of global food loss and waste (FLW), the equivalent in CO₂ emissions is assessed at 4.4 billion tons per annum. This raises acute concern that food loss and waste have a major contribution to climate change from greenhouse gases. These losses can only be minimized by proper handling, marketing and processing of the agricultural commodities.

In India, the level of value addition is very low (2.2 %) as compared to our neighbor countries like Malaysia (65%), Philippines (78%), China (23)% etc. Though India occupies second in food grain production in the world, still one out of four children is below poverty line (BPL) globally. Moreover, increasing production leads to more intensive farming or to an expansion of the area under cultivation, both of which may have negative effects on the environment especially when poor rural households tend to farm in fragile ecosystems or marginal land. If the quantum of losses are reduced, then the supply can be increased by 10-15% approx. without cultivating additional hectares of land or increasing any additional expenditure on seed fertilizer, irrigation and plant protection measures to grow the crops which in turn meeting the overall goals of food security, poverty alleviation and sustainable agriculture particularly in developing countries.

Value adding opportunities is one of the best way that enhance the value of key commodities leading to higher income generation and provide rural women a viable option to empower them socio-economically which finally in turn to become a successful entrepreneur.

2.0 Defining value added agriculture and entrepreneurship

Value added agriculture entails changing a raw agricultural product into something new through packaging, processing, cooling, drying, extracting or any other type of process that differentiates the product from the original raw commodity to a more valuable one. Value-added agriculture is an important strategy to both agricultural entrepreneurship and rural development (Kilkenny and Schluter, 2001; Womach, 2005). The concept of value addition by Food and Agriculture Organization (FAO) is such that value can be added to an intermediate Agri-food product not only by processing it, but also by storing it (value increasing over time) and transporting it (value increasing over space). The increased demand of prepackaged and prepared foods has contributed to the rise of food processors as lead firms in Agri-food value chains with recognizable brands and large processing and buying power (Humphrey and Young and Hobbs, 2006). For value chain stakeholders, value added is defined as the difference between the non-labour costs incurred to produce and deliver a food product and the maximum price the consumer is willing to pay for it. Value added agriculture can only be achieved when farmers are able to supply the market with products carrying form, space, time, quality, functionality, and identity characteristics for which consumers are

willing to pay a premium over raw generic commodities without these characteristic, (Ruoxi Lu & Dudensing, 2015).

Entrepreneurship in agriculture is a concept which has recently received considerable interest among policy makers and development practitioners as a means to spurring rural socio-economic development (Envick & Mullen, 2015). The rate of entrepreneurial activity among women continues to increase worldwide as value and new product development are essential for survival of enterprises in today's business environment. Women managed Small and medium enterprises (SMEs) are more dominant within the business environment compared to the large and well established companies continually searching for new platforms and methods to market their products.

So, entrepreneurship development is a vital for bringing out the transformation in our agriculture. Developing agricultural enterprises and making our farmers entrepreneurial is the need of the hour to make farming a sustainable livelihood option. Converting a farmer to an agripreneur is an attainable proposition since the qualities of entrepreneurs are not inherited. These characteristics can be developed through systematic awareness and motivational training of farmers for diversification and commercialization of agriculture and create viable enterprises.

To capitalize on value-added opportunities, women farmers can adopt one or more of the following three approaches based on their capability and resources, including:

- Performing an activity that is traditionally done in another stage down the agricultural supply chain, which changes the form, space and time characteristics of the raw agricultural commodities
- Vertically integrating several stages in the supply chain, or horizontally coordinating with other farmers, or bypassing stages in the supply chain in order to create closer or direct connection between farmers and consumers
- Performing an activity or adopting a production practice at the growing stage that changes the identity or quality characteristics of the raw products to characteristics consumers value higher in the market place

3.0 Participation pattern of farm women in post harvesting

Post harvesting is an important component of farm activities and is mostly performed by women. In order to understand the present participation pattern of farm women in post-harvest activities an attempt was made under the Extension component of All India Coordinated Research Project on Home Science. The study conducted on 2999 farm families in rural Punjab represented by five agro-climatic zones and five distinct landholding categories clearly indicate an active participation of women in most of the selected activities in the area of post harvesting. The results varied between zones but the women were found to contribute substantially in drying, storage and cleaning. In other activities majority of the women were working with male members. An analysis of gender disaggregated data collected from 23,000 respondents of 11,500 families from 56 zones conducted by ICAR-AICRP on Home Science revealed highest independent participation of rural women was in homestead gardening (28.8%), followed by livestock management activities (22.3%) and post-harvest management (11.4%). The responsibility profile showed that women shouldered major responsibility in livestock management (29.3%), followed by homestead gardening and post-harvest management activities. Study on percentage share of women labour force in processing of fruit crops in India indicated that women's participation ranged from 20- 80% with 72 % in coconut, 84 % in cashew nut (*Nair and Das, 1990*). Women constitute 90 per cent of labour force in cashew processing industry. Most labour intensive operations like shelling and peeling in cashew are done by women workers, while 60 percent of grading of kernels was carried out by women (*Kannan, 1983 and Das, 1985*). *Tripathiet. al., (2009)*, conducted study in five villages of Orissa and concluded that the role of women was less than men in large orchards but the role of women in maintenance of fruit plants in homestead garden was much higher. In south India, 80% of farm women engaged in post-harvest and processing of fruits and vegetables (*Pandey and Pareek, 1990*). Rural women's participation in agro based activities is much more than what is statistics revealed. This is mainly due to the fact that most of the work done by women at farm and home is disguised as daily chores. Large number of unregistered, unsettled, and unpaid family workers who are women and girls supposedly witness that women's labour contribution to the rural economy is much larger than official records indicate. As a whole, women spend their labour in less lucrative, profitable or unpaid work and much of rural women's work is not included in official statistics.

Thus, increased participation of women in micro enterprises and labour force is a prerequisite for improving the position of women in society self-employed women. The entry of rural women particularly in micro enterprises is of primary importance to tackle various issues affecting their development. Food and Agriculture Organization of U.N. predicts that about 1.3 billion tons of food are globally wasted or lost per year. Food losses at the post-harvest stage are not only a threat to human consumption and returns to the farmers, but it can also harm the environment in various ways. Food loss is estimated to be equivalent to 6- 10 percent of human-generated greenhouse gas emissions. Thus, to sustainably achieve the goals of food security, food availability needs to be also increased through reductions in the post-harvest losses at farm, retail and consumer levels. Value adding opportunities that enhance the value of key commodities would also increase income generation for improving welfare and providing farmers with the financial resources for investment in resource enhancing technologies.

4.0 Policy framework for strengthening women's entrepreneurship in rural areas

4.1. Information, knowledge and trainings

Access to information, knowledge and training opportunities is a key factor to support productivity growth and the income of rural farmers. Acquiring entrepreneurial skills, agricultural techniques and market information, can be particularly beneficial to improving the quality of agricultural outputs by easing the dissemination of knowledge and creating new opportunities for technological change (Jost et al., 2015). Many observers, academics and practitioners, underscore that access to quality trainings of reasonable duration, to mentoring guidance and to social networks can yield significant gains in farming and business practices. Furthermore, sufficient opportunities for training and networking play a pivotal supporting role to the empowerment of women farmers and their entrepreneurial initiatives by allowing them to gain knowledge and skills in a range of technical (hard skills) and non-technical (soft skills) domains. These include the access to more productive agricultural techniques, best practices on agro-farming and sustainable businesses.

4.2. Gender-sensitive approaches to improve women's participation to training

The adoption of gender-sensitive approaches in the design of education and training programmes is a key pre-requirement to reach out to a broad and diverse pool of women

farmers potentially interested in attending them. Not only this means that programmes should be adapted to the skills and literacy levels of all clients. It also means that the structure should take into account the existence of certain day-to-day needs, such as women's time schedules, for example, and the need for assistance at home, to maintain the continuity of care responsibilities, of the children and the elderly, during the time spent in training. In order to increase the chances of a training programme to attract the interest of women farmers, it has to reflect their interests and preferences closely. Evidence suggests that women's participation is significantly higher when the training focusses on agricultural crops, tasks and techniques that women perceive as their prerogative. The support of flexible education and training programmes is also important. This can require a preliminary assessment of gender-specific time, for example. Flexible training courses such as short courses, part time courses, online courses, training videos, and weekend courses could represent the right response, so long as they open up the training to women who would not consider participation otherwise because of lack of time. At the same time, the availability of affordable and secure transportation modes also plays a critical role.

4.3. Networks, mentoring and role models

Networking and mentoring guidance are effective vehicles of dissemination through, for example, the creation of women farmer's associations and forums. They can facilitate knowledge sharing, raise awareness of best practices and role models, ease access to markets and farm inputs and support information about modern farming and marketing techniques among women farmers. Evidence suggests that the role of networking and mentoring is particularly important during the start-up phase of a new farm business. Access to knowledge and the possibility to learn from other women who have gone through similar experiences in the past, encourages judicious business choices capable of limiting the risks of repeating mistakes (Brody et al., 2015).

4.4. Supporting effective training and knowledge transfer

The interactions with peers can play a critical role in ensuring that the tools acquired during a training programme translate into action. Women who can attend the training with a friend generally report better outcomes than participants who attend alone. Perhaps because the absence of peer support increases the exposure to the influence of their male relatives, the latter frequently use their loans for other non-business activities, such as home repairs. The

positive effect of sharing the training with a peer on the quality of the loan seems stronger among women originating from groups where social norms are particularly restrictive (Field et al., 2016). This suggests that peer support mechanisms can be particularly effective to support women farmers in rural areas, where traditional norms are typically relatively more entrenched than in urban areas.

4.5. Social policies for reducing the time spent on unpaid work

Men and women do not split paid and unpaid work equally. Women usually are less likely to work, and to work full-time hours, for pay. Instead, they typically spend more hours looking after children and elderly relatives, doing housework, shopping for food, and so on. This reflects stronger discriminatory social norms and traditional gender roles. Additionally, in rural areas existing gaps in infrastructure compound the observed general pattern, reflecting more demanding care responsibilities in the absence of support facilities and labour-saving technologies such as devices to process food or fuel-saving stoves. As a result, women must spend additional time travelling to purchase necessities, or to collect safe water and fuel. Where the electricity network is weak, the actual number of travels increases even further, reflecting limited storage capacities. Overall, women in rural areas spend more time in unpaid care domestic and domestic work in the comparison with both men and women in urban areas.

4.6. Childcare centres

Reducing the burden of unpaid care work on women from rural villages requires the concurrent implementation of affordable day care centres. Evidence showed that there is a positive relation between expanding the access to formal childcare arrangements and the growth of women's labour force participation. Access to public early childcare (preschool) facilities also plays a positive role. In addition non-formal and community-based approaches can be an option to reach these services out to the rural areas, where formal childcare and pre-schooling services are scarce.

4.7. The co-ordination of care services for the elderly

Care for older parents falls under the legal responsibility of their progenies or/and the family with women acting as main caregivers of their olds. This extraburden on women represents an important challenge in perspective, given that population is already ageing

rapidly in rural areas. Governments can play an active role in the creation of an accessible and affordable system of care services and support programmes for the elderly. The government may organise regular trainings to enhance the capabilities and competencies of professional care providers of older persons. These include counselling on dementia, on one-on-one case management and welfare services targeting doctors, medical officers, social workers and pension officers

4.8. Social protection programmes

Although social protection policies and programmes aim to reduce and prevent poverty and vulnerability throughout the life cycle, evidence suggests that globally, social protection coverage is lower for women than for men. These policies and programmes can take diverse forms, including cash transfers (e.g. childcare grants), public works (e.g. employment guarantee programmes), social security and social protection floors, and income security for children and their families. They also involve family policies, including the regulations governing paid maternity, paternity and parental leave. These provisions and policies influence women's decisions with regard to the split of their time between paid and unpaid work activities, ultimately affecting their participation in the labour market.

4.9. Health and social insurance

Affordable health care is particularly important for women because they have less access to personal income, face costly health conditions such as pregnancy and childbirth, and are often responsible for the health care of family members. A number of health and social insurance programmes have shown progress in covering event over the life cycle events that put women in a more vulnerable position. These include health insurance programmes that specifically include family planning; cover pregnant women and/or childbirth and/or waive the premiums for pregnant women; and offer maternity insurance. There are also pension programmes that amend the calculation of pension benefits, which leads to women benefiting even when they live longer on average. Over the past two decades, several countries have started to roll out universal health coverage reforms, using a variety of approaches and funding sources to enhance affordability for the poor and workers in the informal economy.

4.10. Tackling traditional gender roles and social norms

By perpetuating the disproportionate balance of paid and unpaid work between men and women, gender stereotypes and gendered norms limit access of women to productive resources, opportunities and markets. These dynamics exacerbate, in turn, unequal power relations, ultimately reinforcing patriarchal attitudes. In many countries, strong patriarchal social norms continue to play an important part in shaping gender roles, with men, especially from rural areas, often reporting a fear that performing ‘women’s chores’ will result in social stigma. Changing deep-rooted social norms requires combining legislative and policy incentives, on the one hand, with, on the other hand, public awareness raising campaigns, supported by the media, and community dialogue. For instance, TV programmes could show how women can become successful farmers or agribusiness owners. By conveying positive messages about women’s experiences with farming and their achievements, they could help challenging the presumption that these activities are a prerogative of men.

4.11. Voice and representation

One concern that common in women is the lack of voice and representation in decision-making processes. This situation not only raises a broader issue of rights, but also, and more specifically, affects the capacity of women to orient policy choices towards their needs. Women farmers and men farmers do not always have the same views. Priorities as to training needs and infrastructure facilities may differ, reflecting the fact that women and men farmers often specialise in different stages of a crop production, when not different crops altogether. Sometimes, they also have different preferences as to the inputs and services to enhance their agricultural production. There is evidence suggesting that the availability of agricultural and infrastructure policies more responsive to gender needs can enhance farmers’ productivity.

4.12. Promoting women farmer associations

Farmer associations and women’s group are essential institutions for supporting empowerment, poverty alleviation and well-being of women farmers. The role that they play in agricultural decision-making ensures that the needs of women farmers and their views are heard by policy makers and the general public (Akter et al., 2017). For farmer associations with both women and men members, it is important that women farmers have equal access to the services provided and can influence the decision-making, for example with regard to knowledge and training opportunities provided by the associations. Establishing gender

quotas could be a useful means to engage women in all activities and ensure that they influence decisions. Quotas can help support the establishment of a critical mass of women, both as members and leaders within the associations. Gender quotas, could successfully increase women's participation to farmer's forums or farmer's association.

4.13.Unlocking entrepreneurships

Although women make a significant contribution to agriculture and their participation as self-employed is important, there is still a way to go before their role meets full acceptance as entrepreneurs. This reflects various forms of discrimination, which entails substantial social and economic costs, including by undermining the potential for women farmers to engage in new and more innovative entrepreneurial activities. Discrimination can be the outcome of entrenched stereotypes and cultural biases. For example, many women find that the marketing of their products is penalised by the fact their business partners and customers often prefer to engage with men. In addition, a research suggests that the lending officers of banks often have different attitudes towards female and male borrowers, which implies that they can be less willing to provide women with the financial services that they need. In India, even when the land is registered jointly under both names of the husband and the wife, the woman often has no control over the use of the land.

4.14. Addressing gender stereotypes and discrimination

One approach to tackle gender stereotypes and discrimination is by integrating elements of gender de-biasing into training. For example, the focus of trainings programmes could be expanded to raise awareness about the importance of equal treatment of men and women farmers as economic actors, including with regards to the rights on the property of land and the mechanisms and tools to safeguard them (FAO, 2011). Such awareness raising trainings should involve both men and women and at all levels of organisational responsibility, in order to ensure that they lead men and women entrepreneurs to work as business partners. For example, some financial institutions use de-biasing training materials to prove that female clients are as creditworthy as male.

5.0 Entrepreneurship through value addition

Value addition is a process that elevates a production into a product. Value addition is the enhancement added to a product or service by a company before the product is offered to the

customers. It is a business strategy for creating new market demands or indulging renewed demand from the set of conventional customers. A value added horticultural product can ignore the risk of seasonality in crop availability and market vagaries. There are three ways in which value addition to farm produce is possible:

- The primary level involves cleaning, grading and packaging of fruits, vegetables and other horticultural crops
- The secondary level includes basic processing, packaging and branding, e.g. packed item
- The tertiary level includes high-end processing which requires supply chain management, processing technology, packaging of processed foods, branding and marketing.

Fruits and vegetables are highly perishable commodities due to high moisture content and higher metabolic activities. Spoilage to fruits and vegetables mainly occur due to microbial attack, auto-oxidation and insect pest attack. As a result, about 25 to 30% of the production is lost after harvest. The role of post-harvest management is important for reduction of post-harvest losses of fruits and vegetables and to make them available for longer period in the market.

5.1 Entrepreneurship through fruit processing

Fruits are rich source of several vitamins and minerals. Mango, papayas are rich in vitamin A. Cashew nut and walnut are rich in vitamin-B1. Bael, papaya, litchi are rich in vitaminB2 and Barbados cherry, aonla, guava are rich source of vitamin-C. Some fruits are also rich in some minerals like litchi is rich in calcium (Ca) and dry karonda is rich in iron (Fe). Fruits and vegetables are perishables and seasonal. Unless excess production is processed and preserved, it will be wasted. In India only 2.2 % of the total fruits vegetables produced are processed in the 3000 food industries and wastage is estimated to be very high.

Table: 1 Value added products of some fruits in India

Crops	Existing products	New products
Apple	Juice, jam, jelly, cider, wine, pulp	Osmotically dried rings,canned apple, vinegar, Carbonated juice, apple seed for nurseries, pectin.

Apricot	Pulp, squash, Ready to Serve (RTS), jam, appetizer, dried apricot.	Osmotically dried apricot, oil, apricot oil-based cream, etc.
Mango	Pulp, RTS, squash, powder (amchur), slices in brine, pickle	Pulp/juice from in situ mangoes, pectin from just-ripe fruits
Pine apple	Pulp, RTS, squash, powder (amchur), slices in brine, pickle	Pine apple ring, bromolein from stem, concentrated frozen juices, marmalade, vandy, toffee
Banana	juice, ripe banana powder, banana fig	value addition of banana peel
Orange	Pulp, RTS, squash, nectare	Canned frozen pulp, Oil extraction from peel, carbonated beverages
Litchi	Juice, squash,	nectar/RTS Carbonated drink
Peach	Canned peach, pulp, jam/chutney	Wine, kernel oil
Pear	Canned pear, pulp, jam	Apple pear blend, sand pear candy

5.2 Entrepreneurship through vegetables processing

Vegetables are rich and cheaper source of carbohydrate, protein, fat, vitamins and minerals. Storage roots and tubers like potato, colocasia, yam, tapioca, elephant foot yam etc. are rich source of carbohydrate. The leguminous vegetables like pea, cowpea, French bean, lablab bean, cluster bean etc. are rich in protein and supply as high as 14% digestible protein. Major minerals obtained from the leafy vegetables are calcium (Ca), Iron(Fe) and phosphorus(P) and some of the leafy vegetables are rich in micronutrients like copper, manganese and zinc. Carrot, pumpkin, sweet potato, colocasia are rich in vitamin A. Vitamin B is present in appreciable amount in pea, beans, garlic, tomato, colocasia, asparagus etc. Vitamin C rich vegetables are cauliflower, cabbage, knolkhol, turnip, tomato, pepper, drumstick leaves, fenugreek leaves, amaranth etc. Most leafy vegetables are rich in carotene, riboflavin (vitamin B2) and minerals. Every year large amount of fresh vegetables is lost due

to seasonality and perishability and lack of attention in value addition. The wastage of vegetables can be reduced by producing different value added products of vegetables.

Table 2 Value added products of some vegetables

Crops	Value Added Products
Potato	Fried chips (chips), French fries, frozen products (potato patties, potato puffs, potato cakes, defrozen products, packed frozen dishes), dehydrated products (like potato flour, granules and flacks), wine, canned potatoes, etc.
Tomato	Tomato paste, ketchup, paste, chutney, sauce, tomato chilli sauce, tomato seed oil, canned tomato (in the form of fresh tomato, tomato juices, tomato-vegetable juice blend, tomato sauce and tomato ketchup) tomatine alkaloid, soup powder, etc.
Cabbage	Package dry leaves, Sauerkraut.
Cauliflower	Dried cauliflower, frozen cauliflower, cauliflower pickle, etc.
Carrot	Carrot shred, frozen carrot, carrot powder, soup powder.
Pea	Dehydrated peas, frozen pea, pickle, soft drinks, etc.
Cassava	Fried chips, hot fries, crisps, nutrichips
Amaranth	Package dry leaves, Dry powder

5.3 Entrepreneurship through spices processing

India is traditionally known as the spice bowl of the world. According to the Bureau of Indian Standards, about 63 spices are widely grown in our country of which 15 spices are grown commercially in India. India is the largest producer, consumer and exporter of spices in the world with a 46 % share by volume and 23 % share by value, in the world market. Different value added products of spices available in India are spice oils and oleoresin, dehydrated pepper, freeze-dried green pepper, ginger candy, ginger beer/in brine/squash, ginger flakes, garlic pickle and paste, chilli powder, paste, oleoresin, etc. Processing of spices offers considerable business opportunities, despite the presence of several organized and unorganized firms involved in spice processing. Small scale utilization of spices through women in rural areas offers higher price realization than selling afresh.

