



AGRIPRENEURSHIP THROUGH FARMING SYSTEM: A VIABLE TECHNO-ECONOMICAL APPROACH FOR WOMEN EMPOWERMENT

2023

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Agripreneurship through Farming System:
A Viable Techno-Economical Approach for
Women Empowerment

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This e-book is a compilation of resource text obtained from various subject experts as a part of ICAR-CIWA, Bhubaneswar & MANAGE, Hyderabad collaborative training on “Agripreneurship through Farming System: A Viable Techno-Economical Approach for Women Empowerment”. This e-book is designed to educate extension workers, students, research scholars, academicians related to agri-allied sectors. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editor do not give warranty for any error or omissions regarding the materials in this e-book

Forward



Women-led businesses have been providing a great impetus to the economy of our country. Feminisation in agriculture is resulting in increasing number of women farmers pursuing entrepreneurship as a natural progression as well as a strategic choice. These women contribute not only to their families' sustenance but also to the nation's food security. Supportive actions are further needed to effectively unlock women entrepreneurial activities in rural areas. Access to information, knowledge and training opportunities are crucial to increase the productivity and income of women farmers. Moreover, acquiring entrepreneurial skills, agricultural techniques and market information, can be particularly beneficial in molding women entrepreneurship. ICAR-Central Institute for Women in Agriculture (ICAR-CIWA) is an institution first of its kind in the world that is exclusively devoted to gender related research in agriculture. ICAR-CIWA supports women farmers across all agricultural subsectors with women friendly technologies and practices for crop, fisheries, livestock and has also been instrumental in bringing out gender sensitive extension methodologies. The impact of these technologies can significantly reduce work burden and food loss, and improve efficiency of the women farmers. Gender inclusive agricultural extension is one means for women to learn these new or improved production techniques, to receive training and advice, to organize themselves and to improve their access to inputs and markets. Hence, the extension functionaries need to be updated on women friendly and gender sensitive extension methodologies, women-friendly technologies in agriculture and allied sectors and entrepreneurial ecosystem of the country as they are the viaduct between research institutions and farmers and farm women. The publication elaborates on the gendered aspects of agriprenuersip development with focus on the women friendly technologies in agriculture and allied sectors. The agricultural potential of India is colossal, and there lies untapped potential in the growth of women-led agri enterprises. Stimulating women-led businesses in rural and agricultural setups can reduce poverty, generate employment, foster social development, and contribute to a more gender-equitable society.

I appreciate the team of ICAR-Central Institute for Women in Agriculture, Bhubaneswar for organizing this collaborative training program with MANAGE, Hyderabad, on Agriprenuership through farming system: a viable techno-economical approach for women empowerment, from 20-24 November 2023 and bringing out the publication which would prove beneficial to the stakeholders for fostering agriprenuership development among rural women.



(Dr Mridula Devi)

PREFACE

The e compendium is an outcome of the collaborative online training programme of ICAR-CIWA, Bhubaneswar and MANAGE, Hyderabad on “Agripreneurship through farming system: a viable techno-economical approach for women empowerment”. The compendium will serve as a guide to academicians, extension functionaries, students, entrepreneurs, and all those who are stakeholders in promoting rural women agripreneurship. Agriculture being mainstay of Indian economy, has the prospect of social and economic development, for example, employment generation, poverty reduction, improvements in nutrition, health and overall food security in the national economy especially in rural areas. When economically empowered, women reinvest in their communities— leading to greater self-reliance, prosperity, and food security. Business opportunities exist in agricultural production, processing and value addition, agricultural marketing, agricultural inputs manufacturing and marketing, agro service, agro tourism etc. But there is urgent need to strengthen the agency of women farmers by providing technical knowledge on these opportunities so that they could venture out into entrepreneurship to supplement their family income. The E-compendium provides a comprehensive information on the gender sensitive farming system approaches and models, secondary agriculture and value addition in agriculture and allied sectors for entrepreneurship development among farmwomen. Entrepreneurial avenues through farming, post harvest processing and engineering existing in agriculture, horticulture, fisheries, poultry, goat farming and farm machinery and power are dealt in detail in the compendium. It also focusses on the climate smart approaches in agriculture and allied sectors for improving resilience of farm families. The publication also throws light on the entrepreneurial ecosystem existing in India to promote rural women entrepreneurship. Since, digital transformation has been creating a buzz in the agri-food sector for nearly a decade now. Hence attempt has been made to detail about the propsects of digital technologies in paving the way for women agripreneurship.