5.4 Entrepreneurship through minor millets processing

Millets are nutri cereals comprising of Sorghum, Pearl millet, Finger millet (major millets) Foxtail, little, Kodo, Proso and Barnyard millet (minor millets). These are one of the oldest foods known to humanity. They are highly nutritious, nonglutinous and not acid forming foods. Hence they are soothing and easy to digest. Promotion of Nutri cereal for consumption among the people is need the hour and India have more than 20000 ha area of fallow land Scope for research is more in production of fortified foods by using nutri cereal. This is one of the promising means for achieving the goal of doubling the farmers income. Significant Achievements made under ICAR-IIMR, Hyderabad for the popularization of millet based processed products.

5.5 Entrepreneurship through underutilized food crops

In India, underutilized crops make significant contributions to the human and animal food web and are often a means of survival for millions of poor rural households. Uses of non-cultivated foods, of which wild fruits form a part, as a diet supplement, or as a coping mechanism in times of food shortage, provides an important safety net for the rural poor. Minor crops crops such as Bael (*Aeglemarmelos*), Jack fruit (*Artocarpusspp*), Custard apple (*Annonasquamosa*), Wood apple (*Feronialimonia*), Jamun (*Syzygiumcumini*), Aonla(*Emblicaofficinalis*), Star fruit (*Averrhoacarambola*) and Malabar Ebony (Kendu) (*Diospyrosmelanoxylon*) etc grown throughout the state spanning over northern to southernedodisha. Tribals use these plant resources regularly as foods and to cure different ailments. So, there is an urgent need to scientifically study above crops and to develop value added products enhancing the shelf life by which it can be properly utilized in rural level at large. There is now greater recognition that products from the wild may support household subsistence and also that income may be generated from their sale, either in raw or processed forms. This recognition has prompted investigation of the diversity of species that are used and their relation to the socio-economic status of those who use them. Wild fruits contribute to diet diversity and flavour as well as providing essential micronutrients in an otherwise bland and nutritionally poor diet. The majority of households stated that fruit consumption was sporadic, and except for the four or five most prized fruits or seed, most are collected as a result of chance encounter by people in the forests for other purposes.

On account of low returns from agriculture and lack of other economic opportunities, households engage idle family members, mostly women, in the extraction of natural products

from wild fruits for sustenance. Sale of wild fruits in tribal eastern India takes place on a small scale and supports livelihoods by way of income diversification. A strategy to promote commercial production in order to boost the local economy would depend not only on increasing the volume of production, but with initiating processing and value addition for raw fruits—imperative for creating market niches for selected species. A database on availability of different species of wild fruiting species and their uses should be compiled to aid such developments of poor tribal areas.

Conclusion:

In agriculture sector primary focus is given to only one gender. Male is the dominant decision maker of this industry and benefit seeker of the policies. Also, the government has moulded an agricultural policy of India by integrating women as active agents in rural transformation. The voices of distressed women farmers can be easily heard in vast numbers, expressing, as TIME magazine quotes it “Who are we, if not farmers?” Therefore, on this International Women’s Day, it is important to acknowledge the ongoing phenomenon of feminisation of Indian agricultural workforce that has been in play since the past few decades. Since women are traditionally engaged in this sector, more women need to be trained about the new technologies and policies in the post harvest handling and processing of various horticultural crops to fulfill the growing needs of the sector in entrepreneurship mode. The expertise and the knowledge about the local market practices may be helpful and they can easily be partner in the larger chain of supply of these produces. A successful intervention for entrepreneurship among women necessitates several elements – an important one is imparting of new skills: the consequence of women assuming new roles is also support through training for enabling them to perform these roles. There are ample opportunities for the development of entrepreneurship in fruits, vegetables, cereals, pulses, spices and medicinal based products with adequate support from family, Govt and Banks etc. Many policies and programs supporting value added agriculture as a farm entrepreneurship and rural development strategy lack a framework recognizing the importance of consumers’ willingness to pay and farmers’ competitive advantages. So, effective economic development programs must be consistent with the goals of producers and consumers.

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Strengthening Farmwomen perspectives in Nutri Smart Village Development:

A Case Study at ICAR-CIWA

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Women play multiple roles in a family, primarily as mothers and housekeepers and also equally important roles as wage earners, agricultural producers and nutrition providers. They are instrumental in the acquisition of food, its preparation, storage and distribution. While malnutrition is prevalent among all segments of the population, poor nutrition among women begins at infancy and continues throughout their life time .Government of India has been making several efforts in developing health and population policies. However, there are several problems in the implementation of appropriate interventions due to poverty, gender discrimination, and illiteracy. The malnutrition is directly associated with lack of health awareness amongst women, illiteracy, low socio-economic status, poor housing conditions, early marriage, low income, poor sanitation, and stressful environment, use of narcotics, child bearing, overwork and to some extent lethargy. India's maternal mortality rates in rural areas are one among the world's highest.

Awareness on proper nutrition, nutritional value of food and healthy practices in food intake can build a difference in healthy society and nation as a whole. Deficiencies in nutritional practices may lead to unproductive life in farm women. Poor dietary practice is one of the biggest global contributing factors on recurrent disease. Human body derives strengthen and protection against disease through the intake of balance diet. In Indian farming, farm women immensely contribute in food production; however, nutritional status as well as nutritional knowledge of women were unsatisfactory and needs interventions (Upadhyay *et al.* 2011). Hence, the nutrition education about the importance of balanced diet, food groups and their functions and eat right according to body requirements and working status (Jyoshna *et al.* 2017) need to be cater among to the farm women through different media as associated with farm technology dissemination (Panda, 2014). Farm women extent of knowledge in relation to nutrition was low, however, it could be improves through nutrition training programme (Kumar *et al.* 2016). Farm women performed agricultural activities and household activities however, their dietary, nutritional and energy intake was lower (Singh *et al.* 2012).

Nutrition Smart Village Initiative:

On November 10, 2021, Mr Narendra Singh Tomar (Union Agricultural Minister) flagged the smart village initiative under the PoshanAbhiyan. The primary motive of this initiative was to create awareness about the importance of nutrition among the people living in remote areas of India. Children and women were taken into main consideration under this scheme because their number is the highest among the malnourished in the country. Also, women working on farms were prone to the risk of malnourishment thus under this scheme, they were taught some traditional recipes with high nutrition value.

In the initial phase, the *government focused on transforming 75 villages in India and decided to add new villages soon to the list.* The government also tried to promote the local farmers to adopt Nutri farming via this scheme. Nutri farming simply refers to farming that involves the cultivation of a variety of nutrition-rich crops.

How does the Nutrition Smart Village initiative work?

The GOI is trying to achieve the development of a nutrition smart village by dividing the villages under certain government authorities. Like the GOI has appointed the All India Coordinated Research Project (AICRP) and the Indian Council of Agricultural Research (ICAR) to promote this initiative in the designated 75 villages in India. 13 centers across the 12 states of India were allocated to AICRP and each center has to adopt 5 villages and ICAR-CIWA adopted 10 villages in the state of Odisha. The transformations of these dedicated 75 villages are being done by the leading agricultural scientists and science laureates. With the help of advanced technology and the latest innovation in the agricultural industry, the GOI is trying to transform these villages' nutrition smart and future-ready.

These authorities are creating awareness about nutrition among Indian villagers in the below ways.

- **Nutrition camps:** Nutrition camps are being organized in the village by the AICRP to educate the people living in there about the importance of nutrition. The officials teach the women how to prepare a nutrition-rich diet.
- **Food Packets:** Under the nutrition smart village initiative nutrient-rich food packets are being distributed among the people. So that they can get all nutrients packed in one packet.

- **Promoting Nutri-farming:** Under this initiative, the government is promoting Nutri farming so that it allows farmers to feed that same nutrient-rich food to their families and to the nation.

Need for Nutrition Smart Village Initiative:

There is a great need for a nutrition smart village initiative in India as India has one of the highest malnutrition rates in the world. A majority of the rural population of the nation is suffering from malnutrition and almost 44% of children below the age of 5 are underweight. This creates a need for a nutrition smart village initiative in India. Malnutrition among children is one of the main reasons for many diseases and anemia in women.

- Under this initiative, many villages are transforming and it has been observed that the malnutrition rates in these dedicated villages is been significantly decreasing.
- With recent advancements in technology, the cities of India are getting smart but this technology is getting into villages much more efficiently.
- Indian villages need to be smart as the internet connection is now reaching every village and thus with the help of the internet and the latest technology, the Indian villages can get smarter and more productive.
- A majority of the population living in Indian villages is engaged in farming thus if these villages become smart and adopt new technology then the total agricultural production of the country can increase significantly.
- The agricultural sector of India contributes more than 19% of the total GDP of the nation thus if this sector gets efficient with smart villages then the economy of the country will significantly get better.

Efforts of ICAR-CIWA in tackling the malnutrition

In strengthening the POSHAN Abhiyan, the All India Coordinated Research Project on Women in Agriculture (AICRP-WIA) can play a crucial role by promoting good health through proper nutrition, adoption of drudgery reduction tools, psychological counseling, proper parenting and income generation through utilization of conventional agricultural resources in production of diversified value added products. To commemorate with the 75th Independence of India a programme on “**Nutrition Smart Village**” will be initiated to strengthen the PoshanAbhiyan. This new initiative aims to reach out 75 villages across India

through the network of AICRP on Women in Agriculture which is in operation at 13 centres in 12 States of India besides the coordinating institute located at Bhubaneswar.

Objectives:

- Promoting nutritional awareness, education and behavioural change in rural area involving farm women and school children
- Harnessing traditional knowledge through local recipe to overcome malnutrition
- Implementing nutrition sensitive agriculture through homestead agriculture and nutri-garden

Methodology:

Intensive awareness campaign and field activities should be undertaken for focusing on the concept of nutri-village / nutri-food / nutri-diet/ nutri-thali etc. for strengthening the *PoshanAbhiyan*. Awareness among the women farmers should also be created about their legal rights in all walks of life. The products / tools / technologies developed by AICRP centres should be evaluated through multi-location trials.

1. Assessment of Nutritional status of farm families in selected villages:

Base line survey and nutritional status of farm families will be assessed in five villages using standardized tools and techniques.

2. Establishing nutri-gardens in villages and schools:

Nutri-gardens will be initiated in villages and schools by involving farm women, SHGs, School children and teachers, through standard nutri-garden models to achieve food and nutritional security at household and community level.

3. Promoting mixed cropping systems / crop diversification / IFS incorporating minor millets :

In selected villages mixed cropping system or IFS models will be encouraged through family farming approach to achieve food and nutritional security and to address nutritional problems, especially micronutrient deficiency.

4. Nutritional awareness and education through ICT :

Based on nutritional survey in selected villages, nutritional literacy programmes will be organized through capacity building / skill based training / ICTs and the impact will be assessed on nutritional literacy of farm families.

A Case Study at ICAR-CIWA in Nutri Smart Village Development

ICAR-CIWA under the project “ Development of Nutri Smart Villages for food security and Dietary diversity for Combating Malnutrition adopted 10 villages of Odisha, covering four districts i.e Puri, Khorda, Cuttack, Jagatsinghpur. From each village 30 households are randomly selected, the total numbers of households are 300.

Methodology

- Questionnaire developed
- Identification of Locale
- Need assessment
- Constraint Identification
- Knowledge Practice Attitude (KPA)
- Impact Study
- Report Writing

Interventions in nutri-smart village

The interventions were planned such that the nutritional needs of the target families are met round the year.

Nutri-gardens:

Nutri-gardens/kitchen gardens were established in the village by providing vegetable seeds like to the women in the month of March 2022. Perennial plants like papaya, Mango, Lemon were also given to the families to ensure the supply of micro nutrients to their family. They were provided a crop calendar for growing the vegetables. Necessary tools and equipments like were also provided to the families. The women participated in the Poshanmela organized on 22nd April by ICAR-CIWA and exhibited the produce from their farm and different nutritional recipes prepared out of them

Backyard poultry farming

In order to ensure supply of meat and eggs to rural families, one day old chicks of RIR and Vanraja Chicks were procured from CPDO, Bhubaneswar and distributed to the beneficiaries on 30th March 2022. Each beneficiary received 20 chicks each. They were also provided with the critical inputs like poultry feed, vaccines for Lasota and IBD, feeders and waterers. The farmers were also made aware of the management practices that should be followed for backyard poultry production. (Madam if we can add the approximate number of eggs they can get from chicken it will be good)

Homestead Aquaculture

The village is blessed with ample water resources in the form of large number of homestead ponds. Fish is rich in easily digestible protein, essential amino acids and fatty acids. It is also a rich source of minerals and vitamins. On an average the pond size was 0.1 ha. Hence the beneficiaries were facilitated with 1000 nos of fingerlings each to stock their ponds. One Front Line Demonstration on Composite fish farming was also organized on 23rd February. They were also provided with critical inputs like feed, lime and mineral mixture. They were also advised to stock their ponds with small indigenous fishes which are rich sources of Iron and Vitamin A from the wild so that the availability of fish to the rural family will increase. The small indigenous fishes are auto breeders and hence will be self replenished in ponds periodically. It is also possible to harvest these fishes in an interval of 2 weeks to one month.

Mushroom farming

Mushrooms are an excellent source of protein and Vitamins especially Vitamin D. The climate of Odisha is best suited for the production of paddy straw mushrooms and the base material for mushroom beds. i.e, paddy straw is abundantly available in villages of Odisha. To tap these resources and to ensure the availability high quality protein and micro nutrients, the farming of mushroom is being popularized in the nutria-smart villages. The women were given mushroom spawn and the polythene for making the mushroom beds. They could yield around 1.5 kg/bed /cycle of mushroom production. On an average each family could raise 10 beds of paddy mushroom in one cycle.

The 5 Essential Nutrition Interventions for Mothers include:

1. Improving the quantity and nutrient level of food consumed in the household

This primarily includes improving access to generalized household food ration through public distribution system. Also providing access to supplementary foods under the integrated child development services scheme. To impart knowledge to improve the local diet, production and household behaviors through nutrition and health education.

2. Preventing micronutrient deficiencies and anemia

This through providing the Iron Folic Acid Supplementation de-worming, Pre and peri-conceptual folic acid supplementation, Universal access to iodized salt, Malaria prevention and treatment in malaria-endemic areas, Access to knowledge and support to stop use of tobacco products during pregnancy, Maternal calcium supplementation, Maternal vitamin A supplementation.

3. Increasing women's access to basic nutrition and health services

By providing early registration of pregnancy and quality of antenatal checkup, with emphasis on pregnancy weight gain monitoring, screening and special care of at-risk mothers.

5. Improving access to water and sanitation education and facilities.

By providing sanitation and hygiene education, including menstrual hygiene.

6. Empowering women to prevent pregnancies too early, too often and too close together

By ensuring marriage at/after legal age of 18 through awareness and ensuring a girl completes secondary education. Also preventing maternal depletion by delaying first pregnancy and repeated pregnancies through family planning, reproductive health information, incentives and services. Also promoting community support system for women, skill development, and economic empowerment as part of maternity entitlement. Providing community support system for women to support decision making, confidence building, skill development and economic empowerment.

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
4. Minimum Support Price (MSP)
5. The role of women in agriculture
6. Efficient information dissemination
7. Linking farmers and farming households to institutional feeding programmes
8. Promote local agri-food value chains for nutrition.
9. Nutrition gardens of nutrient dense vegetables and fruits
10. Homestead production of animal source foods
11. Social and behavioural change
12. Nutrition sensitive agriculture
13. Farm Mechanization

Conclusion

‘Nutrition Smart Village’ (NSV) concept is based on the multi-sector approach to primarily address the underlying causes of malnutrition and create awareness about the rights

and entitlements of the community. The interventions addressing the underlying causes are the ‘nutrition sensitive’ interventions. The underlying causes are the effect of the social and economic milieu of the country. These are referred to as the basic causes and include quality of human resource, the way economic and social resources are used and the political will of the government. The basic causes can be addressed by ‘building an enabling environment’. Sustainable reduction of long-term chronic malnutrition can be made possible by addressing the majorly the underlying and basic causes.

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Integrated Soil Nutrient and Crop Management in Nutrition Sensitive Agriculture (NSA)

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1.0 Introduction:

Healthy soil is the foundation for profitable, productive, and environmentally sound agricultural systems. By understanding how the soil processes that support plant growth and regulate environmental quality are affected by management practices, it is possible to design a crop and soil management system that improves and maintains soil health over time. India is a seventh largest and second populous country in the world. On an average 70% of its population dwell in rural area. All are dependent on agriculture as their main occupation. Agriculture gives employment to about 60% of the population and contributes 18.1% to GDP. In this agrarian country, before “Green Revolution”, the total food production of the country was very less to feed the existing population and there was outcome of famines like “The Great Bengal famine”. During Independence (1947) the population was only 50 million. But for food grains it has to depend on US. In the year 1960 due to some political misunderstanding US denied to supply food grains to India and it suffered a lot. But gradually due to the introduction of high yielding varieties, chemical fertilizer and pesticides application during Green Revolution period, there was a steep increase in food production. India could produce 257, 273.38 and 275 million tones of food grains in the years 2014-15, 2016-17 & 2018 respectively. India become not only self sufficient in food grain but also a importer of food grains and became the biggest exporter of rice though the population increased to about 132 core. But again the population is bulging day by day. Hence there is a need of producing around 300 million tons of food grains by 2022. On the contrary due to the injudicious application of chemical fertilizer and rampant use of inorganic pesticides the soil fertility is coming down day by day. Most of the farmers used to give importance to the use of chemical fertilizer specially the major nutrient (N, P, K) and that too in an unbalanced way. The use of micro-nutrients and balanced use of fertilizer is very much neglected. This paved the way to decrease in fertilizer use efficiency (FUE). The indiscriminate use of pesticides added mystery to the scenario, with the loss of biological health of the soil. In this way the physical, chemical and biological health of soil in many areas comes down to a great extent. Ultimately the productivity of food grain, fertilizer use efficiency and Water Use Efficiency is affected. This may again lead to big disasters in near

future. The only way to overcome this is maintaining soil health and fertility in a sustainable manner.

2.0 Better the health of soil, better the health of the nation.

Before Green Revolution no deficiency of micro nutrients was observed in Indian soils but the present soil status shows 49% soils are deficient in Zn, 33% in B, 12% in Fe, 5% in Mn, 3% in Cu and 11% in Mo. And the holistic development soil health is possible only through inclusion of organic ways.

Zn	B	Fe	Mn	Cu	Mo
Maharashtra 86%	WB 68%	Karnataka 35%	Meghalaya 23%	TN 6%	Haryana 20%
Karnataka 72%	Bihar 38%	HP 27%	Assam 20%	Karnataka 5%	MP 18%
Haryana 60%	Karnataka 32%	Maharashtra 24%	Karnataka 17%	Gujarat 4%	Gujarat 10%
TN 58%	UP 24%	Haryana 20%	UP 13%	Bihar 3%	
Odisha 54%	MP 22%	TN 17%	Punjab 35%	Haryana 2%	
Bihar 54%	TN 21%	Punjab 4%			
UP 45%	Punjab 3%	Bihar 6%			
All India 49%	All India 33%	All India 12%	All India 49%	All India 49%	All India 49%

3.0 Different components for this holistic development are-

- Recycling of crop residues.
- Use of organic manure and compost.
- Use of vermicompost.
- Cover crop to decrease soil erosion
- Incorporation of green manuring crops into soil.
- Crop rotation and mixed cropping.
- Use of bio fertilizer.
- Use of soil amendments
- Use of bio pesticides and decrease the use of indiscriminate use of pesticides
- Fertigation through drip.
- Use of balanced dose of major nutrients.
- Use of micro nutrient as per soil test report.

Introduction

Assessing the health of soil resources has been stimulated by increasing awareness that it is an important component of the earth's biosphere, functioning not only in the production of food and fiber but also in ecosystems services and the maintenance of local, regional, and global ecological balance (Glanz, 1995). Soil quality primarily describes the combination of chemical, physical, and biological characteristics that enables soils to perform a wide range of ecological functions (Karlen *et al.*, 1997). The functions largely include, sustaining biological activity and diversity; regulating and partitioning water and solute flow; filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic toxic materials; storing and cycling nutrients in soil-plant-atmospheric continuum and providing support of socio-economic treasures. Another way we can tell the quality of a soil is an assessment of how it performs all of its functions now and how those functions are being persuaded in future.

Indiscriminate use of chemical fertilizers and pesticides in intensive agriculture resulted in several harmful effects on soil, water and air quality. This has reduced the productivity of the soil by deteriorating soil fertility and biological activity. However enhancement and maintenance of soil quality is essential for sustainable agriculture. Further, unscientific use of pesticides has led to the entry of harmful compounds into food chain, death of natural enemies and development of resurgence/resistance to pesticides. It is believed that organic farming can solve many of these problems as this system maintain soil productivity and pest control by maintaining natural processes in harmony with environment. Organic farming is defined as a production system which largely excludes or avoids the use of fertilizers, pesticides, growth regulators, etc. and relies mainly on natural organic sources to maintain soil quality, supply plant nutrients and minimize the infestation of insects, weeds and other pests.