Valuable suggestions for future improvement are always welcome.

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Scope, Needs and Constraints in Developing Rural Women Agripreneurship

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Rural Women Entrepreneurship: Generally the rural women run their own enterprises in rural areas concentrating on informal, micro-level and low-return activities. They mostly use the local resources and work from home to enhance their standard of living. Rural women go for entrepreneurship for self-employment to mitigate family poverty and support themselves. It is found that, women obtain 10% of the income and own less than 1% of the world's resources. Further, it is also realized that, for economic progress of any country or society, women entrepreneurship is essential. Although rural women entrepreneurial prospective remain unrecognized, still, it helps in improving their livelihoods and overall well-being.

Need for Rural Women Entrepreneurship

- Helps for poverty alleviation within their communities
- Increases the standard of living and overall well-being of rural areas
- Enables women for their sustainable economic empowerment
- Develops skills among rural women
- Reduces male migration
- Reduces unemployment and offers employment opportunity
- Increases purchasing power of the rural people
- Facilitates in achieving food and nutrition security

Constranits for Women Entrepreneurship

- Limited access to financial resources for any start-up
- Challenges in accessing education and skill training which keep women in dark
- Restriction in mobility and night stay due to socio-culture
- Lack of confidence and decision-making
- Insufficient infrastructure in rural areas (transportation and road connectivity)
- Limited access to market (online marketing) resulting limited business growth
- Inadequate access to high digital technology
- Limited land rights ownership of productive resources
- Climate change leading to increased risks
- Lack of collaboration and support system
- Balancing entrepreneurial work and family responsibility by women
- Problems of availing raw-materials
- Less ability to bear the amount of risk required for running an enterprise

- Inefficient managerial ability of women entrepreneurs
- Challenges in fulfilling official formalities because of corrupt practices
- Exploitation by middle men which results lesser profit

Scope: A rural entrepreneur can set up three types of entrepreneurship like: primary (agriculture), secondary (industry) or tertiary (service) sector. But, many factors are there which contribute for establishment and success of any enterprise as follows:

- **Capacity Building:** Organizing extensive training programmes on need based entrepreneurial skills for continuous learning of rural women entrepreneurs.
- **Access to Credit:** Support for easy access to credit for rural women to start their entrepreneurship.
- **Market Linkages:** Development of strong linkage between rural women entrepreneurs and markets to enhance their reach.
- **Technology:** Empowering rural women by use of digital tools to get information for enhancement of their businesses.
- **Collaboration:** Creating strong collaboration and networks with WSHGs/WFPOs/Federations for knowledge-sharing among rural women entrepreneurs.
- **Government Schemes:** Including rural women under available government schemes meant for entrepreneurship development to derive benefits from schemes.
- **Resource Use:** Promote for efficient use of locally available resources for sustainable environment friendly entrepreneurial practices.
- **Recognition:** Make publicity of the success stories of rural women entrepreneurs to motivate others in rural communities.

Development of Women Entrepreneurship: An Experience from ICAR-CIWA

A) Mushroom Entrepreneurship through Women-Led FPO: Developed rural women entrepreneurship through mushroom cultivation. For the purpose, organized more than 1000 farm women covering 70 SHGs from 25 villages and 10 Panchayats in Nimapara block under Puri district of Odisha. Initially, formulated 'Bhargabi Women Mushroom Producer Federation' and converted it into **CIWANI Women Farmer Producers Company Limited**. Subsequently, built their capacity in the field of mushroom production and marketing. Linked them with funding agencies from where each group availed a credit of Rs.8 to 10 lakh with 50% subsidy for six years for establishment of mushroom unit (net house of 75ft x 35ft) having the facility of producing 1200 beds with 3 tier system. Now, the cost benefit analysis of straw mushroom cultivation found it very much profitable as women groups earned Rs. 2.40 lakh against an investment of Rs.0.87 lakh with a profit of Rs.1.53 lakh within one month by ensuring quality of produce.