2.0 Soil Health/Quality

Soil quality has been defined by scientists as the “fitness for use” (Pierce and Larson, 1993), and by others as the as the “capacity of a soil to function” (Doran and Parkin, 1994). “The capacity of a soil to function within boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health”, was the definition of

soil quality put forth by Doran and Parkin (1994). Lal and Stewart (1995) described soil quality as the inherent attribute of soil and to characteristics and processes that determined the soil's capacity to produce economic goods and services and regulate the environment. The soil quality definition given by Karlen *et al.* (1997) mentioned as, "The capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation". It can be conceptualized as an integration of three major components - sustained biological productivity, environmental quality and plant and animal health.

3.0 Importance of Soil Quality and its Assessment

Soil quality is important for two reasons. First, unscientific use of soil can damage itself and the ecosystem; therefore we need to match the management of land to the soil's capability. Second, we need to establish a baseline understanding about soil quality so that we can recognize changes as they occur. Therefore, the ultimate purpose of assessing soil quality is to protect and improve long-term agricultural productivity, water quality, and habitats of all organisms including human being. In recent years, soil quality research has focused on the linkages among the following: management practices and systems; observable soil characteristics; and soil processes and performance of soil functions. Choosing the appropriate soil attributes to include in an index must include consideration of soil function and management goals that are site specific and user-oriented and must focus on sustainability rather than just crop yields. These indices would be useful in ascertaining the fragility of soil and for understanding how improved management might strengthen its resilience (Chaudhury *et al.*, 2005). The testing of soil for routine analysis can only provide a snap shot on soil fertility which is not able to identify the production constraints because of deterioration of other soil properties. Therefore, assessing soil quality is advantageous for its holistic way to judge the management-induced changes. This capacity of the soil to function can be assessed by physical, chemical, and/or biological properties, which is termed as soil quality indicators (Wander and Bollero, 1999). Individual soil properties/processes may not provide an adequate measure of soil quality and integrated soil quality indicators based on a combination of soil properties can better reflect the status of soil quality than individual parameters. Soil quality changes with time can indicate whether the soil condition is sustainable or not (Arshad and Martin, 2002; Doran, 2002). Soil quality cannot be measured directly however; it can be inferred by measuring soil physiochemical and biological

properties that serve as quality indicator (Brejda *et al.*, 2000, Diack and Stott, 2001). Therefore an integrated ‘soil quality index’ based on the weighted contribution of individual soil property to maintain the soil quality may serve better indicator of soil quality for different land uses.

3.1 Soil quality indicators

Soils have chemical, biological, and physical properties/ processes that interact in a complex way to give a soil its quality (Karlen *et al.*, 1997). Thus, soil quality cannot be measured directly, but must be inferred from measuring changes in its attributes or attributes of the ecosystem, referred to as indicators. Indicators are measurable properties soil. The type of indicator chosen to evaluate soil quality depends on the soil function and the size of the area (i.e. field, farm, watershed, or region etc.) in which the evaluation is made. Considering basic soil functions i.e., provision of sufficient amounts of water, and nutrients, provision of resistance and resilience to physical degradation, and sustaining plant growth under an appropriate utilization, numerous soil analyses might be required to fully characterize the soil/plant system. Thus, broad soil quality indicators could be grouped, *viz.*,

- (i) soil chemical quality and soil fertility indicators,
- (ii) soil physical quality indicators and
- (iii) soil biological quality indicators (Table 1).

3.2 Soil Quality Index

Four major tools have been used for soil quality assessment *viz.*, Soil Conditioning Index (SCI), Soil Management Assessment Framework (SMAF), the Agroecosystem Performance Assessment Tool (AEPAT) and the New Cornell “Soil Health Assessment”. Out of these, SMAF was developed as malleable tools for assessing soil response to management and is most widely used for the assessment of soil quality. The SMAF is an additive, non-linear indexing tool for assessing soil function (Andrews *et al.* 2004). The SMAF is intended for use by land managers and their advisors for use in assessing ongoing management practices. In determination of soil quality index (SQI) using SMAF, four main steps are followed (Fig. 1):

- (i) Formulation of appropriate goals for desired outcomes of soil functions,
- (ii) Selection of a minimum data set (MDS) of indicators that best represent soil function,
- (iii) Scoring the MDS indicators based on their performance of soil function and
- (iv) Integration of the indicator scores into a comparative SQI (Nayak *et al.*, 2016).

Table 1. Soil quality indicators at different levels of soil management and planning

Physical indicators	Chemical indicators	Biological indicators
Field, Farm or Watershed indicators		
Passage of air	Base saturation percentage	Soil Organic carbon
Structural stability	Cation exchange capacity	Microbial biomass carbon
Bulk density	Contaminant availability	C and N/Oxidizable carbon
Clay mineralogy	Contaminant concentration	Total biomass
Colour	Contaminant mobility	Bacterial
Consistence (dry, moist, wet)	Contaminant presence	Fungal
Depth of root limiting layer	Electrical conductivity	Potentially mineralizable N
Hydraulic conductivity	Exchangeable sodium percentage	Soil respiration
Oxygen diffusion rate	Nutrient cycling rates	Enzymes
Particle size distribution	pH	Dehydrogenase
Penetration resistance	Plant nutrient availability	Phosphatase
Pore conductivity	Plant nutrient content	Arlylsulfatase
Pore size distribution	Sodium adsorption ratio	Biomass C/total organic Respiration / biomass carbon/
Soil strength		Microbial community fingerprinting
Soil tilth		Substrate utilization
Structure type		Fatty acid analysis
Temperature		Nucleic acid analysis
Total porosity		
Water holding capacity		
Regional or National level		
Desertification	Organic matter trends	Productivity (yield stability)
Vegetative cover	Acidification	Taxonomic diversity at the group level
Water erosion	Salinisation	Species richness diversity
Wind erosion	Changes in water quality	Keystone species and ecosystem engineers
Siltation of rivers and lakes	Changes in air quality	Biomass, density and abundance
Sediment load in rivers		

Source: Singer and Ewing (2000); Nayak *et al.* (2016)

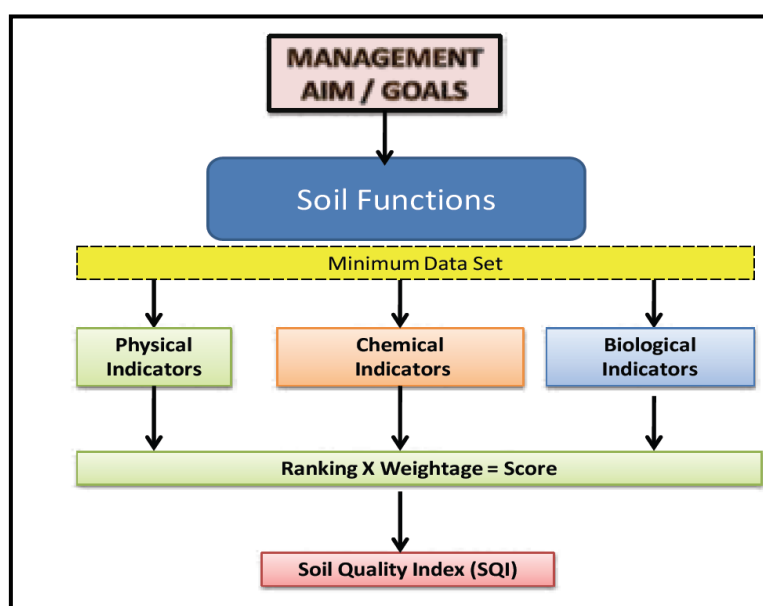


Figure 1. A generalized framework for developing soil quality indices

3.2.1 Formulation of appropriate goals for desired outcomes of soil functions

Soil quality indices and indicators should be selected according to the soil functions of interest and the defined management goals for the system. Management goals are often individualistic, primarily focused on on-farm effects, but can also be societal, including the broader environmental effects of farm management decisions such as soil erosion, agrochemical contamination of soil and water, or subsidy imbalance (from over-use of fossil fuels or agrochemicals). Management goals may also differ by the interests and visions of different sections of people concerned with agriculture.

3.2.2 Selection of a minimum data set (MDS) of indicators

Once the system's management goals are identified, the next step for soil quality indexing is to choosing appropriate indicators for a minimum data set (MDS). It would be unrealistic to use all ecosystems or soil attributes as indicators, so a minimum data set (MDS) consisting of attributes encompassing chemical, physical and biological soil properties are selected for soil quality assessment. Nearly all of the physical, chemical, and biological attributes that comprise a minimum data set have established meanings and published procedures that predate the soil quality concept. A minimum dataset for assessing soil quality should have the characteristics (Doran and Parkin, 1994) like, easy to measure, detect changes in soil function, integrate soil physical, chemical, and biological properties and processes, accessible to many users and applicable to field conditions, sensitive to variations in management and climate, encompass ecosystem processes and relate to processoriented modeling and where possible, be components of existing soil data bases. Minimum data set components can be selected based on expert opinion (Karlen *et al.*, 1996) and/or by using statistical methods. The physiological rhizosphere studies of Bachmann and Kinzel (1992) used principle component analysis (PCA), multiple correlation, factor analysis, cluster analysis and star plots to select characteristics for their diagnostic index. Bentham *et al.* (1992) used principal component analysis and other statistical clustering techniques to choose variables best representing the progress of soil restoration efforts. The principal component analysis generally relies less on any individual scientist making selections of goals, functions, and indicators. It uses a statistical technique to identify the indicators that best represent variability in a large existing data set. This technique affords less opportunity for disciplinary bias but does require a robust data set. Mechanistically, the data set must

have a sufficient number of observations and variables. Functionally, whatever is measured must have potential value as an indicator (i.e., some relationship to the critical soil functions). After the data are analyzed and mean comparisons are made, only those indicators showing statistically significant differences are included in the PCA. The data are then analyzed using PCA to prioritize and reduce the number of indicators or variables that need to be measured in subsequent samplings. PCs receiving high eigenvalues best represent variation in the systems (Shahid *et al.*, 2013). Therefore, only the PCs with eigenvalues ≥ 1 (Kaiser, 1960) are taken into consideration. Additionally, PCs that explain $\geq 5\%$ of the variability in the soils data (Wander and Bollero, 1999) could be included when fewer than three PCs had eigenvalues ≥ 1 . Under a particular PC, each variable is given a weight or factor loading that represents the contribution of that variable to the composition of the PC. Only the highly weighted variables were retained from each PC for the MDS (Table 2). Highly weighted factor loadings were defined as having absolute values within 10% of the highest factor loading or ≥ 0.70 (absolute value, Shahid *et al.*, 2013). When more than one factor was retained under a single PC, multivariate correlation coefficients were employed to determine if the variables could be considered redundant and, therefore, eliminated from the MDS (Andrews *et al.*, 2002). Highly correlated variables were considered redundant and only one was considered for the MDS. If the highly weighted factors were not correlated (assumed to be a correlation coefficient < 0.60) then each was considered important, and thus, retained in the MDS. Among well correlated variables, the variable with the highest factor loading (absolute value) was chosen for the MDS. The PCA loading value of the selected variables under the respective PCs is used to provide “weighting factors” for the indicators included in the soil quality indices (Andrews *et al.*, 2002). To check how well the MDS represented the management systems or goals, multiple regressions of both the EO selected and PCA-MDSs are performed using the indicators retained as independent variables and the end point measures (goals) as dependent variables. If any variable within the MDS did not contribute to the coefficient of determination from the multiple regressions, it was also ignored. After the MDS indicators were determined, results may be transformed using a linear or non-linear scoring method.

Table 2. Soil quality indicators and scoring functions

Indicator	Scoring curve	Lower threshold	Upper threshold	Lower baseline	Upper baseline	Optimum	Source of limits
Clay (%)	More is better	0	40	20	-	-	
Bulk density (Mg/m ³)	Less is better	1	2	1.5	-	-	Glover <i>et al.</i> , 2000;
Hydraulic conductivity (cm/h)	Optimum	0.2	2	0.6	1.5	1.6	Lal (1994)
Clay dispersion index	Less is better	0	36	18	-	-	
pH	Optimum	4.5	9	5.5	7.5	6.5	
Electrical conductivity (dS/m)	Less is better	2	12	6	-	-	
Organic carbon (g/kg)	More is better	0	12	6	-	-	Rao (1995)
Microbial biomass carbon (mg/kg)	More is better	0	400	200	-	-	Haynes (2005)
Carbon mineralization (mg/kg)	More is better	0	1200	600	-	-	Haynes (2005)
Total nitrogen (mg/kg)	More is better	0	1200	600	-	-	
Available nitrogen (kg/ha)	More is better	0	400	200	-	-	
Microbial biomass nitrogen (mg/kg)	More is better	0	60	30	-	-	Haynes (2005)
Nitrogen mineralization (mg/kg)	More is better	0	60	30	-	-	Haynes (2005)
Bray's phosphorus (kg/ha)	More is better	0	50	25	-	-	
Available potassium (kg/ha)	More is better	0	400	200	-	-	
DTPA Zinc (mg/kg)	More is better	0	1.5	0.75	-	-	
DTPA Copper (mg/kg)	More is better	0	5	2.5	-	-	
DTPA Iron (mg/kg)	More is better	0	50	25	-	-	
DTPA Manganese (mg/kg)	More is better	0	20	10	-	-	
Urease ($\mu\text{g NH}_4^+/\text{g/h}$)	More is better	0	200	100	-	-	
Dehydrogenase ($\mu\text{g TPF}/\text{g/h}$)	More is better	0	100	50	-	-	
Acid Phosphatase ($\mu\text{g PNP}/\text{g/h}$)	More is better	0	600	300	-	-	
Alkaline Phosphatase ($\mu\text{g PNP}/\text{g/h}$)	More is better	0	400	200	-	-	

Source: Shahid *et al.* (2013)

3.2.3 Scoring the MDS indicators based on their performance of soil function

After determining the variables for the MDS, every observation of each MDS indicator was transformed for inclusion in the SQI methods examined. Knowledge on the variations in soil quality indicators in similar type of soils under various distinct management systems is necessary to convert the raw data on soil parameters/soil quality indicators into unit less numerical scores. This will help us to set the limits or thresholds for the soil quality indicators (Table 2). Based on the range of each soil quality indicators and its measures and reported critical values, the limits/thresholds were fixed. As reported by Mastoet *al.* (2007), the success and usefulness of a soil quality index mainly depends on setting the appropriate critical limits for individual soil properties. The optimum/critical values of soil quality could be obtained from the soils of undisturbed ecosystems (Warkentin 1996; Arshad and Martin 2002), where soil functioning is at its maximum potential to or in best managed systems or on

critical values available in the literature. After finalizing the thresholds or limits the numerical score of each MDS variable is transformed using linear scoring or non-linear scoring functions.

3.2.4 Integration of the indicator scores into a comparative SQI

The last and final step will be integration of indicator scores into a comparative index of soil quality. Soil quality indicator values were normalized on a scale from 0 to 1. Two soil quality indexing methods are mostly used i.e.

- (i) Conceptual framework for analyzing soil quality and
- (ii) Principal component analysis based soil quality index.

3.2.4.1 Conceptual framework

The Conceptual Framework model has been used to determine soil quality as described by Karlen *et al.* (1992) as follows:

Soil quality index (SQI) P = $qnc(wt) + qpss(wt) + qwr(wt) + qrr(wt)$ (for productivity goal)

Soil quality index (SQI) EP = $qnc(wt) + qpss(wt) + qwr(wt) + qrr(wt) + qfb(wt) + qbdh(wt)$

(For Production (P), environmental protection (EP) goal)

Where, qnc is the rating for the soil's ability to nutrient cycling, $qpss$ to facilitate physical stability and support, qwr to water relations, qrr to resistance and resilience, qfb to filtering and buffering, $qbdh$ to sustain biodiversity and habitat and (wt) is a numerical weighting for each soil function. Weights for all soil functions sum to 1.00. An ideal soil would fulfil all the functions considered important and under the proposed framework will receive a SQI of 1.00. As a soil fails to meet the ideal criteria, the SQI would fall, with zero being the lowest rating. Associated with each soil function are soil quality indicators that influence, to varying degrees, that particular function. As with soil functions, numerical weights assigned to selected soil quality indicators must sum 1.00 at each level.

3.1 Recycling of crop residues:-

Crop residues are materials left in an agriculture field after the crop is harvested. During the life cycle the plants remove a lot of nutrients from the soil and utilize a part for their metabolic activities but still some nutrients are left in the residues. Most of the farmers either burn the residues or left unused. But these residues of crop should be incorporated in

situ into the soil so that after decomposing they add a lot of organic carbon and also a good amount of nutrients to the soil.

3.2 Organic manure-

Organic manure including FYM and compost not only contains N, P and K in small quantities but can also improve the physical, biological parameters of soil. FYM, rural and urban compost improves the Organic carbon content, Water Holding Capacity, bulk density, porosity etc; hence the physical quality of soil can improve to a great extent. Soil organic matter is a storehouse of several plant nutrients, including nitrogen, phosphorus, and sulfur. Every 1 percentage point of organic matter in the top 6 inches of soil contains about 1,000 pounds of nitrogen, 230 pounds of phosphorus, and 165 pounds of sulfur per acre. However, most nutrients in organic matter are not directly available to plants. To be used by plants, nutrients in organic matter must be converted to inorganic forms through decomposition and mineralization by soil organisms. Soil organisms form a food web that decomposes organic matter and releases nutrients in the process. At the base of the food web are bacteria and fungi, which obtain energy by decomposing soil organic matter directly. Protozoa and some nematodes are organisms that graze on bacteria and fungi, releasing nitrogen that can then be utilized by plants. There are mainly four ways of preparation of organic manure viz a) Indore Method, b) Bangalore method, c) NADEP compost and d) ICAR method. Out of these first two are old methods and the later two popular now a days.

3.2.1 NADEP method of Composting

- The NADEP method of organic composting was developed by a Gandhian worker called Narayan Deora Pandharipande of Maharashtra (Pusad).
- Compost can be prepared from a wide range of organic materials including dead plant material such as crop residues, weeds, forest litter and kitchen waste.
- Compost making is an efficient way of converting all kinds biomass into high value fertilizer that serves as a good alternative to farmyard manure, especially for crop-growing households without livestock.

3.2.1.1 Description

- This method of making compost involves the construction of a simple, rectangular brick tank with enough spaces maintained between the bricks for necessary aeration.
- The recommended size of the tank is 10 ft (length) x 5 ft (breadth) x 3 ft (height).

- All the four walls of NADEP tank are provided with 6// vents by removing every alternate brick after the height of 1ft. from bottom for aeration.
- Tank can be constructed in mud mortar or cement mortar.

3.2.1.2 Raw materials required for filling NADEP tank

- Agricultural waste (Dry & green) – 1350-1400 kgs.
- Cattle dung or biogas slurry – 98 – 100 kgs.
- Fine sieved soil – 1675 kgs.
- Water – 1350-1400 litres.
- The important technique in the manufacture of NADEP compost is that the entire tank should be filled in one go, within 24 hours and should not go beyond 48 hours, as this would affect the quality of the compost.
- Thatched roof, Brick Wall Flooring, Air Vents, Green-farm technologies for small and marginal farms Resources Center for Sustainable Development
- Before filling: the tank is plastered by dilute cattle dung slurry to facilitate bacterial activity from all four sides. It is also filled in definite layers each layer consisting of the following sub layers.

3.2.1.3 Sub-layer-1

- 4 to 6// thick layer of fine sticks, stems, (To facilitate aeration) followed by 4 to 6// layer of dry and green biomass.

3.2.1.4 Sub-layer-2

- 4 kgs. Cow dung is mixed with 100 litres of water and sprinkled thoroughly on the agricultural waste to facilitate microbial activity.'

3.2.1.5 Sub-layer-3

- 60 kgs. of fine dry soil is spread uniformly over the soaked biomass for moisture retention and acts as a buffer during biodegradation. Thus the proportion of organic materials for each layer is 100 kgs. Organic biomass: 4kgs.cowdung + 100 litres water+60 kgs soil. In this way, approximately 10 -12 layers are filled in each tank. After filling the tank, biomass is covered with 3// thick layer of soil and sealed with cow dung +mud plaster.

3.2.1.6 Maintenance

- After 15-30 days of filling the organic biomass in the tank gets automatically pressed down to 2 ft.
- The tank is refilled by giving 2-3 layers over it and is resealed.

- After this filling the tank is not disturbed for 3 months except that it is moistened at intervals of every 6-15 days.
- The entire tank is covered with a thatched roof to prevent excessive evaporation of moisture.
- Under no circumstances should any cracks be allowed to develop. If they do, they should be promptly filled up with slurry.

3.2.1.7 Benefits

- Reduced cash expenses on chemical fertilizer, improved soil fertility, increased crop yield.
- Supports organic crop production, reduced dependence on outside inputs.
- From each NADEP tank approximately 2.5 tons of compost is prepared with in 90-120 days.
- The use of compost reduced the need for mineral fertilizer thus reducing production costs and outside dependence.

3.2.1.8 Important Specifications of Organic compost as per FCO, 1985

Moisture 25%, BD<1.0, Total OC 12.0%, Total N 0.8%, P 0.4%, K 0.4%, C:N ratio <20, P^H 6.5 to 7.5.

3.3 Vermicompost-

Vermicompost is a product of composting process of biological wastes including half decomposed cow dung, crop residue, vegetable waste or any other organic waste using vermi of species *Eisenia foetida* or *Lumbricus rubeslus*. Vermicompost is a nutrient rich organic fertilizer and soil conditioner. Hence the all round development of soil quality can be achieved by using vermicompost.

3.3.1 Important Specifications of Vermicompost as per FCO, 1985

Moisture 15-25%, BD<0.7-0.9, Total OC 18.0%, Total N 1.0%, P 0.8%, K 0.8%, C:N ratio 20, absence of foul order

3.3.2 Procedure of preparation of vermicompost

- To prepare compost, either a plastic or a concrete tank can be used. The size of the tank depends upon the availability of raw materials.
- Collect the biomass and place it under the sun for about 8-12 days. Now chop it to the required size using the cutter.
- Prepare cow dung slurry and sprinkle it on the heap for quick decomposition.

- Add a layer (2 – 3 inch) of soil or sand at the bottom of the tank.
- Now prepare a fine bedding by adding partially decomposed cow dung, dried leaves and other biodegradable wastes collected from fields and kitchen. Distribute them evenly on the sand layer.
- Continue adding both the chopped bio-waste and partially decomposed cow dung layer-wise into the tank up to a depth of 0.5-1.0 ft.
- Once, after adding all the bio-wastes, release the earthworm species over the mixture and cover the compost mixture with dry straw or gunny bags. Sprinkle water on a regular basis to maintain the moisture content of the compost.
- Cover the tank with a thatch roof to prevent the entry of ants, lizards, mouse, snakes, etc. and protect the compost from rainwater and direct sunshine.
- Have a frequent check to avoid the compost from overheating. Maintain proper moisture and temperature.

3.4 Concentrated manure/oil cakes

De Oiled cakes like karanj, neem, mahua cakes act as concentrated manure which are as much beneficial as bulky organic manures.

3.5 Cover crops

Cover crops like cowpea, runner beans give protection against soil erosion. They give economic yield, checks soil erosion and along with this the green stems can be incorporated into the soil which would contribute a lot for improving soil quality.

3.6 Green Manure-

Dhanicha (*Sesbaniaaculata* or *Sesbaniabispinisa*) can successfully be used as green manure. It should be sown 45 days before transplanting in paddy main field and should be incorporated at the time of puddling. Similarly, in uplands sun hemp (*Crotoleriajuncea*) can be sown in the pre monsoon showers and can be incorporated in the fields at 40-45 days. These tender green plants after incorporation not only add atmospheric Nitrogen but also add a lot of organic carbon on decomposition. This will enhance the physical and chemical properties of soil, increase organic matter, nitrogen fixation, prevent soil erosion, reduce susceptibility to leaching.

3.7 Crop rotation and mixed cropping

Mixed cropping plays a major role in keeping up soil fertility. Two crops having root growth up to different depths can be grown in a single plot so that the nutrients from different

depth are taken up by the plants and the load on top soil is reduced. Due to crop rotation the pest infestation of some monophagous insect, pests reduced. Similarly crop rotation with a leguminous crop which enriches the soil with fixing atmospheric nitrogen not only helps in reducing the load of nitrogen but also helps in checking some pest attack.

3.8 Use of biofertilizer

Now biofertilizers are available for N fixation, P-solubilation, K- mobilization in both solid and liquid consortium. Symbiotic N fixer like rhizobium, azotobactor and non symbiotic free living bacteria and mycorrhiza, azosporillum, Blue Green alga can fix N from the atmosphere and make it available to the crops. Similarly P- bound to the soil colloids can be released using the P. solubilising bacteria to the soil solution and thus can be made available to the crop. The k- releasing bacteria also play a major role for making K-available to the plants. Thus the pressure build on chemical fertilizers for crop growth can be reduced in this organic manner by the application of biofertilisers. These biofertilisers can be applied as seed treatment inoculants or can be mixed in soil along with compost.

Presently eleven number of biofertilisers are included in the Fertiliser Control Order, 1985 and the specifications are mentioned. Example: The CFU of Rhizobium, Azotobactor, Azosporillum, PSB, KMB, ZSP, Acetobactor should not be less than 5×10^7 cells /gram of the powder, P^H should be 6.5-7.5 and the materials should pass through 0.15-0.212 mm IS sieve, moisture content should be 30-40%

3.9 Use of Bio-pesticides-

Biopesticides are pesticides derived from living organisms used as a major component of integrated pest management will help in maintaining soil properties specially biological. The indiscriminate use of pesticides kills a lot of micro & macro fauna including the beneficial. Moreover, the inorganic or synthetic pesticides leach down to the soil and pollute even the soil upto the underground water level. Use of bio pesticides will help in restoring the helpful biomass, decrease soil toxicity and increase soil chemical & biological properties.

3.10 Soil reaction & Soil amendments -

Basing on the Soil sample analysis we can know the soil reaction (pH) of the soil. All the crops can grow well in neutral soil. Also all the elements are available to the plants in neutral soil. If the pH of the soil is less than 6.5 or if acidic, then paper mill sludge or liming materials can be added to the soil before last ploughing. The quantity of liming materials depends on the difference between existing Soil pH and pH 6.5. In general 05 quintals per hector can be added for three consecutive years. Similarly if the soil is alkaline or pH is more

than 7.5 then gypsum or phospo-gypsum (CaSO_4) can be added in the soil which brings down the pH and there by the alkalinity.

3.11 Fertigation through micro-irrigation system –

To decrease the loss of chemical fertilizers by evaporation, leaching and surface run off, the fertilizers can be applied through fertigation in micro irrigation system like drip method. The required nutrients can be added to water in required quality and can be applied at required time and place. So loss of water, loss of nutrients is checked to a great extent and at the same time soil physical properties can be maintained.

3.12 Use of balanced dose of major and micro nutrients

Mostly the farmers are using inorganic fertilizers especially major nutrients in an unbalanced way. Further, among the major nutrients, much attention is given to Nitrogen and the micro nutrients are not addressed even the required quantity of farm yard manures are not applied. This wrong way of use of chemical fertilizers has contributed a lot to increase the soil acidity, decrease the soil quality and there is a decrease in fertilizer use efficiency and water use efficiency ultimately resulting in decrease in productivity of soil in many parts of the country. For Example- The farmers of Umerkote area of Nabarangapur District used highest quantity of chemical fertilizers including high dose of nitrogen fertilizers to get maximum productivity of maize crop. They failed to apply required quantity of FYM or compost. This resulted in heavy deterioration of soil quality of many agricultural lands which are left most unproductive or literally unsuitable for agriculture production. Similar is the case of many agricultural lands in Punjab state. The solution of this major problem is the use of required fertilizers including both major and minor essential elements as per the site specific soil testing reports along with organic manure, bio fertilisers Green manuring etc.

4.0 Government of India Initiative

Based on the recommendations of the Task Force on Balanced use of Fertilizer, this new Centrally Sponsored Scheme entitled National Project on Management of Soil Health and Fertility has been formulated. The scheme is broad based in terms of its activities, subsidy rates etc. The component relating to Balanced Use of Fertilizers, will henceforth be taken out of the purview of the Revised NMA Scheme and subsumed in the National Project on Management of Soil Health and Fertility. The scheme is being launched with the following broad objectives,

- To facilitate and promote Integrated Nutrient Management through judicious use of chemical fertilizers, including secondary and micro nutrients, in conjunction with organic manures and bio fertilizers, for improving soil health and its productivity.
- To strengthen soil testing facilities and provide soil test based recommendations to farmers for improving soil fertility and economic return to farmers.
- To improve soil health through green manuring.
- To facilitate and promote use of soil amendments for reclamation of acidic or alkaline soils for improving their fertility and crop productivity.
- To promote use of micro nutrients for improving efficiency of fertilizer use.
- To upgrade the skill and knowledge of STL or extension staff and farmers and their capacity building through training and demonstration including demonstration on farmers fields regarding benefits of balanced use of fertilizers.
- To ensure quality control of fertilizers through strengthening of fertilizer quality control facility including training to enforcement officers of State Governments for effective implementation of Fertilizer Control Order.
- To provide financial assistance for upgrading and setting up of STLs or Fertilizer Testing Laboratories and various activities for promoting balanced use of fertilizers. The training programme to be organized for farmers on Balanced Use of Fertilizers will be a two day programme. State Governments and agencies associated with it or ICAR or SAUs or Fertilizer Industry are responsible for this training programme.

5.0 Soil Health Card Scheme and interpretation of results in SHC

Looking into the deterioration soil quality and with an aim to give one soil health card to each farmer of the nation, Soil Health Card Scheme (SHC) has been introduced by the Govt of India from the year 2015-16. Cycle-I included two years 2015-16 & 2016-17. Similarly Cycle-II included 2017-18 & 2018-19. In each cycle a plan was prepared to include all the farmers. But considering the soil sample analysis capacity of the existing Static Soil Testing Laboratories & Mobile Soil Testing Laboratories in the nation, a grid system was introduced. Each grid consisting of 10 hectares of un-irrigated or 2.5 ha of irrigated land. Thus the total cultivated area of the village is divided into number of grids.

कृषिरत महिलाओं के लिए विकास योजनाएं

अनन्त सरकार

भा.कृ.अ.प. - के.कृ.म.सं., भुवनेश्वर

कृषि में महिलाएं बुआई से लेकर कटाई और कटाई उपरांत सभी प्रकार के क्रियाकलापों में महत्वपूर्ण भूमिका निभाती हैं। इसीलिए राष्ट्रीय कृषि नीति 2007 में कृषि में महिलाओं की भूमिका को अत्यधिक महत्व देने के साथ-साथ कृषि विकास एजेंडा में उनसे संबंधित मुद्दों को भी प्राथमिकता दी गई है। कृषि एवं किसान कल्याण मंत्रालय महिलाओं को कृषि की मुख्यधारा से जोड़ने के लिए विभिन्न स्कीमों/ कार्यक्रमों/ मिशनों में महिला समर्थित गतिविधियों को अधिक से अधिक बढ़ावा दे रहा है। कृषि एवं किसान कल्याण मंत्रालय के कृषि, सहकारिता एवं किसान कल्याण विभाग में स्थापित राष्ट्रीय कृषि महिला संसाधन केन्द्र ने कृषि संबंधी नीतियों एवं कार्यक्रमों के उपर पुस्तिका 'महिला किसानों के लिए मित्रवत् पुस्तिका' प्रकाश किया है। इस पुस्तिका में महिलाओं के लिए सहायता के विशेष प्रावधानों एवं पैकेजों को सम्मिलित किया गया है।

ईए पुस्तक महिलाओं को न केवल अवगत करवाने बल्कि उन्हें महिलानुकूल प्रावधानों का पूरा लाभ दिलाने के लिए प्रकाश किया गया। महिला किसान/ लाभार्थियों को तुरंत सहायता और सुविधाओं की जानकारी/ लाभ प्राप्त करने के लिए अपने नज़दीकी जिला स्तरीय परियोजना निदेशक (आत्मा)/ उप निदेशक (कृषि) कार्यालय या ब्लॉक स्तरीय ब्लॉक प्रौद्योगिकी प्रबंधक/ सहायक प्रौद्योगिकी प्रबंधकों (आत्मा) से सम्पर्क करना चाहिए। इस अध्याय में इस पुस्तक में शामिल कुछ महत्वपूर्ण महिलानुकूल प्रावधानों की उल्लेख किया गया है। पाठकों कृपया ईए पुस्तक पढ़ें और योजनाओं के बारे में बेहतर जानकारी के लिए मंत्रालय वेबसाइटों (https://agricoop.nic.in/sites/default/files/ext_rpt.pdf) का दौरा करें और अपने नज़दीकी जिला स्तरीय परियोजना निदेशक (आत्मा)/ उप निदेशक (कृषि) कार्यालय या ब्लॉक स्तरीय ब्लॉक प्रौद्योगिकी प्रबंधक/ सहायक प्रौद्योगिकी प्रबंधकों (आत्मा) से सम्पर्क करें।

विभिन्न स्कीमों/ मिशनों के अन्तर्गत महिलाओं के लिए विशेष प्रावधान:

क. राष्ट्रीय कृषि विस्तार एवं प्रौद्योगिकी मिशन (एनएमएईटी) - कृषि विस्तार प्रौद्योगिकी संबंधी उप मिशन (एसएमएई)

1. कृषि प्रौद्योगिकी प्रबंधन एजेंसी (आत्मा)
2. एग्रीक्लिनिक एवं एग्रीबिज़नेस केन्द्र (एसीएबीसी)
3. कृषि विस्तार के लिए जन संचार सहायता

महिला खाद्य सुरक्षा समूह (एफएसजी) को प्रोत्साहन देने के लिए अनिवार्य गतिविधि के रूप में आत्मा कैफेटेरिया के अंतर्गत घरेलू/ गृह स्तर पर खाद्य सुरक्षा के लिए महिला किसान समूहों को गृहवाटिका, गैर कृषि गतिविधियों जैसे सूकर पालन, बकरी पालन, मधुमक्खी पालन इत्यादि को

प्रोत्साहन देने के लिए रु. 10000/- प्रति समूह/ प्रति वर्ष आवंटित हैं। प्रति ब्लॉक न्यूनतम दो खाद्य सुरक्षा समूह के लिए सहायता उपलब्ध कर सकते हैं।

एक किसान मित्र 2 गाँव के लिए चुना जाता है जिसको रु. 6000 प्रतिवर्ष/ प्रति किसान मित्र दिया जाता है। किसान मित्र के लिए पुरुष की तुलना में महिला को प्राथमिकता दिया जाता है।

आकाशवाणी और दूरदर्शन के कार्यक्रमों में महिला किसानों के कार्य क्षेत्र से संबंधित सूचना/ जानकारी प्रदान करने के लिए अलग से एक दिन निर्धारित है।

ख. समेकित बागवानी विकास मिशन (एमआईडीएच)

ईस मिशन के अंतर्गत कृषि मशीनों एवं उपकरणों की खरीद (सब्सिडी) में महिलाओं के लिए पुरुषों से ज्यादा सब्सिडी के प्रावधान दिया जाता है। लाभार्थी के रूप में बागवानी मशीनीकरण के लिए उत्पादक संगठनों, किसान समूहों, स्व-सहायता समूहों, महिला किसान समूहों, जिसके कम से कम 10 सदस्य बागवानी फसलों की खेती कर रहे हों बशर्ते ऐसे समूहों द्वारा मशीनों और उपकरणों की लागत का शेष 60% खर्च वहन किया जाता है।

मशीनों एवं उपकरणों	सब्सिडी (रु प्रति इकाई)	
	महिलाओं के लिए	पुरुषों के लिए
ट्रैक्टर (20 पीटीओ हार्सपावर तक)	35% (अधिकतम 100000)	25% (अधिकतम 75000)
पावर टिलर (8 हार्सपावर से कम)	50000	40000
पावर टिलर (8 बीएचपी एवं अधिक)	75000	60000
भूमि विकास, जुताई और बीज की क्यारी बनाने का उपकरण	15000	12000
बुवाई, रोपाई, कटाई एवं खुदाई यंत्र	15000	12000
प्लास्टिक मल्लिचंग मशीन	35000	28000
हस्तचालित बागवानी मशीनें	125000	100000
पौध संरक्षण उपकरण मैनुअल स्प्रेयर: नैपसैक/ पदचालित स्प्रेयर	600	500
पावर चालित नैपसैक स्प्रेयर/ पावर चालित ताड़वानी स्प्रेयर (8-12 L)	3100	2500
पावर नैपसैक स्प्रेयर/ पावर चालित ताड़वानी स्प्रेयर (12-16 L)	3800	3000
पावर नैपसैक स्प्रेयर/ पावर चालित ताड़वानी स्प्रेयर (>16 L)	10000	8000
ट्रैक्टर धारक/ चालित स्प्रेयर	10000	8000
ट्रैक्टर धारक/चालित स्प्रेयर (35 हार्स पावर से अधिक)	50% अधिकतम रु. 63000	40% अधिकतम रु. 50000

पर्यावरण हितैषी लाइट टैप	14000	12000
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ग. राष्ट्रीय तिलहन और ओयल पाम आधारित मिशन (एनएमओओपी)

ईस मिशन के अंतर्गत तिलहन और ओयल पाम के किसानों को कृषि मशीनों एवं उपकरणों की खरीद में सब्सिडी मिलती हैं। महिलाओं किसानों को पुरुषों से ज्यादा सब्सिडी के प्रावधान दिया जाता है।

मशीनों एवं उपकरणों	सब्सिडी (रु प्रति इकाई)	
	महिलाओं के लिए	पुरुषों के लिए
हस्त चालित स्प्रेयर: नैप सैक/पद चालित स्प्रेयर, पर्यावरण हितैषी लाइट टैप	800	600
नैपसेक और ताड़वानी स्प्रेयर के लिए (क्षमता 16 लीटर से कम)	3800	3000
नैपसेक और ताड़वानी स्प्रेयर के लिए (क्षमता 16 लीटर से अधिक)	10000	8000
हस्त/पशु चालित उपकरण, चिज़लर सहित	10000	8000
ट्रैक्टर चालित कृषि उपकरण जैसे; रोटावेटर/ सीड ड्रिल/ ज़ीरो टिल सीड ड्रिल/ बहुफसलीय प्लांटर/ ज़ीरो टिल बहुफसलीय प्लांटर/ रिज फुरो प्लांटर/ ऊँची क्यारी प्लांटर/ पावर वीडर/ मूंगफली खोदक और बहुफसलीय थ्रेशर	63000	50000
ट्राली के साथ छोटा ट्रैक्टर	100000	75000

घ. कृषि विपणन के लिए समेकित योजना (आईएसएएम)

संसाधन	सब्सिडी (रु)	
	महिलाओं के लिए	पुरुषों के लिए
भण्डारण संसाधन	33.33% (पूँजी लागत पर) अधिकतम सब्सिडी: 1000 मी.टन तक रु 1166 1000-30,000 मी.टन तक रु 1000 अधिकतम सीमा रु 300 लाख	25% (पूँजी लागत पर) अधिकतम सब्सिडी: 1000 मी.टन तक रु 875 1000-30,000 मी.टन तक रु 750 अधिकतम सीमा रु 225 लाख
भण्डारण संसाधन के अलावा अन्य संसाधन	33.33% (पूँजी लागत पर) अधिकतम सब्सिडी: रु 500 लाख	25% (पूँजी लागत पर) अधिकतम सब्सिडी: रु 400 लाख

च. राष्ट्रीय खाद्य सुरक्षा मिशन (एनएफएसएम)

किसान उत्पादक संगठनों (एफपीओ) को प्रोत्साहन और वैल्यू चेन एकीकरण के लिए विपणन सहायता (दालों और बाजरा के स्थानीय स्तर पर विपणन के लिए अपंजीकृत किसान समूहों,

महिलाओं एवं अन्य के स्व-सहायता समूहों के लिए): 15 किसानों के एक समूह के लिए 2.00 लाख रुपये, केवल एक बार सहायता। निधि का न्यूनतम 30% आवंटन केवल महिला किसानों के लिए है।

छ. राष्ट्रीय सतत् कृषि मिशन (एनएमएसए)

मिट्टी एवं जल संरक्षण, जल उपयोग दक्षता, उपजाऊ मिट्टी प्रबंधन और सिंचित क्षेत्र विकास में छोटे एवं मझोले किसानों के लिए निधि का न्यूनतम 50% आवंटित किये जाने का प्रावधान है, जिसमें कम से कम 30% महिला लाभार्थियों/ किसानों के लिए नियत होगा।

ज. कृषि मशीनीकरण उपमिशन (एसएमएस)

ईस उपमिशन में कृषि मशीनरी जाँच एवं प्रशिक्षण संस्थानों द्वारा किसान महिलाओं के लिए महिला अनुकूल उपकरण संबंधित प्रशिक्षण कार्यक्रम आयोजित किये जाते हैं। लाभार्थी के रूप में निधि का न्यूनतम 30% आवंटन महिला किसानों के लिए निर्धारित है। इस उपमिशन में नया मशीन खरीदने के लिए सब्सिडी भी दिया जाता है जिसमें महिलाओं के लिए पुरुषों से जायदा सब्सिडी का प्रावधान है। सब्सिडी के बारे में अधिक जानकारी के लिए इह किताब पढ़ें ([farm Women Friendly Handbook- Hindi](https://agricoop.nic.in/sites/default/files/ext_rpt.pdf); https://agricoop.nic.in/sites/default/files/ext_rpt.pdf)।

झ. कृषि बीमा

योजना के अंतर्गत अनुसूचित जाति/ अनुसूचित जनजाति/ महिला किसानों की अधिकतम भागीदारी सुनिश्चित करने के लिए संबंधित राज्यों में बजट आवंटन और उपयोग उनकी आबादी अनुपात के अनुसार करने का प्रावधान है।

संदर्भ

https://agricoop.nic.in/sites/default/files/ext_rpt.pdf

<https://agrionline.nic.in/dash/dash.html>

Potential role of dairy sector in improving household nutrition and livelihood

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Introduction

Livestock sector particularly dairy has a crucial role in making India self sufficient in food production. The growing demand of healthy food by burgeoning human population, and shrinking land resources make dairy a life saving option for farmers at the time of climatic distress. About 4.6 percent increase in livestock population in 20th census over 19th animal census reflects their popularity among Indian farmers. Even if India is the largest milk producer (23% of world production) but Indian dairy is not recognised for its mass production; rather dairy is a commodity of mass as reared by mostly small holder dairy farmers. As per last census report the population of cross bred and exotic cows has been increased by 27%. Nearly 75% of total cattle population are female, that shows the preference of farmer's for milk. Therefore, role of dairy sector in poverty alleviation, employment generation, gender equality and strengthening rural economy cannot be underrated. Role of women is critical in the livestock economy as in agriculture most women are involved in less paid back-breaking agricultural activities related to production like weeding, sowing, harvesting etc. whereas in livestock particularly cattle rearing apart from care-giving production activities like shed cleaning, feeding, watering they also get involved in marketing activities like milking, milk processing and milk and milk product marketing. There were five million women members in dairy cooperatives in 2015-16, and this increased further to 5.4 million in 2020-21. Women accounted for 31% of all members of dairy producer cooperatives in 2020-21. In India, the number of women's dairy cooperative societies rose from 18,954 in 2012 to 32,092 in 2015-16. Apart from gender equality, livelihood and income generation the nutritional richness and nutrient diversity make dairy a weapon to tackle malnutrition in India and other developing and underdeveloped countries. Dairy being the most affordable and year-round available nutritious food, large segments of the population of developing countries consume it as a staple food in their diet. The per capita availability of India is 425g/day which is much higher than the ICMR's recommendation (280g/day).. Reports say about 48% of total milk produced in India is consumed at farmer's level and 52% is as marketable surplus. Out of this marketable surplus 50% is poured in organised sector. Dairy

sector supports 8 crore dairy farmers out of which only 2 crore are associated with organised sector.