B) Entrepreneurship through Custom Hiring Centre (CHC): Selected SC farm women in Jaguleipadar village of Kanas block in Puri district who live below poverty line. Based on need assessment, opted Custom Hiring Centre as an alternative for entrepreneurship development of women and installed a spice grinding machine. A MoU was signed between farm women and ICAR-CIWA with some conditions. Initially Rs.10000 (ten thousand only) was supported to the SHG as the seed money to initiate the work. Subsequently, the selected SHG members started spice making. After four months of successful running, it is found that: all most all the 750 families in the village purchase spices produced from Cusrom Hiring Center. Some of the retailers from Astharang and Gadishagada (Puri), Chandapur (Nayagarh) come to buy. Interaction with the group revealed that spice making through Custom Hiring Center is a good micro-enterprise for supplementing income for the resource poor Scheduled Caste farm women for livelihood development which gives five times return within four months (Initial investment of Rs.10,000/- increased to Rs.50,000/-)

Conclusion: Entrepreneurship among rural women has the scope for enhancement of livelihoods of farm families. Therefore, continuous hand holding support with encouragement from family as well as community and government is the prime call for for success of the women entrepreneurship. In this connection, more number of capacity building programmes with women prospective should be organized to develop their entrepreneurial skill.

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Participation and Contribution of Women in Agriculture

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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.

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).

There has been considerable diverse views in literature, of the women's participation in agriculture and many times the participation have been misunderstood as contribution, thereby eulogising them to the status of demi-god and in this process the worldly hurdles she face is often relegated to the hushed up affair. There have been reports that say that women constitute 65-76.6 percent in the total agricultural workforce (Planning Commission 2012; Ghosh and Ghosh 2014; Bedi 2018; Dudi et al 2019), 55-71 percent of the labour force in livestock farming

(Planning Commission 2002, 2007; FAO 2013; Singh et al 2020), 77.0 percent participation in animal care, 93.0 percent participation in dairy (FAO 2013), produce between 60-80 percent of food, responsible for half of world's food production (Mehra and Rojas 2008; FAO (undated); Dutt 2017), involved in 55-80 percent of all farm related work (Dutt 2017; Makaam (undated); Pachauri 2019; Oxfam 2020) etc.

The paper attempts to make a distinction between participation and contribution and presents the estimate of participation and contribution of men and women in rural areas of India using first Time-Use Survey-2019 (TUS-19). The paper ensues by describing the data and methodology, empirical findings on participation of men and women along with contribution in agriculture and allied activities followed by conclusion. In this article the term 'agriculture' means 'agriculture and allied activities including crop and livestock sector' and the data is presented for rural India only.

Data for this study

The data used for this study was taken from the first Time-Use Survey-2019 (TUS-19) conducted by National Statistical Office (NSO 2020) which included all States and Union Territories of India. The dataset contained 10.68 million records from which the relevant records were extracted for analysis. Since agriculture was the focus of this study therefore, only rural areas were considered. In the rural areas data were collected from 272117 individuals (above 6 yr of age) (137730 male, 134319 female and 68 transgender) from 82897 households. The activities reported by respondents over a period of 24 hours were recorded for every 30 min and codified (3-digit code) into 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 for this study

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)

Analysis of data: The relevant variables were extracted from the unit level data available as text files using STATA software. The different activities carried out in a day by an individual were consolidated. Thereafter, total number of unique individuals and unique individuals for each major activity were identified. Then, the number of persons represented by each individual was calculated by multiplying the unique individuals with the final weight. Finally, minutes spent on each major activity by each individual (projected to number of persons represented by them) were obtained by multiplying the minutes spent and the final weight.