Preferences for dairy products in India:

The per capita availability of milk is highest in Punjab and Haryana followed by Rajasthan and Gujarat. There is also a lot of disparity in milk consumption of rural and urban areas. Many traditional milk products are important part of Indian cuisine from centuries. The presence of dairy products as traditional food items, like chachh of western India, sweets of eastern India, ghee of northern India and yogurt of south India, signifies the mass appeal of these traditional dairy products. As in eastern and north eastern India most non-vegetarian people reside here meat is the preferred animal protein. Similarly in western and central India milk is the most preferred animal protein. Many research claim that eastern and north eastern people are lactose intolerant so they do not prefer to consume liquid milk.

Nutrient richness of dairy and dairy product

Milk is regarded as nature's most nearly complete food. Cow milk dominates (83%) in world followed by buffalo. Apart from these bovine some non-bovine milk like camel, goat, sheep and donkey milk are gaining importance in world forum for their therapeutic value. Dairy and its products are considered as super food not only for its energy dense, protein rich and micronutrient adequate nature but also for its high bioavailability. Micro-minerals (especially calcium, magnesium, potassium, zinc, and phosphorus) essential for human health are available in milk. Richness of calcium and phosphorous in dairy products make it a functional food for pregnant women, growing children, old age and arthritic people. Calcium has essential role in bone development in children; it provides strength and density to bones and prevents bone degeneration and osteoporotic fractures in old age people. Calcium reduces cholesterol level, maintains blood pressure and reduces the chances of coronary heart diseases. Table 1 shows nutritive value of milk from different species and their similarity with human health.

Table 1 Nutritive value of milk from different species

Nutrients (in 100g)	Cow	Human	Buffalo	Sheep	Goat
Water (%)	87.99	87.50	83.39	87.03	80.70
Energy (Calorie)	61	70	97	69	108

Protein (g%)	3.29	1.03	3.75	3.36	5.98
Fat (g%)	3.34	4.38	6.89	4.17	7.00
Calcium (mg)	119	32	169	134	193
Potassium (mg)	152	51	178	204	136
Vitamin C (mg)	0.94	5.00	2.25	1.29	4.16
Vitamin A (IU)	126	241	178	185	147
Riboflavin (mg)	0.162	0.036	0.135	0.138	0.335

Protein rich dairy products

Protein rich dairy products are considered ideal for weight loss. Plenty of protein in our diet triggers metabolism and improves body composition. Liquid milk (3-4%), yogurt (10%), paneer (15-16%) and cheese (22-25%) are considered protein rich dairy products.

Yogurt/Dahi:

An ideal fermented food excellent for gut health. Fermentation of lactose to lactic acid reduces the carbohydrate content of yogurt resulting higher protein percentage. Along with nutritional property it has therapeutic and health promoting properties. Concentration of lactic acid bacteria improves the gut health. Milk protein degraded by the action of bacterial proteases into peptides, possessing various health benefits called as bioactive peptides, which has antioxidant, antithrombotic, ACE inhibitory activity and anti-aging activities.

Paneer: It is rich in potassium and selenium and helps in curbing memory loss and reducing fertility problems. Paneer works best for women. It helps in proper fetal formation in pregnant women, eases menstrual cramp, and reduces the risk of breast cancer. It is the best source of proteins for vegetarians. It helps in easing muscle cramps. Buttermilk is a by-product in paneer making. Consuming buttermilk substantially reduces the risk of high blood pressure. It aids in the proper digestion and absorption process. Consuming buttermilk daily regulates the gastrointestinal system and improves metabolism. It cools down the body heat and balances body systems.

Cheese: like yogurt and paneer cheese is also a fermented dairy product. It is a protein rich diet traditionally part of the Mediterranean diet. Present day due to its high protein content and mineral richness it is well accepted in Indian market. A large variety of cheese is

available in world market as per the health need, preference and taste of consumers. As it is a concentrated dairy product, it has good source of micronutrients and probiotic bacteria that have numerous health benefits.

Fat rich dairy products

Cream (20%), butter (80%) and ghee (99%) are fat rich dairy products. These are good for skin, bones, hair and general well being due to a rich source of fat soluble vitamins along with beneficial fats.

Ghee:

Ghee aids in digestion and it also acts as a natural antioxidant and anti-cancer element. It has various fat-soluble vitamins and fatty acids. Ghee is a shelf-stable product because of its antioxidant properties. It is the ideal food for maintaining our gut-health to prevent any risks of ulcers. Due to its lower moisture content it has a longer shelf life.

Non-bovine milk and its health benefits:

Small ruminants i.e. sheep and goat act as a supplementary source of income for poor families owing to their higher reproductive rate, small reproductive cycles, hardy nature, easier management, small cost involvement, small space requirement and drought resistant ability over large ruminants. They are mostly reared for meat but in hilly and desert areas people consume their milk. There are many anecdotal evidences that this milk have health influential benefits. Sheep and goat milk has ample amount of calcium, zinc, vitamins and beneficial fatty acids which make it an ideal agent for bone health, immunity, skin health and anti-ageing formulations. Topical use of this milk in skin lotions, soap and creams for managing autoimmune diseases like psoriasis is a recent trend. World class cheese and yogurt from sheep milk has created a new realm for sheep rearing. Similarly low fat content of camel milk, micro nutrient richness and therapeutic importance in autism heighten its cost in dairy market.

Dairy for livelihood:

Livelihood is the capability, assets or activities followed to earn income and secure living. Dairy as a livelihood option is secondary to agriculture in most part of India. But in hilly or natural calamity prone areas many farmers acknowledged dairying as the primary option for their livelihood. Industrialisation, privatisation and male migration resulted village economy

White revolution and series of operation floods transformed India from a milk deficit to top milk producing country. National Dairy Development Board (NDDB) was set up in 1965 at Anand, Gujarat for creating Anand pattern dairy in different parts of India for liquid milk procurement. These milk shed development programme not only provide market for dairy farmers rather it increases milk production through different initiatives (Artificial insemination, subsidies, quality feed, training etc.) and also provides quality milk to consumers at a reasonable price. After 1950 the milk production of India has followed an increasing trend. In 1991, private companies gain entry in dairy sector. Most dairy farmers are women. Competition among private companies and dairy cooperatives created market for them at their doorstep round the year and they are able to sell milk at a competitive rate. Gender inclusive nature of dairy cooperatives succeeded in creating leadership quality, decision making power and enhancing social status and connections by women apart from income generation. Since milk production requires family labour which is adequately available in poor families and also it does not require large land therefore, landless and women farmers can conventionally opt it as a livelihood option.

Conclusion

Milk is one of the most nutritious foods in its natural form. Its inherent nutrients are essential for all age group of people. Milk can be easily fortified with vitamin D, calcium and many other essential nutrients. Low fat or skimmed milk can also be a good option for human health. Training on cattle rearing, linking farmers with banks and veterinary departments, farmer friendly policy changes can give dairy farmers their actual identity in this sector and their livelihood from cattle rearing can be profitable and sustainable.

Locally available Fruit crops: An important component of family food and nutrition security

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The increasing population, depleting natural resources and changing climate scenario have resulted in huge impact on sustainability. The UN sustainable development goals which are fundamental for inclusive achievement of sustainability have included ‘Zero hunger’ and ‘Good health and well-being’ as some of its sustainable development goals (SDGs). At present, there is a growing consumer demand for wholesome, nutritional and convenient food products. Food security is defined as the availability and the access of food to all people; whereas nutrition security demands the intake of a wide range of foods that provides the essential nutrients. The FAO estimates in ‘*The State of Food Security and Nutrition in the World, 2020 report*’, states that about 190 million Indians are undernourished, comprising 14% of total world population. India also accounts for the highest proportion of stunted (31%) and wasted children (51%) worldwide (FAO, IFAD, UNICEF, WFP and WHO, 2019). In the Global Food Security Index 2021, India ranked 107 out of 121 nations (The Global Hunger Report, 2022). The major issue relating to India’s nutrition security is poor intake of micronutrients and proteins, below the Recommended Dietary Allowances (RDAs). Recommended Dietary Allowances (RDAs) are the levels of intake of essential nutrients that are adequate to meet the known nutrient needs of practically all healthy persons. Suboptimal protein consumption in India has resulted in stunting and wasting in children and issues like muscle loss and low immunity. Anaemia is among the most common micronutrient deficiencies, primarily due to iron deficiency and also due to protein deficiency as well as folic acid and B₁₂ deficiencies. Thus, the existing nutrition scenario warrants a paradigm shift from quantity consumption to quality supplementation of diets. The nutritional awareness among the population, shift to nutri-sensitive agriculture and innovation in food technology can reframe India’s food environment through food diversification.

Over the past years, India has attempted huge strides to ensure nutrition security by popularization of fortified rice to PM- *Poshan* mid-day meal scheme and subsidized food grains through the public distribution system (PDS). However, adequate addressal of nutrition security is required through alternative options in which horticultural crops can play a pivotal role. Horticultural crops are denoted as ‘protective food’ as they are important source of vitamins and minerals. Fruit crops in particular can ensure nutrient fortification due to abundance of several bio-active compounds in them. The indigenous fruit crops that are available locally are the cheapest reliable source of nutrients for small, marginal, landless farmers, farm women and rural children. There exists tremendous scope for utilization of the underutilized fruit species to augment the nutritional dimensions of rural masses. The present chapter highlights the nutritional significance of the locally available underutilized fruit species for ensuring nutritional security.

A variety of fruit crops grow naturally in degraded soil and bear profusely without any management practices. These crops have limited market and are termed as underutilized horticultural crops (UUHC). Underutilized fruits are known as “fruit crops of future” due to its nutritive value and medicinal properties. There are reasons for poor popularity of underutilized fruit crops are: (i) Cultivation in restricted areas, (ii) Limited knowledge about its food value, (iii) Non-availability of quality planting materials, (iv) Prolong gestation period and technological gap in enhancing fruit production, (v) Poor marketing network and (vi) Inadequate processing and value addition. Fruits that are grown commercially are accessible to many but due to higher price, they are still unaffordable by the poor and rural mass. The underutilized locally available fruit crops can play a significant role in overcoming problem of malnutrition. The nutritional composition of some underutilized fruit crops are as follows:

1. **Bael:** *Aegle marmelos*

It is also called as Bengal quince/ stone apple and belongs to family Rutaceae. The fruit crop is indigenous to India. It is a dry land plant and has great medicinal, nutritional, environmental and commercial importance. The fruit is loaded with more than 100 biologically active compounds. Moreover, it also contains anti-nutritional factors that help in controlling blood sugar. The fruit is rich in carbohydrate, dietary fibre, minerals and vitamins. The unripe and half ripe fruits are used to cure scurvy which is due to deficiency of vitamin C. In India the ripe fruit is consumed fresh and also used in preparation of squash, sherbet, jam and marmalades. Bael seed is an

affluent source of good quality protein and would also be used as protein supplement in meals and food products. The amino acids such as leucine, tyrosine and phenylalanine were found quite abundant. The young leaves and shoots are eaten as vegetable in Thailand and used as seasonal food in Indonesia. The bael fruit pulp contained high level (26.2%) of total soluble solids, the thaibael fruit pulp contain higher TSS (39.50%). The sweetness of bael fruit is mainly contributed by the sucrose followed by glucose. The seeds of bael fruit contained high fat content (14.94%). The seed of bael also possess high protein level and is used in preparation of protein concentrate meal. Bael fruit pulp is a good source of crude fiber. The bael fruit is a good source of ascorbic acid and some vitamins of B group.

2. **Jamun:***Syzygium cumini*

Among several tropical fruits in India, Jamun is a potentially important indigenous minor commercial fruit with high medicinal uses. The fruit is a member of the Myrtaceae family. Jamun, also known as Indian blackberry, Malabar plum, Portuguese plum, Java plum, black plum, or jambolana. The fruits are harvested in monsoon and have relatively shorter harvesting period (30-40 days). Jamun pulp contains sugars (glucose, fructose), free amino acids, minerals (Na, K, Ca, Mn, Mg), dietary fiber, ascorbic acid, β -carotene, organic acids, phenolic compounds, anthocyanins, flavonols, ellagotannins and gallotannins, volatile compounds. Jamun is having higher amount of antioxidants when compared to the other seasonal fruits like papaya, sapota, guava and banana. Not only antioxidants jamun is having high amount of vitamins, tannin and anthocyanins. Whole fruit is used for extracting juice and to prepare processed product like jam, jelly, vinegar, wine, squash, non-fermented ready-to-drink beverages etc. The jamun seeds are a potential source of bioactive compounds such as tannins, phenolic acids, flavonoids, terpenoids and saponins, which have several biological activities. High contents of carbohydrates, dietary fiber, minerals, and ascorbic acid have also been found in jamun seeds. Additionally, seeds have its own medicinal properties and are used for curing diabetes. The fruit pulp can be used as a food colorant and as a nutritious and health-promoting food additive. Jamun is having a lot of medicinal and pharmaceutical advantages.

3. **Jackfruit:***Artocarpus heterophyllus*

It belongs to the family Moraceae and popularly known as jackfruit or Ceylon Jack tree. It is one of the important and commonly found trees in the home gardens of

India. Ripe jackfruit is richer than apple, apricot, avocado, and banana in some minerals and vitamins. The caloric content of jackfruit is low, where 100 g of jackfruit contains only 94 calories. The predominant carbohydrate is starch that is present in the jackfruit perianth and seed. The starch and dietary fiber content of the flesh increase with the maturity. The carbohydrate concentration in seed may vary from 37.4% to 42.5%. The fiber content of the jackfruit flesh varies from 0.57 to 0.86%, depending on the variety and the season. Amino acids like arginine, cystine, histidine, leucine, lysine, methionine, threonine, and tryptophan are present and total protein content is 1.9 g/ 100 g in ripe jackfruit. The protein concentration of the jackfruit seeds varies from 5.3 to 6.8%. Jackfruit is rich in vitamin C and it is one of the rare fruits that is rich in B-complex group of vitamins and contains very good amounts of vitamin B₆ (pyridoxine), niacin, riboflavin, and folic acid. Ripe jackfruits are high in mineral content like potassium (287-323 mg), calcium (30.0-73.2 mg). Jackfruit contains many classes of phytochemicals such as carotenoids, flavonoids, volatile acids sterols, and tannins, with varying concentrations depending on the variety. The total phenol content is 0.36 mg GAE/g DW and the pigment in jackfruit is carotenoid, which have colourant properties and also provitamin A activity and are known to have beneficial effects on several chronic degenerative diseases. Dietary fiber present in jackfruit makes it a good bulk laxative. The fruit is rich in magnesium, which is important for the absorption of calcium and helps strengthen the bones and prevents bone-related disorders such as osteoporosis. Iron in jackfruit helps to prevent anemia and aids in proper blood circulation and copper plays an important role in thyroid gland metabolism. The flavonoid from the fruit has anti-inflammatory properties. The flavor of the fruit is mainly due to presence of esters. The fruit is rich in antioxidants and the phenol content in fruit contributes to about 70% of the total antioxidant activity. The seeds are nutritious and important source of diet. Flour prepared from jackfruit seed is high in protein and carbohydrate and is used as an alternative for wheat flour. Tender jackfruit leaves and young male flower serve as vegetables.

4. **Aonla:***Emblica officinalis* (aonla) is native of tropical India and Southeast Asia, commonly named as 'Indian gooseberry'. Aonla is an excellent source of ascorbic acid (300-900 mg/100 g), amino acid and minerals along with phytochemicals such as polyphenols, tannins, emblicol, linoleic acid, corilagin, phyllembelin and rutin. Protein contents varies from 2.05 to 3.17%. Fruits are recommended as a good source of

dietary fibres. The crude fibre which generally includes polysaccharides such as cellulose, hemicelluloses and lignin are observed maximum in the fruit of Desi variety. The fruits of desi variety also show the maximum values for acidity, ascorbic acid, fat, polyphenol and pectin. However, the total sugar content was lower in desi type when compared with commercial varieties. The acidity of fruits ranged from 11.08 to 12.06%. The Ascorbic acid content was within the range of 400 to 900 mg/100 g on fresh weight basis. The antioxidant properties in aonla are due to high ascorbic acid and polyphenol contents. Polyphenol content as gallic acid equivalent was observed maximum in the fruit of Desi variety. Total sugar content ranged from 28.01 to 36.91% and starch content varied from 16.07 to 29.23%. The predominant minerals identified were iron, calcium and potassium. The excellent nutritional profile and physico-chemical properties of aonla offers its utilization in the form of value-added product like juice, squash, ready to serve beverage, aonla murrabah, pickle, chutney that are preferred by the consumer for its rich source of vitamin C and antioxidants. The fruit is a main constituent of many ayurvedic preparations like Triphala and Chyawanprash.

- 5. Tamarind:** *Tamarindus indica* is an important tree legume in tropical and sub-tropical countries. The fruit consists of the seed (33-9%), pulp (55.0%), and shell and fibre (11.1%). The carbohydrate content is more in seeds 49.5 g/100g than in pulp 35.56 g/100g. The crude fiber content is 14.75% for seed powder and 18.75% for pulp. The seed and pulp contain high level of protein and therefore could be used as protein supplement. The most outstanding characteristic of tamarind is its sweet acidic taste due to the presence of tartaric acid (10%). It also contains other organic acids such as succinic and malic acid. According to the World Health Organization (WHO) tamarind can be considered as a source of all essential amino acids, with the exclusion of tryptophan. Presence of tannins is most likely to be responsible for the antioxidant and anti-inflammatory properties of the fruit. Flavonoids are responsible for other medicinal properties. The bio-active compounds include tannin, flavonoid, saponin, glycosides. The tamarind seed is processed into tamarind-kernel powder and it has immense industrial uses, production of protein concentrates and can also serve as a food ingredient. Tamarind seed protein is rich in glutamic acid (18-5%), aspartic acid (11.6%), glycine (9.1%) and leucine (8-2%). The proportion of total essential amino acids in tamarind kernel protein is 33.6%. The fruit is commercially used as a raw

material for the manufacture of numerous food products such as tamarind juice concentrate, curries, tartaric acid, tamarind pulp powder, sauces, pectin, ice cream, and alcoholic beverages.

6. **Karonda:** *Carissa carandas* commonly known as Karonda 'Christ's thorn' is a very hardy and drought tolerant plant and thrives well throughout the tropical and subtropical climates. Karonda has been used widely in indigenous systems of Indian medicine like Unani, Ayurveda and Homeopathy due to its various medicinal properties. Karonda fruits are sour and astringent in taste and are a rich source of iron and an excellent source of vitamin A, C and B complex, fibre, carbohydrates and minerals such as calcium, phosphorous, potassium, sodium and sulphur. The predominant sugar are glucose and galactose. The bio-active compounds include flavonoids, saponins and large amounts of cardenolides, triterpenoids, phenolic compounds, organic acids and other volatile compounds. Organic acid such as oxalic, tartaric, citric, malic, malonic, glycolic acids and amino acid like glycine, alanine, phenyl alanine, serine are present in the fruit. Ripe fruits are sub-acidic to sweet in taste with peculiar aroma. It is a coloured fruit rich in pigments, antioxidant. After ripening, the fruit contains high amount of pectin therefore it is also used in making jelly, jam, squash, syrup, tarts and chutney. The fruit is also popular for its anti-inflammatory activities.
7. **Phalsa:** *Grewia asiatica* is a drought-resistant plant. The fruit contains carbohydrate (21.1g), fibre (1.2g) and sugar (10-11%). The major carbohydrates are xylose, arabinose and glucose. It is a good source of protein (1.5g), amino acids. The predominant amino acids are proline, phenylalanine, lysine and glutaric acid. Citric acid and malic acids are the major organic acids in the fruit. The fruit is rich in calcium (129 mg), phosphorus (39mg), iron (3.1 mg), potassium (375 mg). It contains pigment anthocyanin. The fruit also possess dietary fibre, vitamin A & C, volatile compounds and bio-active compounds like anthocyanins, tannins, phenolics, and flavonoids. The oil in phalsa seeds is of a bright-yellow color, 5% oil with a composition of oleic acid (13.4%), stearic acid (11.0%), palmitic acid (8.3%), unsaponifiable material (2.8%) and linoleic acid (64.5%). This multipurpose plant possesses antioxidant, anti-hyperglycemic, radioprotective, hepato-protective, antifungal, and antiviral activity. The fruit is consumed fresh and used for the

formulation of beverages such as juices, squashes, syrups, jams, and carbonated drinks. The leaves are used as fodder for cattle.