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.

Major findings

Of the 82897 households surveyed for this study in the rural areas covering all States and UT of India, 57.3 percent of the households were engaged in agricultural and allied activities. Again, 22.45 percent of the rural households were engaged in livestock related activities. Thus, of the agricultural households, 39.2 percent households owned livestock. Participation, time spent, relative share (participation) and contribution of men and women in agriculture as a whole, and in crop and livestock sectors have been given in Table 2.

Participation

Participation in agriculture by the respondents were grouped under one of the thirteen activities (Table 1) which fell under either of the two major divisions viz., Employment and related activities (1) or Production of goods for own final use (2). Analysis of participation in agriculture of men and women under the two major divisions mentioned above has not been covered separately in this paper and the two divisions has been grouped into one for this study.

In rural areas of India, 28.55 percent persons participated in agriculture who lived in the 57.3 percent of the rural households which were engaged in agricultural and allied activities. In rural areas 16.61 percent of persons participated in agriculture under major division 1 i.e. Employment in agriculture and allied activities whereas, 14.09 percent were under major division 2 i.e. Agriculture and allied activities for own final use. There were 2.16 percent persons who participated in agriculture under both the two major divisions. Participation, in this paper denotes all who are engaged in, in either of the two major divisions i.e., employment related or for own final use.

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.

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 substantiates 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).

Table 1: State wise participation, time spent and contribution of men and women in agriculture and allied activities in India (2019)

SN	State	Participation (%)						Participation (%) (relative share)			Contribution (%)		
		Agriculture		Crops		Livestock		Agri culture	Crops	Live stock	Agri culture	Crops	Live stock
		M	W	M	W	M	W	Women			Women		
1	Andhra Pradesh	33.2	21.3	25.8	14.8	10.4	6.7	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	42.5	42.5	49.3	38.2	37.9	^{h3} 54.5
3	Assam	37.9	20.0	33.2	13.9	5.5	2.7	34.3	29.2	32.9	¹⁵ 19.8	18.4	27.0
4	Bihar	29.4	¹² 8.8	25.5	4.9	7.0	3.9	¹³ 21.5	¹⁵ 15.0	33.7	¹² 13.2	¹³ 11.1	27.4
5	Chhattisgarh	39.5	31.9	34.3	^{h5} 27.5	8.4	3.6	44.4	44.2	30.0	41.1	42.3	21.2
6	Goa	¹³ 4.0	¹² 8.8	¹² 2.6	6.2	¹¹ 0.4	¹¹ 0.1	^{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	42.0	32.4	^{h5} 58.5	34.0	27.7	^{h3} 61.0
8	Haryana	29.2	26.6	22.0	¹³ 3.1	15.9	^{h4} 24.5	44.7	¹² 11.0	57.7	31.9	¹⁴ 11.3	^{h5} 59.4
9	Himachal Pradesh	35.3	^{h1} 46.4	20.1	17.7	^{h3} 20.5	^{h1} 39.3	^{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	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	35.9	33.0	37.9	31.0	30.5	35.7
12	Kerala	¹⁴ 17.4	¹⁴ 9.5	¹⁴ 13.2	5.7	4.3	4.5	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	36.2	32.3	36.8	30.0	29.6	30.2
14	Maharashtra	^{h3} 43.7	31.0	^{h2} 39.1	27.2	10.1	4.4	40.6	40.1	29.5	36.8	37.9	23.6
15	Manipur	27.5	27.3	22.6	20.7	¹⁴ 2.0	¹⁵ 2.6	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	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	33.8	30.7	^{h4} 58.8	29.7	28.6	^{h2} 58.3
18	Nagaland	35.6	^{h3} 37.5	30.2	^{h1} 32.6	5.4	6.1	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	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	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	^{h4} 54.2	41.9	^{h1} 69.2	42.8	33.2	^{h2} 66.5

SN	State	Participation (%)						Participation (%) (relative share)			Contribution (%)		
		Agriculture		Crops		Livestock		Agri culture	Crops	Live stock	Agri culture	Crops	Live stock
		M	W	M	W	M	W	Women			Women		
22	Sikkim	39.4	26.9	27.9	18.2	^{h2} 23.7	.	37.0	36.0	^{l1} 0.0	28.6	28.5	^{l1} 0.0
23	Tamil Nadu	25.8	19.9	20.3	13.5	7.7	7.2	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	^{l4} 2.2	43.4	43.9	^{l5} 23.5	40.6	^{h5} 42.4	^{l5} 17.5
25	Tripura	29.5	14.3	25.1	7.9	5.0	5.3	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	37.0	22.6	48.0	27.1	17.8	47.9
27	Uttarakhand	21.8	^{h4} 35.6	^{l5} 13.9	19.1	13.7	^{h3} 26.3	^{h2} 61.7	^{h2} 57.5	^{h3} 65.5	^{h2} 56.1	^{h3} 50.7	^{h4} 60.8
28	West Bengal	30.9	10.9	27.3	^{l5} 4.3	5.5	6.2	^{l4} 25.5	^{l3} 13.1	52.3	^{l3} 15.2	^{l4} 11.3	40.5
29	A&N Island	31.3	11.4	16.5	^{l2} 2.2	5.0	^{l3} 1.7	^{l5} 30.6	^{l4} 13.8	28.7	28.3	^{l2} 8.1	27.2
30	Chandigarh	^{l1} 1.9	.	.	.	^{l2} 1.9	.	^{l1} 0.0	.	^{l1} 0.0	.	.	^{l1} 0.0
31	D&NH and D&D	23.1	29.2	20.1	^{h4} 27.8	^{l5} 3.4	^{l2} 1.0	^{h5} 53.2	^{h3} 55.5	^{l4} 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	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	48.9	33.8	50.0	35.3	25.2	43.0
34	Lakshadweep	24.3	^{l1} 4.7	^{l3} 6.7	^{l4} 3.9	4.6	.	^{l2} 16.1	36.4	^{l1} 0.0	^{l1} 6.3	32.2	^{l1} 0.0
35	NCT of Delhi	^{l2} 2.9	.	^{l1} 1.0	.	^{l2} 1.9	^{l1} 0.0
36	Puducherry	^{l5} 20.4	^{l5} 9.6	16.2	7.1	5.1	3.1	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	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.

Conclusions

The study has revealed that women contribute 53.2 percent of labour in the agricultural household in rural areas as compared to 46.8 percent by men. On a daily basis, women put in 1.6 hr more than men. They 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%). If the burden of unpaid domestic and care work is shared equally, the participation and contribution of women will increase. There is need to develop and strengthen institutional arrangements like anganwadi kendras (day care centres) in rural areas to take care of the growing children for enhanced participation of women in agriculture as well as other sectors.

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Gender Sensitive Agri-Nutri Farming System Model and Value Chain Analysis in Crop-based Farming System for Entrepreneurship

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Agriculture as a source of food is a pathway that mainstreams nutrition into the farming system and is capable of bringing about direct changes in food production system. Agriculture and nutrition are intricately linked and the outcome of one directly influences the outcomes of the other. Between the two, the strongest linkage is the farm women who must be prioritized in the large-scale nutrition programme. The concerted efforts of the farmers and agricultural scientists together with enabling policies have made India self-sufficient in food production. However, the malnutrition continues to exist even today and presents an important challenge towards holistic human development. Traditionally, agricultural interventions have focused on increasing food production and rising income to reduce malnutrition, hunger and poverty. Although this remains a part of a valid approach however, a more comprehensive approach is necessary to optimize agriculture's contribution to good nutrition and make agriculture nutri-sensitive. Women farmers are important stakeholders in agriculture who can address a secondary status within the household and workplace which has resulted in a huge gender gap.