8. Custard apple: *Annona squamosa*

Custard apple is a member of the family Annonaceae usually called sugar apple, *sita phal*, *sharifa*. The fruit contains numerous phenol-based compounds, e.g., proanthocyanidins, with 18 different phenolic compounds, mainly alkaloids or flavonoids. The fruit possess pharmacological properties and biological activities, such as antioxidant, antimicrobial, antidiabetic, antiviral, anticancer, and hepatoprotective activities due to presence of glycosides, phytosterols, carbohydrates, oils, saponins, tannins, alkaloids, phenols, flavonoids, peptides, and various acetogenin compounds. It contains numerous bioactive chemicals like annonaceousacetogenins, annocherine A, cherianoine, annocherine B, cherimoline, anomolin, romucosine H, anonaine etc. The fruit of *Annona cherimola* (*Hanuman phal*) is nutritionally important as it contains high amount of carbohydrates and is a rich source of diverse vitamins such as vitamin C, vitamin B₆, thiamine, riboflavin and folate.

9. Carambola: Bilimbi (*Averrhoa bilimbi*) and carambola (*Averrhoa carambola*) are among the underutilized fruits belonging to family oxalidaceae. Carambola is popularly named as star fruit. The fruit is rich in dietary fibre. Starfruit is known for its richness in phenolics, including flavonoid C-glycosides like carambolaflavone and carambolaside. The fruit also contain alkaloids and volatile compounds like esters, acids, carbonyl compounds. Among sugars, monosaccharides were the most abundant ones, represented by fructose (38–48%) followed by glucose (21–25%) in ripe fruits. The fruits also contain sorbitol (2.4–10.5%).Carambola are often categorized into sweet and sour classes, mostly attributed to differences in its organic acid content. Organic acids like citric acid, tartaric acid, malic acid, and oxalic acid are reported to contribute to fruit acidity. Oxalic acid was the chief organic acid and accounted for almost 30% to 60% of the organic acid pool in the fruit.

10. Wood apple: *Limoniaacidissima*

Wood apple fruits are considered as a potential source of natural antioxidants and seed oil

The fruits are rich in total carbohydrates (24.74%), total proteins (9.30%), oil (0.99%) and fiber (3.32%).The predominant sugars were fructose (16.40%) and glucose

(14.23%), whereas the predominant organic acids were tartaric acid (4.01%), ascorbic acid (4.51%) and citric acid (4.27%). The oil content of fruit pulp was 0.99%. The percentage of saturated fatty acids were 32.17%, that includes palmitic (18.52%) and stearic acids (9.02%), whereas, the unsaturated fatty acids were 51.98%, including oleic acid (23.89%), α -linolenic acid (16.55%), linoleic acid (10.02%) and vaccenic acid (1.78%). The fruit flavor is contributed by the presence of different types of organic acids in fruits such as ascorbic acid, citric acid and tartaric acid.

11. Star Gooseberry:*Phyllanthus acidus*

It is one of the trees with edible small yellow berries belonging to [family Phyllanthaceae](#). The fruits are rich in ascorbic acid and minerals like calcium, iron, phosphorus. Vitamins like thiamine and riboflavin are also present. These fruits are used as a blood purifier and appetite stimulant. It is also used to treat a wide spectrum of diseases such as inflammatory, [rheumatism](#), [bronchitis](#), asthma, [respiratory disorder](#), hepatic diseases and diabetes in India and Asia. The predominant classes of bioactive substances found in this fruit include [triterpene](#), [diterpene](#), [sesquiterpene](#), and [glycosides](#).

Conclusion:

The locally available underutilized fruits are considered as a vital source of essential nutrients. In addition, they have potential bio-active compounds and have immense therapeutical potential which can confer health benefit. Mainstreaming these fruit crops in daily diets need a concerted political, social, technological and economical efforts. Since these underutilized fruits are mostly grown in degraded wastelands and landless women farmers and rural communities mostly rely on them for their seasonal requirement. These potential tree species can be utilized for nutrient fortification of common masses through adequate popularization and market-smart approaches. This in turn will help in economic upliftment of the rural women and rural communities, who sustain their livelihood from these plantations. Additionally adequate nutrient sensitization to popularize these undervalued fruits is also critically required. Further, various studies suggest that the efficacy of nutritional-sensitive interventions in rural areas depends upon underlying factors such as household income and mother's education. Hence, adequate policy advocacy is required to strengthen the use of the underutilized fruit species along with strengthening farm women

awareness, education and income earning dimensions to make nutri-sensitive approaches effective for holistic nutrition security of the country.

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Participation and contribution of male and female in agriculture in rural areas of India

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Agriculture sector plays an important role in the livelihood of people in India providing employment and income. This sector has shown resilience in the face of the COVID pandemic when most of the other sectors of economy have registered marginal or negative growth. The share of agriculture and allied sectors in the Gross Value Added (GVA) of the country at current prices in 2019-20 was 16.5 percent. Although the growth of GVA in 2019-20 was only 2.8 percent as compared to 6.3 percent in 2016-17, yet it was higher than all the other sectors of economy (GOI, 2020).

Women play a key role in agriculture in India apart from the reproductive role and her duty in household activities, care giving, involvement in the society/community etc. They provide critical labour by carrying out large number of activities in agriculture viz. land preparation, sowing operations, planting, weeding, pest control, harvesting, threshing, winnowing, management of livestock & fisheries, storage, processing, and marketing.

Understanding the world of women's work especially in agriculture has generally been studied and discussed from the perspective of participation. Participation indicates involvement or being engaged in an activity and denotes the qualitative aspect whether or not a person is carrying out an activity. Contribution, on the other hand is quantification of the participation and has two dimensions i.e. being engaged (or not) and the duration of engagement. Data on participation is widely available from sources like Census exercise, the periodic National Sample Survey and small-scale field studies. Most of the discourse on women in agriculture in India is built on the data on participation and very often, unknowingly the participation in agriculture is taken as the contribution which presents a narrative far away from the truth. This issue has been lucidly raised by Doss (2011) and Doss et al (2018) citing 'four myths'. The study on quantifying the participation in agriculture requires deeper involvement of time and resources by the researchers and such study are hard to find. To fully understand the world of women's work there is need to study not only their participation in myriad activities from dawn to dusk in various farming situations but also specific to crop/livestock/other enterprises.

Women participating in agricultural activities face a number of challenges which limit the human potential they have. The challenges are in the form of social barriers, lower asset ownership, technological constraints and institutional bias. In spite of the real challenges that they come across, the advocacy for the women's cause in agriculture often gets exaggerated.

Time use study (TUS) provides an important insight into the participation and contribution in different activities. Jain and Chand conducted first mini-TUS called “time allocation survey (TAS)” (Jain 1996) in two states Rajasthan and West Bengal based on 127 households; MoSPI conducted first official pilot TUS in 1998-99 across six states in India: Haryana, Madhya Pradesh, Gujarat, Odisha, Tamil Nadu, and Meghalaya based on 18591 households; NSO (2020) conducted the first nation-wide time use survey on 138799 households and covered the entire country except Andaman & Nicobar Islands (Deshpande 2021).

The unit level data of the first time use study (TUS-19) was taken to analyze the participation and contribution of male and female in agriculture for all states and Union Territories of India. All the activities of men and women are reported under 9 major division and 165 activities according to the International Classification of Activities for Time Use Statistics 2016 (ICATUS 2016). Thirteen activities falling under major division 1 and 2 were considered as agricultural activities (Table 1).

Table 1. List of activities considered as agricultural activities

Sl no	Major division / Activity title (group code)
	<i>Major division 1: Employment and related activities</i>
1	Growing of crops for the market in household enterprises (121)
2	Raising animals for the market in household enterprises (122)
3	Forestry and logging for the market in household enterprises (123)
4	Fishing for the market in household enterprises (124)
5	Aquaculture for the market in household enterprises (125)
	<i>Major division 2: Production of goods for own final use</i>
6	Growing crops and kitchen gardening, for own final use (211)
7	Farming of animals and production of animal products for own final use (212)
8	Hunting, trapping and production of animal skins for own final use (213)
9	Forestry and logging for own final use (214)
10	Gathering wild products for own final use (215)
11	Fishing for own final use (216)
12	Aquaculture for own final use (217)
13	Making, processing food products, beverages and tobacco for own final use (221)

Participation rate was calculated as the percentage of person's age 6 years and above, performing that activity during the 24 hours of the reference period. Average *time spent on an activity* was calculated by taking into account the total time spent by those who participated in the activity. *Participation (relative share in agriculture)* of male and female was calculated as the percentage of men and women involved in agriculture. The *contribution of male and female* in different sectors of agriculture was calculated by aggregating the total time spent by male and female and thereafter calculating the relative share of male and female.

The study revealed that in rural areas 22.4 percent women (age 6+) and 34.6 percent men (age 6+) participate in agriculture and allied activities including crop and livestock sector, spending on an average 233 min/day by women 330 min/day by men. Sector wise estimates revealed that in crop sector, 13.3 percent of women participate spending 274 min/day as against 28.9 percent rural men with 330 min/day. Similarly, for the livestock sector participation was 10.7 percent with 129 min/day for women and 10.8 percent with 147 min/day for men.

Among states and UTs, Gujarat had the highest male participation in agriculture (45.8%) followed by Mizoram (44.4%), Maharashtra (43.7%), Karnataka (42.3%) etc. Fifteen states and UTs had male participation more than the country's average (34.6%). Very low male participation in agriculture was observed in Chandigarh, Delhi and Goa. Among states and UTs, Himachal Pradesh had the highest female work participation in agriculture (46.4%) followed by Rajasthan (38.6%) and Nagaland (37.5%) and the lowest was in Lakshadweep (4.7%) followed by Bihar (8.8%) and Goa (8.8%). Nineteen states and UTs had female participation more than the country average (22.4%). Sector wise participation depicts that gender parity is more in livestock sector (10.8% male, 10.7% female) than the crop sector (28.9% male, 13.3% female). States with higher male work participation in agriculture are due to relatively more involvement of males in crop sector and the states with higher female participation were due to higher participation in the livestock sector.

Time spent

With respect to time spent, Telangana had the highest average time spent per day by male in agriculture (390 min) followed by Mizoram (379 min) and Punjab (372 min). On the other

hand, Chandigarh the lowest time spent (180 min) followed by Lakshadweep (223 min) and Kerala (235 min). Among states and UTs, Telangana had the highest time spent by female agriculture (349 min) followed by Mizoram (314 min) and Maharashtra (304 min) and the lowest was observed in Lakshadweep (79 min) followed by Goa (101 min) and Assam (122 min).

Participation (relative share of men and women in agriculture)

Of the total (wo)manpower engaged in agriculture, 38.7 percent are women, the rest (61.3) being men. Share of women in livestock sector is much higher (49.1%) as compared to crop sector (31.1%). Considering agriculture as a whole, the highest share of women was observed in Goa (72.6%). Five states and UTs had higher relative share of women participation than men. In crop sector also, the highest share of women was in Goa (74.5%) whereas, in livestock Rajasthan (69.2%) had the highest share of women of the total (wo)manpower engaged. Uttarakhand is the only state having higher share of women in all the three categories i.e. overall agriculture, crop and livestock sector.

Contribution

Contribution in agriculture was arrived by projecting the participation rate to population, multiplying with time spent per day and thereafter, calculating the relative share of men and women. It was observed that women contribute 30.8 percent and men 69.2 percent of the total time required in agriculture. In crop sector alone, women's time contribution was 27.2 percent as against 72.8 percent by men. In livestock sector women's time contribution was 45.8 percent as against 54.2 percent by men. This substantiate the general perception that women contribute on a much higher scale in livestock management activities in the country than that of crop production activities.

Among states and UTs, Himachal Pradesh had the highest contribution of female in agriculture (57.5%) followed by Uttarakhand (56.1%) and Goa (52.4%) and in these three states the contribution of women were higher than men. Contribution of women were higher than men in three states and UTs in crop sector and eight in livestock sector. In Uttarakhand women's contribution was found to be higher than men in both crop and livestock sector. Lakshadweep had the lowest contribution of women in agriculture (6.3%) followed by Bihar (13.2%) and West Bengal (15.2%) (Table 2).

It was concluded that women contribute 53.8 percent of labour in the agricultural household in rural areas as compared to 46.2 percent by men. Women get less time for learning, socialization and self-care. Because of burden of unpaid domestic and care work, their participation in agriculture is lower (22.4% women vs 34.6% men) and their contribution is also lower 30.8 percent than men (69.2%).

Table 2. State wise participation, time spent and contribution of men and women in agriculture and allied activities in India (2019)

S N	State	Participation (%)						Time spent (min/day)		Participation (%) (relative share)			Contribution (%)		
		Agriculture		Crops		Livestock		Agriculture		Agri cultu re	Crop s	Live stock	Agri cultu re	Crop s	Live stock
		M	W	M	W	M	W	M	W	Women			Women		
1	Andhra Pradesh	33.2	21.3	25.8	14.8	10.4	6.7	360.0	^{h4} 297.0	39.8	37.3	40.0	35.3	36.6	34.4
2	Arunanchal Pradesh	40.1	32.4	35.1	^{h3} 28.3	7.0	7.4	290.0	242.0	42.5	42.5	49.3	38.2	37.9	54.5
3	Assam	37.9	20.0	33.2	13.9	5.5	2.7	258.0	^{l3} 122.0	34.3	29.2	32.9	^{l5} 19.8	18.4	27.0
4	Bihar	29.4	^{l2} 8.8	25.5	4.9	7.0	3.9	312.0	174.0	^{l3} 21.5	^{l5} 15.0	33.7	^{l2} 13.2	^{l3} 11.1	27.4
5	Chhattisgarh	39.5	31.9	34.3	^{h5} 27.5	8.4	3.6	314.0	275.0	44.4	44.2	30.0	41.1	42.3	21.2
6	Goa	^{l3} 4.0	^{l2} 8.8	^{l2} 2.6	6.2	^{l1} 0.4	^{l1} 0.1	^{l4} 244.0	^{l2} 101.0	^{h1} 72.6	^{h1} 74.5	26.1	^{h3} 52.4	^{h1} 61.5	17.6
7	Gujarat	^{h1} 45.8	^{h5} 34.8	^{h1} 40.7	20.5	12.6	18.5	^{h4} 363.0	258.0	42.0	32.4	^{h5} 58.5	34.0	27.7	^{h3} 61.0
8	Haryana	29.2	26.6	22.0	^{l3} 3.1	15.9	^{h4} 24.5	316.0	183.0	44.7	^{l2} 11.0	57.7	31.9	^{l4} 11.3	^{h5} 59.4
9	Himachal Pradesh	35.3	^{h1} 46.4	20.1	17.7	^{h3} 20.5	^{h1} 39.3	^{l5} 245.0	233.0	^{h3} 58.7	48.7	^{h2} 67.5	^{h1} 57.5	40.5	^{h1} 70.9
10	Jharkhand	26.8	17.3	23.6	12.4	6.0	4.1	319.0	210.0	38.7	34.0	40.0	29.4	26.9	33.3
11	Karnataka	^{h4} 42.3	23.5	^{h4} 38.0	18.5	11.4	6.9	344.0	276.0	35.9	33.0	37.9	31.0	30.5	35.7
12	Kerala	^{l4} 17.4	^{l4} 9.5	^{l4} 13.2	5.7	4.3	4.5	^{l3} 235.0	^{l4} 140.0	38.7	33.4	55.0	27.3	22.5	44.0
13	Madhya Pradesh	^{h5} 40.9	24.7	34.7	17.6	12.9	8.0	349.0	264.0	36.2	32.3	36.8	30.0	29.6	30.2
14	Maharashtra	^{h3} 43.	31.0	^{h2} 39.	27.2	10.1	4.4	357.0	^{h3} 304.	40.6	40.1	29.5	36.8	37.9	23.6

S N	State	Participation (%)						Time spent (min/day)		Participation (%) (relative share)			Contribution (%)		
		Agriculture		Crops		Livestock		Agriculture		Agri cultur e	Crop s	Live stock	Agri cultur e	Crop s	Live stock
		M	W	M	W	M	W	M	W	Women			Women		
		7		1					0						
15	Manipur	27.5	27.3	22.6	20.7	¹⁴ 2.0	¹⁵ 2.6	261.0	180.0	48.2	46.1	54.4	39.1	40.5	38.8
16	Meghalaya	35.2	18.5	29.9	16.4	8.7	3.0	315.0	231.0	35.1	36.1	26.2	28.4	28.8	22.4
17	Mizoram	^{h2} 44.4	24.5	^{h3} 38.4	18.4	3.7	5.7	^{h2} 379.0	^{h2} 314.0	33.8	30.7	^{h4} 58.8	29.7	28.6	58.3
18	Nagaland	35.6	^{h3} 37.5	30.2	^{h1} 32.6	5.4	6.1	310.0	248.0	49.7	^{h5} 50.3	51.4	^{h5} 44.1	^{h4} 45.0	43.8
19	Odisha	31.3	16.1	26.7	7.6	6.5	7.7	325.0	193.0	33.8	22.1	53.8	23.3	18.1	41.6
20	Punjab	25.0	12.7	20.1	¹¹ 1.8	10.4	11.8	^{h3} 372.0	149.0	31.5	¹¹ 7.4	50.8	¹⁴ 15.6	¹¹ 5.2	43.6
21	Rajasthan	32.0	^{h2} 38.6	26.4	19.4	12.9	^{h2} 29.4	352.0	222.0	^{h4} 54.2	41.9	^{h1} 69.2	42.8	33.2	^{h2} 66.5
22	Sikkim	39.4	26.9	27.9	18.2	^{h2} 23.7	.	310.0	211.0	37.0	36.0	¹¹ 0.0	28.6	28.5	¹¹ 0.0
23	Tamil Nadu	25.8	19.9	20.3	13.5	7.7	7.2	^{h5} 362.0	^{h5} 295.0	44.7	41.1	49.7	39.7	39.5	45.6
24	Telangana	40.2	30.7	^{h5} 36.8	^{h2} 28.7	7.3	¹⁴ 2.2	^{h1} 390.0	^{h1} 349.0	43.4	43.9	¹⁵ 23.5	40.6	^{h5} 42.4	¹⁵ 17.5
25	Tripura	29.5	14.3	25.1	7.9	5.0	5.3	303.0	187.0	31.8	23.1	50.3	22.3	17.3	52.3
26	Uttar Pradesh	37.6	22.7	29.0	8.7	^{h5} 17.8	16.9	298.0	188.0	37.0	22.6	48.0	27.1	17.8	47.9
27	Uttarakhand	21.8	^{h4} 35.6	¹⁵ 13.9	19.1	13.7	^{h3} 26.3	260.0	206.0	^{h2} 61.7	^{h2} 57.5	^{h3} 65.5	^{h2} 56.1	^{h3} 50.7	^{h4} 60.8

S N	State	Participation (%)						Time spent (min/day)		Participation (%) (relative share)			Contribution (%)		
		Agriculture		Crops		Livestock		Agriculture		Agri cultur e	Crop s	Live stock	Agri cultur e	Crop s	Live stock
		M	W	M	W	M	W	M	W	Women			Women		
28	West Bengal	30.9	10.9	27.3	¹⁵ 4.3	5.5	6.2	356.0	186.0	¹⁴ 25.5	¹³ 13.1	52.3	¹³ 15.2	¹⁴ 11.3	40.5
29	A&N Island	31.3	11.4	16.5	¹² 2.2	5.0	¹³ 1.7	305.0	273.0	¹⁵ 30.6	¹⁴ 13.8	28.7	28.3	¹² 8.1	27.2
30	Chandigarh	¹¹ 1.9	.	.	.	¹² 1.9	.	¹¹ 180.0	.	¹¹ 0.0	.	¹¹ 0.0	.	.	¹¹ 0.0
31	D&NH and D&D	23.1	29.2	20.1	^{h4} 27.8	¹⁵ 3.4	¹² 1.0	^{h5} 362.0	282.0	^{h5} 53.2	^{h3} 55.5	¹⁴ 20.5	^{h4} 47.0	^{h2} 51.9	24.0
32	Jammu & Kashmir	34.7	34.2	19.3	21.2	^{h1} 24.5	19.6	287.0	155.0	49.1	^{h4} 51.8	43.9	34.3	36.9	31.2
33	Ladakh	23.7	27.1	15.4	9.4	^{h4} 19.3	^{h5} 23.1	259.0	¹⁵ 147.0	48.9	33.8	50.0	35.3	25.2	43.0
34	Lakshadweep	24.3	¹¹ 4.7	¹³ 6.7	¹⁴ 3.9	4.6	.	¹² 223.0	¹¹ 79.0	¹² 16.1	36.4	¹¹ 0.0	¹¹ 6.3	32.2	¹¹ 0.0
35	NCT of Delhi	¹² 2.9	.	¹¹ 1.0	.	¹² 1.9	.	337.0	¹¹ 0.0
36	Puducherry	¹⁵ 20.4	¹⁵ 9.6	16.2	7.1	5.1	3.1	263.0	224.0	32.8	31.1	38.3	29.4	30.3	30.1
37	India	34.59	22.36	28.88	13.33	10.8	10.69	330	233	38.7	31.1	49.1	30.8	27.2	45.8

*h1,h2,... represents highest values in descending order and l1, l2,... represent lowest values in ascending order; M-Men; W-Women;
Abbreviations: A&N Island: Andaman & Nicobar Island; D&NH and D&D: Dadra & Nagar Havelli and Daman & Diu
Source: Authors' calculation using TUS 2019.