The existing gender gap in agriculture arises due to many socio-cultural, economic and technological factors which ultimately hinders the productive output of women farmers. Additionally, the evidence from various literature sources highlight that women farmers are exposed to more socio-cultural challenges than their male counterparts (Gichuki *et al.*, 2014). The socio-cultural challenges arise due to cultural expectations such as values, gender roles, attitudes etc. and the intricate societal structures that influence farm women's development. Furthermore, gender inequalities in technology delivery enforce real constraints on societal outcome in terms of untapped potential leading to marginal agricultural development (Ragasa, 2012). Farm women, representing a significant clientele in agriculture, can promote substantially to agricultural development if provided with an initial institutional support and technical backstopping. In this context, the research project aimed at identifying the critical gender gaps indicators in agriculture, which provided a basis to formulate a women-centric holistic model addressing the nutritional, livelihood and entrepreneurial concerns in agriculture. The heterogeneous agricultural women groups were addressed with three different vital dimensions, addressing their economic enhancement, nutrition & well-being and economic empowerment through agri-preneurship. Constituting an extremely diverse mass, the needs and concerns of farm women are highly varied. Hence, considering income enhancement as the critical area of development for small and marginal women farmers, a livelihood enhancing cropping model was extended, to upgrade their socio-economic status. Likewise, for women farmers who have a balanced income, where oriented towards the concept of bio-fortified varieties for nutritional enrichment of farm families. Consequently, to make farming more profitable it's essential to convert it into an agri-business

mode, hence the big women farmers were focused for transforming their agriculture to agri-preneurial mode through promotion of women FPOs. The research targeted to promote an inclusive development of women farmers of the region through an integrated approach of addressing the basic needs of livelihood to meeting their unmet needs towards nutrition security along with triggering a need in them to upscale their existing farming practices into a commercial venture. The brief accomplishments of the research project along with the impact of the interventions and a way forward has been summarized in the technical bulletin. It is expected, that the research findings will be of great use to various researchers, developmental workers and policy makers for mainstreaming women farmers in agriculture.

Conceptual Approach

Development of new approaches in agricultural extension in India and worldwide is a continuous process with its focus on increasing productivity and profitability. Since the green revolution during late 1960s, Indian agricultural extension has adopted decentralized, participatory and demand driven approaches, in which accountability is geared toward the users (Kokate *et. al.* 2009; Sulaiman and Hall 2008; Swanson 2009). Extension organizations in general have been using a wide range of methods for reaching individuals, groups and the wider public in rural areas with new information/ knowledge. Approaches to extension also vary widely from top-down and supply-led to bottom-up, demand-led and participatory. Approaches also vary depending on the mandate of the organization or the programme. Advances in information and communication technologies (ICTs) have also provided new opportunities for extension to reach more farmers in a short amount of time (Sulaiman et al 2011).

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.

- 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.

<The 3 Es' Concept of Women Entrepreneurship

With the prevailing trend of feminization of agriculture, the changing socio-cultural-economic scenario of our country has realized the significance of women empowerment in agriculture. As a result, there have been several facilities created to uplift the socio-economic status of women farmers but the quantum of farm women evolving as successful agri-entrepreneurs is very scarce due to several reasons among which collaboration among the developmental organization and failure of industrial linkage are some of the lesser visible but critical causes, which can play as a game changer in empowering the women farmers. Thus, a novel approach is required to promote agri-preneurship among the budding women farmers through development of agricultural value chain by converging all the developmental stakeholders in a single platform to ensure holistic entrepreneurship coverage to the concerned women farmers.

Closing the gender gap in agriculture would generate significant gains for the agriculture sector as well as society for whole by bringing EQUITY, promoting ENTREPRENEURSHIP and realization of EMPOWERMENT (3 Es' Concept).