Effective Management of Family Resources for Nutritional Security of Women

Dr. H.K. Dash
Principal Scientist, ICAR-IIWM

Distribution of women according to frequency of foods taken

Addressing the triple burden of malnutrition – **prevalence of underweight, micronutrient deficiencies and overweight-obesity** is a key policy priority for India.

	Daily	weekly	Occasionally	Never
Milk/curd	48.8	23.5	21.9	5.8
Pulses/beans	49.6	43.3	6.7	0.4
Dark green, leafy vegetables	52	38.8	8.7	0.3
Fruits	12.5	37.1	48.7	1.6
Eggs	5.2	39.9	26.9	28
Fish	5.1	30.6	29.9	34
Chicken or meat	1.4	34.5	32.6	31.5

Fruit and Vegetable consumption in India

Possible reasons for low level of food & vegetable consumption

- low income, high prices and social and geographical inequities are hypothesized as potentially important constraints.
- Sekhar et al. (2017) found F&V prices to be a major contributor to overall food inflation in India.
- Access to fruits and vegetable including seasonal availability
- Lack of education and about long term benefits of F&V consumption

Burden of disease

The overall burden of disease is assessed using the Disability-Adjusted Life Year (DALY), a time-based measure that combines

- years of life lost due to premature mortality (YLLs) and
- years of life lost due to time lived in states of less than full health, or years of healthy life lost due to disability (YLDs).

DALY= YLL +YLD

One DALY represents the loss of the equivalent of one year of full health.

Using DALYs, the burden of diseases that cause premature death but little disability (such as drowning or measles) can be compared to that of diseases that do not cause death but do cause disability (such as cataract causing blindness).

What studies suggest?

- Malnutrition in 2017, accounted for 68.2% of the total under-5 deaths, and the leading risk factor for health loss for all ages, responsible for 17.3% (of the total disability-adjusted life years (DALYs)).
- *Malnutrition continues to be the leading risk factor for disease burden in India. It is encouraging that India has set ambitious targets to reduce malnutrition through NNM. The trends up to 2017 indicate that substantially higher rates of improvement will be needed for all malnutrition indicators in most states to achieve the Indian 2022 and the global 2030 targets.*

(The burden of child and maternal malnutrition and trends in its indicators in the states of India: the Global Burden of Disease Study 1990–2017 (Lancet Child Adolesc Health 2019; 3: 855–70)

- Globally, consumption of nearly all healthy foods and nutrients was suboptimal in 2017
- The largest gaps between current and optimal intake were observed for nuts and seeds, milk, and whole grains, with mean consumption at 12% of nuts and seeds per day), 16% of whole grains per day of the optimal levels
- In parallel with suboptimal healthy food consumption, daily intake of all unhealthy foods and nutrients exceeded the optimal level globally .
- The consumption of sugar-sweetened beverages (49 g per day) was far higher than the optimal intake.
- Similarly, global consumption of processed meat, red meat and sodium (more than an the optimal amount) were far above the optimal levels.

Diet and disease linkage

The COVID-19 pandemic has raised further concerns about the mental health of a generation of children, but the pandemic represents the tip of the iceberg.

Around the world, mental disorders are a significant and often ignored cause of suffering that interfere with children's and young people's health and education and their ability to reach their full potential.

Unicef

Cost of NCDs

- Huge global loss in output (during 2011-2030, the total lost output was US\$47trillion,)
- Mental health conditions and cardiovascular diseases cost the most accounting for 70% of global output (mental illness -US\$16.3 trillion, CVD -US\$15.6 trillion)
- The higher the income, the higher the burden

- By 2030 total output loss will soar

(Study by *World Economic Forum and the Harvard School of Public Health*)

Transforming the food system to fight non-communicable diseases

Published online 2019 Jan 28. in *Solutions for Prevention and Control of Non-communicable Diseases*

Francesco Branca, director,¹ Anna Lartey, director,² Stineke Oenema, global coordinator,³ Victor Aguayo, director of nutrition,⁴ Gunhild A Stordalen, founder and executive chair,⁵ Ruth Richardson, executive director,⁶ Mario Arvelo, chair,⁷ and Ashkan Afshin, assistant professor of health metrics sciences⁸

Nutrition and Mental Health Linkage

- Overall data support a positive role for the nutrients in the preservation of normal brain function and mental well-being, also through the control of neuroinflammation, and encourage their integration in a well-balanced and varied diet, accompanied by a healthy lifestyle. considering the global human aging and that the brain suffers significantly from the life-long impact of stress factors

Muscaritoli Maurizio (2021) The Impact of Nutrients on Mental Health and Well-Being: Insights From the Literature. Frontiers in Nutrition .

- Magnesium plays a key role in differentiation, proliferation, functioning, and movement of immune cells and is important for balanced immune cell responses.....has beneficial effects on anxiety,
- Magnesium and vitamin B6 help in reduction in stress level
- Vitamin E (alpha tocopherol) deficiency during pregnancy leads to irreversible alterations in brain glutamate levels, and is associated with increased anxiety at adulthood.
- EPA, DHA deficiency linked to anxiety and depression
- Omega-3 PUFA deficiency affects the sleep/wake patterns, cognitive capacity, inflammation
- Antioxidants
- Folic acid, the synthetic form of the water-soluble vitamin B9, also known as folate, must be metabolized into the more bioavailable form L-methylfolate which regulates the production of the neurotransmitters dopamine, norepinephrine and serotonin, thus contributing to mental function and performance and related to neuroinflammation.
- Vitamin B6, or pyridoxine, is a water-soluble vitamin (found as Pyridoxal 5 phosphate CoE) assists more than 100 enzymes to perform various functions, including the breakdown of proteins, carbohydrates, and fats; maintaining normal levels of homocysteine (since high levels can cause heart problems); and supporting immune function and brain health.

Shifting to plant based diet

- Need for extensive changes in various sectors of the food system to improve diet.
- Changes in agricultural practices to reduce potential environmental effects on climate change, biodiversity loss, degradation of land and soil, and freshwater depletion.
- Shifting diet from unhealthy animal-based foods (eg, red meat and processed meat) to healthy plant-based foods (eg, fruits, vegetables, and whole grains) might be associated with lower emission of greenhouse gases and thus might be more environmentally sustainable.
- Shift from animal-based to plant-based diet have also demonstrated that this shift might be associated with lower land use and water footprint.

Food loss and waste (SDG-12)

- Globally, 1.3 billion tonnes of food i.e. around 14 percent of food produced is lost between harvest and retail, while an estimated 17 percent of total global food production is wasted,
- Indian households waste 50 kilograms of food per person per year; 40% of the food is wasted which is equivalent to Rs 92,000 crore a year (UNEP, 2021)
- Undermine the sustainability of our food systems.;
- Undermine our efforts to create a world free of malnutrition
- Means wastage of all the resources used to produce this food - including water, land, energy, labour and capital.
- Reducing food loss and waste can support both F&N security and climate change mitigation efforts.

Challenges to Nutritional security

- Inadequate diet diversity
- Cost of fruits and vegetables/ healthy foods
- Supply
- Distance from point of production to consumption
- Food quality and safety
- Climate risks

Dietary Diversity

- Dietary diversity is a **qualitative measure of food consumption that reflects household access to different kinds of foods**. It is also a proxy for nutrient adequacy of the diet of individuals.
- Different foods and food groups are good sources for various macro- and micronutrients,
- There are approximately 100,000 bioactive phytochemicals available in plant sources including vegetable, fruit, berry, and whole grain consumption that have positive effects on health

Food groups for dietary diversity score

	HDSS (score 0-12)	MDD-W (score 0-10)
1	Cereals	Grains, white roots and tubers, and plantains
2	Roots and tubers	Pulses (beans, peas and lentils)
3	Vegetables	Nuts and seeds
4	Fruits	Dairy products
5	Meat, Poultry	Meat, poultry and fish
6	Eggs	Eggs
7	Fish and seafood	Dark green leafy vegetables
8	Pulses/legumes/nuts	Other vitamin A fruits and vegetables
9	Milk and milk products	Other vegetables
10	Oils/ fats	Other fruits
11	Sugar/honey	
12	Spices, condiments...	FAO and FHI 360. 2016. Minimum Dietary Diversity for Women: A Guide for Measurement. Rome: FAO.
	If the category of biofortified crops is added, increase the cut-off point to at least 6 or more for women; and 5 or more for children.	

HDSS and MDD-W

- MDD-W is a dichotomous indicator of whether or not women 15 to 49 years of age have consumed at least five out of ten defined food groups the previous day or night.
- It is a food group diversity indicator that reflects one key dimension of diet quality – micronutrient adequacy – summarized across 11 micronutrients: vitamin A, thiamine, riboflavin, niacin, vitamin B6, folate, vitamin B12, vitamin C, calcium, iron and zinc.
- The proportion of women of reproductive age (WRA) who achieve this minimum of five food groups out of ten in a population can be used as a proxy indicator for higher micronutrient adequacy. In other words, a higher prevalence of MDD-W among a group of WRA is a proxy for better micronutrient adequacy in a given population (Martin-Prével et al., 2015)

Types of foods

- Super foods
- Functional foods
- Nutrient dense foods
- Enriched foods
- Enhanced foods

The 2015–2020 US Dietary Guidelines recommend healthy eating patterns, "combining healthy choices from across all food groups — while paying attention to calorie limits."

Nutrient dense foods

- Nutrient-dense foods **contain vitamins, minerals, complex carbohydrates, lean protein, and healthy fats**. Examples of nutrient-dense foods include fruits and vegetables, whole grains, low-fat or fat-free milk products, seafood, lean meats, eggs, peas, beans, and nuts.
- The term *nutrient density* -eating mostly nutrient-dense foods.
- There are many ways that health experts describe the idea of eating a nutrient-dense diet.
- The term “nutritarian (by Dr. Joel Fuhrman, author of the book “Eat to Live,”) describes someone who chooses foods based on their *micronutrient per calorie* content.
- In other words, a nutritarian doesn’t bother counting calories, eating only low-fat foods or sticking to a raw food diet. Nor does a nutritarian follow a “one-size-fits-all” diet plan or theory.
- Rather, he or she focuses on eating a variety of the most nutrient dense foods available — in other words, unprocessed, whole foods — in order to feel satisfied and remain healthy.
- Nutrient density refers to the amount of beneficial nutrients in a food in proportion to how many calories it has (or its energy content).
- According to the National Institutes of Health and the U.S. Department of Health & Human Services, “nutrient-dense foods” are those that provide a high amount nutrients but have relatively few calories.
- Fruits and veggies are probably what come to mind when you think of healthy foods, but other whole foods have high nutrient density values, too. Examples include wild-caught fish, cage-free eggs, beans and peas, raw nuts and seeds, grass-fed lean meats and poultry, and ancient/whole grains.
- Let’s look at eggs as an example: are eggs nutrient-dense? Yes, free-range eggs are considered by most to be healthy foods — because in just 75 calories per large egg, you’ll get plenty of B vitamins, choline, vitamin D, plus healthy fats like omega-3s, and some protein, too.

Why Are Nutrient-Dense Foods Important?

- Healthy, whole foods provide us with essential vitamins, minerals, amino acids (that form protein), fatty acids and more.
- Another way a nutrient-dense diet could be described is as an anti-inflammatory diet, which is important for preventing chronic diseases and risk factors like heart disease, high blood pressure, diabetes and obesity.
- The overall quality of people’s diets depends the level of micronutrients and macronutrients they obtain per calorie that they eat.(USDA)

Global action-transforming food systems

The health impacts associated with poor diet quality.

Diets of poor quality : a principal contributor to the multiple burdens of malnutrition - and are significant risk factors for NCDs.

Increasing healthcare costs linked to increasing obesity rates

Three types of diets

- basic energy sufficient diet meeting calorie needs,
- nutrient adequate diet,
- healthy diet which includes recommended intake of more diversified and desirable food groups.
- the cost of the diet increases incrementally as the diet quality increases and this is true across all regions and country income groups.
- The cost of a healthy diet is 60 percent higher than the cost of the nutrient adequate diet, and almost 5 times the cost of the energy sufficient diet.
- *Question is if three levels of diet quality are within reach of the poor.*
- Diet quality is a critical link between food security and nutrition outcomes --- to achieve the hunger, food security and nutrition targets of SDG 2.
- ensure that people have enough food to eat, and that what they are eating is nutritious.
- However, one of the biggest challenges to achieving this is the current cost and affordability of healthy diets,

Six possible pathwaysto transform food systems

Drivers of food insecurity and malnutrition	<ul style="list-style-type: none"> • Integrating humanitarian, development and peace building policies in conflict-affected areas; • Scaling up climate resilience across food systems; • Strengthening the resilience of the most vulnerable to economic adversity; • Intervening along the food supply chains to lower the cost of nutritious foods; • Tackling poverty and structural inequalities, ensuring interventions are pro-poor and inclusive; and • Strengthening food environments and changing consumer behaviour to promote dietary patterns with positive impacts on human health and the environment. 	Transformation of food systems for improved nutrition and access to affordable healthy diet
Conflict		
Climate variability and extremes		
Economic slowdowns		
Unaffordability of healthy diet		
Underlying poverty and inequality		

- Fiscal subsidies provided incentives to growing production and reducing the prices of cereals (especially maize, wheat and rice).
- created (relative) disincentives towards producing nutritious foods, encouraged monocultures in some countries,
- ceased the farming of certain nutritious products, and discouraged the production of some foods that do not receive the same level of support.

Sustainable solutions.....

- Reducing distance between point of production and consumption
- Making food affordable for all; improving access to quality foods ensuring dietary diversity for women
- Introducing good practices for production of nutrient rich food
- Efficient and effective use of available resources including natural resources
- Reducing wastes at household and community level and utilizing wastes/biomass/crop residues for creation of wealth;
- Overall, India produces 686 MT gross crop residue biomass on annual basis, sugarcane produces the highest amount of surplus residue followed by rice.
- Collective efforts , leveraging existing programmes, institutions policies through application of S&T
- Brining convergence among departments/agencies/ institutions
- Harnessing potential of women groups

Key questions...

- What to produce ---type of food/composition
- How to produce ----process and method
- How much to produce –volume /quantity
- When to produce----timing /seasonality

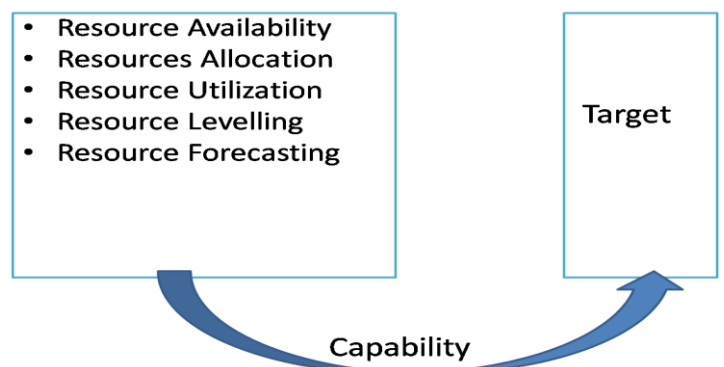
Ultimately, to plan and design creating food systems---nutri-gardens, homestead farms etc.

Resource types

Key words...

- Women
- Nutrition
- Family Resources Management
- Community Participation

Elements in Resource Management



G 20 2023 summit

- The theme of India's G20 Presidency - "Vasudhaiva Kutumbakam" or "One Earth · One Family · One Future"
- Essentially, the theme affirms the value of all life – human, animal, plant, and microorganisms – and their interconnectedness on the planet Earth and in the wider universe.
- The theme also spotlights LiFE (Lifestyle for Environment), with its associated, environmentally sustainable and responsible choices, both at the level of individual lifestyles as well as national globally transformative actions resulting in a cleaner, greener and bluer future.

Water availability

About 4000 bcm of water comes from annual precipitation.

But harvestable component is only 2000 bcm

Falkenmark indicator based on PCWA <1700cum (water stressed)

<1000cum (water scarcity)

<500cum(absolute water scarcity)

Water conservation and its efficient and effective management remain the key issues.

Govt. efforts on tackle water problems

- Jal Shakti Abhiyaan(JSA): Launched in 2019 to improve water availability including ground water conditions in water stressed blocks of 256 districts in the country.
- Catch the rain where it falls- launched on 22nd March 2021 by PM to create awareness and develop action plan on rain water conservation in all districts .
- Jal Jeevan Mission (*Har Ghar Jal*) : to provide safe and adequate drinking water through individual household tap connections by 2024 to all households in rural India

As on 30-12-2022, 10.79 crore out of 19.23 crore households provided tap connections (56.14% coverage)

Public policies and programmes

- MoRD —
- MoSW
- MoWCD
- MoHFW
- MoE
- MoA

Land resources with HH-Odisha

	Category	Homestead land(ha)	Other land owned(ha)	No. of HH(L)
Non-agril	SC	0.14	0.091	7.48

Agril.		0.020	0.346	8.41
Non-agril	ST	0.016	0.130	10.1
Agril.		0.022	0.59	13.12
Non-agril	OBC	0.012	0.087	10.05
Agril.		0.019	0.559	17.95
Non-agril	Others	0.024	0.126	5.8
Agril.		0.028	0.556	8.65
Non-agril	All	0.016	0.108	33.44
Agril.		0.021	0.532	48.53

Constraints

- Fragmentation of land holdings including homestead land
- Deterioration of soil quality-physical, chemical and biological - very low organic carbon,
- Community lands usurped by individuals

Opportunities

- Large part of land owners leasing out their land
- Various govt. schemes incentivizing agriculture through
- Land transfer policy

Human resources

- More than 1.1 crore SHGs linked to banks in India
- Increasing literacy, education, among women
- Skill development efforts, training and empowerment programmes for farmers
- Special incentives for women
- Low work participation rate among women indicating greater scope for productive engagement
- Greater recognition to women's work
- Digitalization offers a world of ideas and knowledge

Constraints

- Poor access to resources and technology
- Limited capability and exposure to scientific knowledge new technology
- Declining interest of youth in agriculture
- Narrowing base of social capital base
- Increasing social and political conflicts

Physical resources

- Increasing mechanization
- Govt. schemes/incentives to acquire and own machines for farm operations
- Innovative operation specific technologies
- Availability of input supply dealers at panchayat level

Constraints

- High cost of energy
- High hiring cost
- Problems in maintenance of equipment

Financial resources

- Host of govt. schemes proving direct benefits
- Increasing flow of institutional credit (₹16.5 Lakh crore in 2021-22)
- Expansion of micro credit base

R&D efforts

- Several projects focusing on areas -SCSP, TSP, nutri-smart villages by ICAR including release of nutrient rich, climate resilient varieties
- NGOs and international agencies- Helen Keller international, Unicef, Akshaya patra foundation...FAO, IFPRI...
- Pvt. Entitites under CSR initiatives

What is for us to do?

- Develop a concept with targets including villages /clusters to be developed
- Bring convergence among us
- Try to fit our institute work/project into a framework to create model
- Monitor and document the evidences on progress
- Our small interventions can bring big differences
- Rural-urban divide in malnutrition

Making Extension & Advisory Services Nutrition-Sensitive: Linkages & Capacity Building

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Introduction

Agriculture remains as the prime source of women's livelihood and women remain as the backbone of the agricultural workforce. Hence, the development of both women and agriculture being essential for the progress of any agrarian economy like India. Indian agriculture supports 17.70% of the world's population, 30% of the world's livestock, and accounts for 20.20% of the country's Gross Domestic Product (GDP) and 17.34% of its exports and having over half of the nation's population dependent on it as a major source of income (NSO, 2021). Globally, women play key roles in harvest and post-harvest activities both in agriculture and allied sectors. The sector includes horticulture, livestock, dairy, fisheries, agro-forestry and agro-processing. Recent statistics released by the National Council of Applied Economic Research (2018) state that women constitute over 42% of the agricultural labour force in India. Agriculture sector employs 80% of economically active women in India and 48% of the self-employed farmers are women. About 60-80% of the world's food is produced by rural women. In Maharashtra, 88.46% of rural women are employed by agriculture, the highest in the Country. The percentage share of female operational holders has increased from 12.79% in 2010-11 to 13.96% in 2015-16 with the corresponding figures of 10.36% and 11.72% in the operating area. In 2015-16, participation of female operational holders was highest under marginal category (72%) followed by small (17%) and semi-medium (8.10%). The share of female operational holders belonging to SC and ST social groups were estimated at 11.40% and 7.90% respectively (Agricultural Census 2015-16, 2020).