Strategy to reduce Gender Gap

The World Bank has made gender equality in the agriculture and food sector an explicit goal. Each project includes actions based on a thoughtful gender analysis that aim to result in positive gender outcomes. The Bank works to:

- ❑ **Expand women's access to land and rural finance:** Providing women with greater access to land, finance, and production inputs is critical to closing the productivity gap between men and women. Microfinance institutions and other financial service providers with presence in rural areas can play a key role in supporting women farmers. The Bank also ensures that women benefit from land titling projects.
- ❑ **Link women to agricultural value chains:** When women are linked to agricultural value chains from production all the way to processing and marketing, they help make traditional farming more productive and commercially viable. Inclusive value chains also offer work opportunities for women and men off the farm.
- ❑ **Improve rural women's access to training and information:** Knowledge of farming techniques is critical to productivity; however women farmers have inadequate access to agricultural extension and training services. It is also important that training and agricultural technologies are accessible and adapted to rural women's needs and constraints.
- ❑ **Produce knowledge, data and tools that promote gender equality in agriculture and food sector projects:** The Bank produces resources that help practitioners integrate gender-sensitive actions in their projects. This includes the Gender in Agriculture Sourcebook and an e-learning course, as well as the World Development Report 2012: Gender Equality and Development.

Family Farming: A Way for Improving Livelihood and Promoting Gender Equity

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

Challenges for Gender Sensitive Family Farming

Agricultural Technology

Technologies are seldom wealth and gender neutral, women's participation in the agricultural labour force has decreased due to the mechanization of their tasks because of men's appropriation of machinery. Women were reluctant to adopt mechanized technology due to lack of education, socio-cultural norms, and also because the machinery was not designed for use by women.

Historically, national agricultural research systems have been oriented towards cash crops and commercial farming, and little has been invested in research on other topics that might be more useful to women. This trend, combined with gender blindness in research organizations, leads to the generation of knowledge and technologies that are, in general, focused on the needs of larger-scale, male farmers. Although women can benefit from technologies and information on cash crops, as explained above, they have additional content needs that have been largely ignored by the agricultural research system. In many countries, the majority of agricultural research staff, managers and policy-makers are men, and the perspectives and needs of rural women are not always considered (Beintema, 2014). A study in 64 countries for 2003–2008 found that on average, women made up 23 percent of agricultural research staff (at both public and private institutions), but only 14 percent of managers (Meizen-Dick et al., 2011). The lack of gender balance in leadership positions means that decisions about research agendas and policies are made mainly by men, with little input from women.

Institutional Interventions for Farm Women

In a country with predominant gender bias, the vagaries of rural life is more reflected on the weaker sex, the poor working class women with their increasing dependence on their families for their livelihood and their decreasing bargaining power in the society. Economic empowerment should have backing of sound financial system. The recent report of the 'National Commission on Self-Employed Women' observed that women on being given institutional support, demonstrated high productivity, a better record of payment of loans and the assets are sustained. However, in doing

so, it is important to recognize women as a major earner, not as a supplementary worker. The major institutional support is provided to the women by the government, financial institutions and voluntary agencies. However, it was seen that the women focused government programmes suffered from the problems of mis-identification of beneficiaries. Also, use of ‘household’ approach in allotting the welfare schemes in a male-dominated society like India prevented women quite often from receiving the benefits.

The national data on allocation of credit based poverty alleviation scheme showed that less than 15 per cent of the beneficiaries were women, which was barely half the target of 30 per cent. An in depth study of credit flow by gender in a bank in Andhra Pradesh state suggested that disbursement to women ranged between 6 to 12 per cent over all, but dropped to zero for agricultural loans. It was found that since land has been the major source of collateral, women’s lack of ownership barred them from the access to the formal credit system, thus limiting their ability to acquire other productive resources also.

Organizing women into groups has been proved to be a good intervention. It can transform women from the status of “beneficiaries”, into “clients”, who are in a long-term can have a reciprocal relationship with the institutions meant to serve them. The self-help groups (SHGs) or the thrift and credit groups are mostly informal groups whose members pool their savings and lend within the group on rotational or need basis has been a success story in the country. SHGs take loans from banks/ voluntary agencies/ self-help promoting institutions to meet the needs of the farmwomen. Along with implementing the micro finance programmes, SHGs take up many other important social issues like health care, sanitation, family planning, literacy, management of common resources etc. This in the long run, makes the delivery system more responsive to local priorities and replaces centrally determined prescriptions and top-down approaches with more flexible planning of both contents and mechanism of service provisions.