Malnutrition Scenario

Nutrition security of all human beings continues to be an important item in the development agenda of the global community. This is clearly reflected in the Sustainable Development Goals (SDGs) of the UNO to be achieved by 2030. Out of 17 SDGs, the first three, i.e. No Poverty, Zero Hunger, Good Health and Wellbeing are directly related to nutrition. The fifth one, i.e. Gender equality has significant implications for creating a nutrition secured society-a

target that is still elusive despite the collective efforts of countries and organizations across the globe. Globally, 795 million people, 10.9% were chronically undernourished during 2014-16. Out of 780 million undernourished people in developing countries, 194.6 million people in India, constituting 15.2% of its population, were malnourished during the said period. Only 9.6% of total children (aged 6-23 months) receive adequate diet in India. About 38.4% of the children (under 5 years) in India are stunted, 21% are wasted and 35.7% are underweight. About 56.4% women have Body Mass Index (BMI) in normal (18.5 - 25 kg/m²) rangewhere 61.2% men have BMI in normal range. About 58.4% children (6-59 months) are anemic, 53% women and 22.7% men (15-49 years) are anemic (NFHS, 2016). Thus, incidence of malnutrition is relatively more among women and children. Women who suffer malnutrition are less likely to have healthy babies. Consequently, new born infants are unable to get adequate amount of nutrition from their mothers. Deficiencies in nutrition inflict long-term damage to both individuals and society. Compared with their better-fed peers, nutrition-deficient individuals are more likely to have infectious diseases such as pneumonia and tuberculosis, which lead to a higher mortality rate. In addition, nutrition-deficient individuals are less productive at work. Low productivity not only gives them low pay that traps them in a vicious circle of under-nutrition, but also brings inefficiency to the society, especially in India where labour is a major input factor for economic production.

Why Nutrition in Agriculture?

Malnutrition is worldwide problem which is affecting individuals, households and societies. Agriculture and nutrition are intrinsically interlinked. Beyond producing sufficient quantity food, agri-food systems should also:

- Provide diversified, safe and nutritious foods
- Improve rural incomes and resilience, and thus enhance access to healthy diets
- Make foods that contribute to a healthy diets available and accessible at grassroot level

Principles of the Nutrition Sensitive Agriculture

1. Community participation and ownership
2. Special consideration to women and children
3. Need evidence based planning and implementation
4. Innovative and indigenous knowledge based

5. Environmental friendly and sustainable
6. Multi-sectoral collaboration and coordination
7. Building competency based capacity of frontline service providers

Objectives of the Nutrition Sensitive Agriculture (NSA)

- To leverage nutrition in to agriculture sector policy, strategy, program and work plans at all levels
- To establish institutional structures and capacity responsible for planning and implementing NSA
- To increase year-round availability, access and consumption of diverse, safe and nutritious foods
- To enhance resilience of vulnerable communities and households prone to climate change and moisture stress
- To ensure women's empowerment and gender equality
- To establish/strengthen multi-sectorial coordination within the agriculture sectors and other development partners

Key EAS Interventions for Promoting NSA

- **Adopt a food-system approach** rather than focusing on production alone
- **Promote sustainable ways to increase and diversify production** - Cultivation of nutritious crops, backyard animal rearing, etc. can improve availability of diversified food at household, community, and perhaps national level.
- **Adapt every intervention and promoted practice** to the dietary issues of households, local dietary preferences, agricultural calendar and agro-ecological conditions.
- **Promote home/kitchen/school gardens** and homestead food production and processing
- **Raise awareness** of nutrition and basic dietary principles in line with national food-based dietary guidelines (if available), hygiene, food preservation and preparation
- **Facilitate access** to markets and promote on- and off-farm income generation activities. Additional income - improve access to nutritious non-farm food

- **Empower women** who are often responsible for household food production and nutrition. Gender-based division of tasks must be considered.
- **Target both men and women**-Women are more often targeted by nutrition interventions, but sometimes neglected by agricultural ones.
- **Work in collaboration** with influential community members and health workers to raise awareness on NSA

How to Strengthen Linkages among NSA Actors?

- Establish nutrition sensitive agriculture forum/taskforce to establish/ strengthen strong linkage with government, donors, NGOs, academia, researchers and private sectors to jointly plan, implement and monitor NSA interventions
- Capacitate the agriculture sector bodies to actively engaged in co-chairing the nutrition coordination bodies and vice-versa to improve implementation and adequately address NSA issues
- Actively engaged in strengthening the national and regional nutrition coordination bodies and technical committees.
- Strengthen the institutional linkages at grassroots level (e.g. health extension workers and development agents) for improved nutrition practices at household and community levels.

Assess Nutrition-related Capacity of EAS System

- Map the pluralistic EAS landscape and activities relevant to nutrition and NSA
- Engage with EAS/nutrition champion organizations
- Assess the capacity of various EAS providers
- Become familiar with local diet and nutrition issues, local dietary patterns and foods, and local food growing and production conditions

Organizational and Individual Capacity Building

- **Include nutrition-related objectives** in EAS mandates and work plans, even if their mandate and business model do not envision it.

- **Strengthen the material and financial capacities** of EAS providers. Investment is often needed in training, recruiting, and improving staff mobility.
- **Work with agricultural education institutes** to integrate NSA into their curricula.
- **Food system and value chain approach** can help foster a holistic understanding of how agriculture and food chains are linked to healthy diets and nutrition.
- **Conduct reciprocal training** for extensionists on the fundamentals of nutrition and NSA, and for nutritionists and health workers on how agricultural interventions can improve nutrition.

Strengthening the Enabling Environment

- ❖ **Raise awareness** among agricultural stakeholders, especially **policy makers**, on the importance of nutrition and advocate for recognition of their role in addressing it.
- ❖ **Review current agricultural and sectorial policies and strategies** to explicitly state the role of agriculture in addressing nutrition.
- ❖ **Create national and local dialogue and coordination** mechanisms between government, research and EAS stakeholders.
- ❖ **Create incentives for sustainable partnerships** among nutrition and agricultural stakeholders.
- ❖ **Document good practices** and promote NSA knowledge platforms

Empower Women and Enhance their Role in NSA

A. Increase access to resources and inputs for women

1. Promote and support women's involvement in on/off-farm income generating activities
2. Provide agriculture extension services and inputs for women
3. Increase female membership and leadership in cooperatives and farmers' groups
4. Organise women farmers' groups (FPOs) in different income generating activities and facilitate market access
5. Strengthen awareness of women farmers on nutrition sensitive production & consumption

B. Promote labour and energy saving technologies to reduce women's work load

1. Identify, test and demonstrate labour and time saving technologies.
2. Avail labour & time saving technologies at FTC's

C. Promote gender sensitivity in NSA at all levels

1. Develop and disseminate tools to assess women's involvement and benefits from NSA interventions.
2. Monitor and analyze women's empowerment and benefits from NSA interventions

D. Address socio-cultural issue

1. Promote active male involvement in feeding and caring practices
2. Develop and disseminate material to address socio-cultural barriers to women's nutrition

The Monitoring and Evaluation Aspects of the NSA

1. Provide support to establish comprehensive monitoring and evaluation system
2. Review the implementation of NSA interventions on regular basis
3. Ensure the incorporation of NSA indicators and targets in work plans at all levels
4. Develop checklist of key NSA indicators to monitor progress
5. Integrate the recording, analysis and reporting of sex disaggregated nutrition data
6. Build the capacity of staff in data management at all levels - Collect & analyze data to see progress, trends and changes over time
7. Conduct surveys/assessments to document knowledge products/success stories

Holistic Intervention Involving Women

There are a number of pathways to address the issue of nutrition insecurity. The informed decision making by women farmers can reduce the burden of malnutrition to a great extent. Some of the interventions that may be targeted involving rural women are given below.

- (a) **Enhancing Pulse Production:** Pulses, being an important source of protein, different essential amino acids, vitamins and minerals, do form an inalienable component of human diet and under-consumption of pulses is therefore the most likely cause of malnutrition. One of the pathways to increase production of pulses could be to strengthen women's role in pulse production through science and technology interventions supported by farmer friendly policies to make pulse production remunerative. Additionally, available fallow lands around village may be brought under pulse cultivation with involvement of women groups. Towards this end, village level

Para extension workers can play a pivotal role in learning the technologies and demonstrating the same in fields.

- (b) **Nutrition Garden:** Development of nutritional gardens in the homesteads where family members including women can contribute their labour is a convenient and effective way to improve consumption of fruits and vegetables. In this case also Village level Para Extension workers can play an important role for promotion of nutrition gardens by making available quality seeds and package of practices to women.
- (c) **Livestock and Poultry Rearing:** Though rearing of milch animals and poultry birds are common in rural areas; low yield from these sources is one of the reasons of poor access to animal based products. Therefore, scientific management of such resources is critical to augment availability of foods like milk and egg at household level. Interventions could be at household or community level. There are many government programmes that women can take advantage of. In this case also village level para extension workers can facilitate timely flow of information both ways benefiting rural women.
- (d) **Nutrition Education:** Lack of proper awareness and education among a large section of rural women on nutrition requirements, nutrition sources and benefits and nutrition related problems is an important factor of malnutrition. Often availability of different food sources fail to ensure nutrition security due to ignorance of women about what is required and what is to be taken. Therefore, it is imperative to promote nutrition education among rural women where in village level para extension workers can play pivotal role by disseminating nutrition related information brochures.

Conclusion

In conclusion, there are a number of pathways to address the issue of nutrition insecurity at household level. Long term food security demands production technology of non-cereal food as well as technology access to the small producers especially women farmers should be promoted. Many traditional vegetables and underutilized legume crops are an essential source of energy, vitamins, micronutrients and protein and, thus, a valuable component to attain nutritional security. The informed decision making by women farmers can reduce the burden of malnutrition to a great extent. Extension systems need to facilitate both men and women to become an active change agent for gender sensitive decision making at household level. Therefore, it is worthwhile to capture, integrate and scale out best bet practices to build

gender transformative agricultural extension system for strengthening household food and nutrition security in India.

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Prevalence and Challenges of Malnutrition in India

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According to the National Family Health Survey (NFHS)-5, India has unacceptably high levels of stunting, despite marginal improvement over the years. The number of children under 5 years who are stunted (less height-for-age) in India has come down from 38.4% to 35.5% and the number of children who are underweight (less weight-for-age) has come down from 35.8% to 32.1%. The NFHS-5 reported wasting (weight-for-height) in 19.3% children less than five years as compared to 21 per cent in NFHS-4.

So far as Odisha is concerned, there is noticeable improvement in figures relating to child malnutrition as compared to the national averages. Stunting in Odisha has come down significantly from 38.2% in NFHS-4 to 31% in NFHS-5. The percentage of underweight children has gone down from 34.4% to 29.7% and there has been a marginal improvement of 0.2% in the figures concerned with wasting. Though there is a long way to go to achieve top performing status, it seems that there is a good momentum on key essential nutrition actions.

To address the issue of malnutrition, especially in women and children, the Government of Odisha has been implementing the flagship centrally sponsored schemes such as the Integrated Child Development Services (ICDS), the Mid-Day Meals (MDM) scheme and the Central Government's food subsidy scheme called the Targeted Public Distribution System (TPDS). It has also seen good results in its schemes MAMATA and Janani Suraksha Yojana targeting the overall well-being of pregnant, lactating women and their infants (including their nutritional needs). It aims to promote the thought of healthcare seeking behaviour amongst all echelons of the society.

According to the National Family Health Survey (NFHS) 2019-21, the 5th in the series India has seen no significant improvement in health and nutritional status among its population. The latest data shows, **7.7% of children are severely wasted, 19.3% are wasted and 35.5% are stunted.**

33 Lakh Children in India Malnourished, **Over 50% Cases Severe.**The bane of child and maternal malnutrition is responsible for 15 per cent of India's total disease burden.

There are 51 million wasted children in the world; India alone houses **20 million** - that's half of the world's severely wasted children. (CNNS 2016-18 and JME 2018 in India). Wasting, or low weight for height, is a strong predictor of mortality among children under five.

Recently, the Union Minister for Women and Child Development has informed Rajya Sabha that there were **927,606 severely acute malnourished children in India**.

Child Malnutrition

- **Malnutrition**, in all its forms, includes **undernutrition** (wasting, stunting, underweight), **inadequate vitamins or minerals**, **overweight**, **obesity**, and resulting diet-related noncommunicable diseases.
- The term malnutrition **addresses 3 broad groups of conditions**:
 - **Undernutrition**, which includes **wasting** (low weight-for-height), **stunting** (low height-for-age) and **underweight** (low weight-for-age)
 - Together, the stunted and wasted children are considered to be **underweight**, indicating a **lack of proper nutritional intake and inadequate care post-childbirth**.
 - **Micronutrient-related malnutrition**, which includes micronutrient deficiencies (a lack of important vitamins and minerals) or micronutrient excess; and
 - **Overweight, obesity and diet-related noncommunicable diseases** (such as heart disease, stroke, diabetes and some cancers).
- It is a **chronic problem** and a **longstanding challenge** for the public administration of India.

Causes

- **Agriculture Output**: The agriculture output from small and marginal holdings are either stagnant or declining due to reasons such as reduced soil fertility, fragmented lands or fluctuating market price of farm produce.
- **Low Income**: Relative income of one section of people has been on the decline.
 - This has adverse effects on their capacity to buy adequate food, especially when food prices have been on the rise.
 - The kinds of work a section of people have been doing are less remunerative or there is less opportunity to get remunerative work.

- **Public Distribution System:** The public distribution system of the state is not functioning well or is not accessible to everyone.
- **Rural Unemployment:** The emaciated rural livelihoods sector and lack of income opportunities other than the farm sector have contributed heavily to the growing joblessness in rural areas.
 - The PLFS 2017-18 revealed that **rural unemployment** stood at a concerning **6.1 per cent**, which was the **highest since 1972-73**.

India's Malnutrition Profile

- The first **National Family Health Survey (NFHS)** in **1992-1993** found that India was **one of the worst performing countries** on child health indicators.
- There are about **189.2 million undernourished people** in India with a majority of who are women and children.
- According to government figures from the year **2015-2016**, **22.9 per cent** of women in the 15-29 age group are underweight, as compared to 20.2 per cent of men in the same age group.
 - Further, according to **The State of Food Security and Nutrition in the World 2020 report**, in 2016, nearly 51.4 per cent of women of reproductive age in India were suffering from anemia.
 - Almost 50 per cent of women are facing severe undernutrition and Anaemia.
- Around **60 million children**, which is roughly about half, of all children in India are **underweight**, about 45 per cent are stunted, 21 per cent are wasted, 57 per cent are vitamin A deficient and 75 per cent are anemic.
- Malnutrition has thus become the **major contributor to the under-five mortality rate in India**.
- These statistics indicate that **under nutrition in India is a gendered problem**.
 - The root cause for these male-female differentials can be found in native socio-cultural norms and mindsets.
 - Such norms, rooted in patriarchy, would suggest that distribution of resources, including food, should be done in a hierarchical manner, with male members of the family typically at the top of the ladder.

- Malnutrition and the widespread prevalence of stunting, wasting and nutritional deficiencies among women and children are **well-recognized elements of India's profile** in the **Global Hunger Index**.
- The prevalence of malnutrition in India has notably declined over the last decade, and the **Comprehensive National Nutrition Survey 2016-18** revealed that major challenges remain.
 - According to the NFHS-4, the **percentage of wasted, stunted and malnourished** children in 2015-16 stood at **21, 38.4 and 35.7** respectively.
 - As compared to NFHS-4 data, the **Comprehensive National Nutrition Survey (CNNS)** compiled in 2017-18 showed an **improvement of 4 per cent, 3.7 per cent and 2.3 per cent** in wasted, stunted and malnourished children **respectively**.

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
4. Minimum Support Price (MSP)
5. The role of women in agriculture
6. Efficient information dissemination
7. Linking farmers and farming households to institutional feeding programmes
8. Promote local agri-food value chains for nutrition.
9. Nutrition gardens of nutrient dense vegetables and fruits
10. Homestead production of animal source foods
11. Social and behavioural change
12. Nutrition sensitive agriculture
13. Farm Mechanization

Measures Taken to Tackle Malnutrition

- **Poshan Abhiyan**

- It was approved in **2017** and launched in **2018**
- It is a **multi-ministerial convergence mission** with the vision to ensure the attainment of malnutrition free India **by 2022**.
- The **Ministry of Women and Child Development** (MWCD) is implementing POSHAN Abhiyaan.
- **Integrated Child Development Services**
 - It was launched on **2nd October 1975** and it represents one of the world's largest and unique programmes for **early childhood care and development**.
 - The beneficiaries under the Scheme are children in the **age group of 0-6 years, pregnant women and lactating mothers**
 - **Ministry of Women and Child Development** is the implementing agency
- **MatritvaSahyog Yojana**
 - Indira Gandhi MatritvaSahyog Yojana (IGMSY) is a **Conditional Maternity Benefit (CMB)** Scheme launched in **2010**.
 - The scheme is being implemented by the **Ministry of Women and Child Development as the centrally sponsored scheme**.
 - It was launched for **pregnant and lactating women** to improve their health and nutrition status to better-enable the environment by providing cash incentives to pregnant and nursing mothers.
- **Pradhan Mantri Matru Vandana Yojana**
 - The **centrally sponsored scheme** was launched in **2017**.
 - **Rs. 6,000** is transferred directly to the bank accounts of pregnant women and lactating mothers for availing better facilities for their delivery to compensate for wage loss and is eligible for the first child of the family.
 - Implementation of the scheme is closely **monitored** by the **central and state governments** through the **Pradhan Mantri Matru Vandana Yojana-Common Application Software (PMMVY-CAS)**.
- **Mid-Day Meal Scheme**
 - The Mid-day Meal Scheme is a **school meal programme** in India designed to better the nutritional standing of school-age children
 - It covers all school students studying in **Classes 1 to 8** of government schools, government-aided schools, special training centres, including madrasas supported under Samagra Shiksha Abhiyan.
- **National Food Security Mission**

- It was launched in **2007-08** by the **Ministry of Agriculture and Farmers' Welfare** as a **Centrally Sponsored Scheme**.
- It was based on the recommendations of the agriculture sub-committee of **the National Development Council (NDC)**.
- It focuses on the sustainable increase in the production of targeted crops through area expansion and productivity enhancement.
- **National Nutrition Mission**
 - It is the government's **flagship programme to improve nutritional outcomes** for children, pregnant women and lactating mothers.
 - **Aim:** To reduce stunting and wasting by 2 per cent per year (total 6 per cent until 2022) among children and anemia by 3 per cent per year (total 9 per cent until 2022) among children, adolescent girls and pregnant women and lactating mothers.
 - The **Ministry of Women and Child Development** is the nodal ministry for implementation.
- **National Nutrition Strategy**
 - The Strategy aims to **reduce all forms of malnutrition by 2030**, with a focus on the most vulnerable and critical age groups.
 - The Strategy also aims to **assist in achieving the targets identified as part of the Sustainable Development Goals** related to nutrition and health.

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Strategic nutrition related interventions rolled out by government of India

Various community nutritional programmes are running in India to combat child malnutrition and to get nutrition on track. These are based on strategic nutrition related interventions. A few of them are discussed below.

Promotion of Infant and Young Child feeding practices (IYCF): exclusive breastfeeding for first 6 months, complementary feeding beginning at 6 months and appropriate infant and young child feeding practices (IYCF) are being promoted. Mother's Absolute Affection (MAA) programme was launched in 2016 to promote breastfeeding and infant feeding practices by building the capacity of frontline health workers and comprehensive IEC campaign.

Establishment of Nutritional Rehabilitation Centres (NRCs): NRCs have been set up at facility level to provide medical and nutritional care to Severe Acute Malnourished (SAM) children under 5 years of age who have medical complications. In addition, the mothers are also imparted skills on child care and feeding practices so that the child continues to receive adequate care at home.

AnaemiaMukt Bharat (AMB): to address anaemia, NIPI has been launched which includes provision of supervised bi-weekly Iron Folic Acid (IFA) supplementation by ASHA for all under-5 children, weekly IFA supplementation for 5–10 years old children and annual/biannual De-worming. The AMB strategy—Intensified Iron Plus Initiative—aims to strengthen the existing mechanisms and foster newer strategies of tackle anaemia, focused on six target beneficiary groups, through six interventions and six institutional mechanisms; to achieve the envisaged target under the POSHAN Abhiyaan. The strategy focuses on testing & treatment of anaemia in school going adolescents and pregnant women using newer technologies, establishing institutional mechanisms for advanced research in anaemia, and a comprehensive communication strategy including mass/mid media communication material.

National De-worming Day (NDD): recognising worm infestation as an important cause of anaemia, National Deworming Day (NDD) is being observed annually on 10th February targeting all children in the age group of 1–19 years (both school enrolled and non-enrolled).

Biannual Vitamin A Supplementation is being done for all children below 5 years of age.

Village Health and Nutrition Days (VHNDs) are also being organized for imparting nutritional counselling to mothers and to improve child care practices.

Conclusion

The facts and discussion presented above, highlights the worrying unacceptably high prevalence and universality of malnutrition in all its forms in Indian communities, but it is both preventable and treatable. Beyond health, malnutrition is also impacting the social and economic development. In Indian context, poverty, maternal health illiteracy, LBW, diseases like diarrhoea, home environment, dietary practices, hand washing and poor hygiene practices are few important factors responsible for very high prevalence of malnutrition. Government of India has rolled out various community nutritional programmes to combat malnutrition and to get nutrition on track. Despite enormous challenges, India has made considerable progress in tackling hunger and under nutrition in the past two decades, yet this pace of change has been unacceptably slow, uneven and many have been left behind. But with sustained prioritization, increased resource allocation, adopting comprehensive, coordinated and holistic approach with good governance and help of civil society, India has the potential to end malnutrition in all its forms and turn the ambition of the Sustainable Development Goals into a reality for everyone.