Besides development organizations there are research institutes and projects under Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs) which are engaged in developing gender sensitive technology, drudgery reducing implements etc. A group of social scientists in the system are specially assigned to promote gender sensitization in agriculture and develop approaches and models for gender mainstreaming.

Development of Gender Sensitive Approach for Entrepreneurship Development through Institute-Industry-Stakeholders Linkage in Convergence Mode

The important aspect that can be derived from the assessment done to design the Gender Sensitive Entrepreneurship Model is to develop a strategy to address the identified core areas of improvement required to refine the farm women for transformation from ‘Farmers’ to ‘Entrepreneurs’. This can be achieved through successful “Institute-Industry-Stakeholders Linkage” in Convergence mode for ensuring profitability at an earliest and with the vision to attain sustainability of this approach on long term basis.

At first, the concept behind designing the “Gender Sensitive Entrepreneurship Model” has been framed, which gives a clear idea for the need of convergence, a SWOT analysis of the convergence is also done to analyze the prevailing condition of the system so that a better way out can be thought

of. The critical areas of improvement for women farmers have been discussed and finally the convergence model has been laid out which can be instrumental in promoting agri-preneurship among the women farmers.

The approach aims at linking the women groups with successful agro-based industries, for effective establishment of a demand supply chain. The role of women in field activities, dairy and horticulture sector is quite prominent but it needs to be practically signified in terms of visible output, in which women farmers get due acknowledgment and benefit for each aspect of their investment in terms of time, money and labour. There is a need of collective effort from each level through a successful convergence between Research Institutes-industries-stakeholders (public and private organizations) and women farmers. The question may also arise, why it is only for women? It is because women are most vulnerable and need constant support to bring them to a level, where they can represent themselves. It is the need of the hour to promote gender equity in agriculture by bringing them to a level equal to their male-counterparts. Secondly we have reached surplus of agriculture production and there is a need for secondary agriculture to enhance the profit gained in agriculture through suitable industries. As most of the farmers in India are small and marginal, most of the women are landless, there is tremendous scope for value chain based enterprises, which in a country like India can be initiated by linking the aspiring farmer groups with successful industries. This will help in changing the face of Indian agriculture by making it more commercial and enterprise oriented from the existing pattern of subsistence mode.

The economic scenario in India makes it crucial that a more active and sensible approach is required to create entrepreneurs on a comprehensive scale which would help in tackling the problem of unemployment and also help in the growth of new entrepreneurs. The present study in designing a gender sensitive entrepreneurship model will help in efficient utilization of human resources in agriculture in a more productive and profitable way. There is a need to make agriculture commercial by linking it with industries. Thus this calls for a novel approach to converge all the relevant stakeholders. Market analysis and linking with it has become more crucial rather than focusing solely in increasing production, hence linkage of women farmers with industries is the need of the hour which could play a dual role in ensuring quality market driven production along with socio-economic upliftment of the under-privileged farming groups.

There is also a need to upgrade the skill and working performances of the farmers and farm women which can be achieved through skill India programmes. Besides, the enormous workforce of women farmers, we also have the bulk of rural youth, who will be the face of future agriculture but unfortunately, they lack interest in agriculture. Hence, to make agriculture more lucrative, there is a need to transform it into a commercial mode and these rural youth can be transformed into budding agri-preneurs through ARYA (Attracting and retaining youth in agriculture) programmes, which has been initiated and implemented by Govt. of India.

Women farmers are fundamental in ensuring crop production and food security. However, they are often deprived of all privileges due to orthodox nature of the society which results in their poor ownership in farm and non-farm assets, lower degree of empowerment and lack of leadership position in any sector. ICAR-CIWA is an exclusive Institute in the world to promote the women farmers and together with all stakeholders; agri-preneurship can be promoted among the women

farmers. There is a need to develop suitable women friendly models to promote women entrepreneurship in agriculture for instance the Vedanta group has promoted village *Sakhi* (farm women friend) concept; a friend from village and there are different *Sakhis* for different aspects *viz.*, textile and clothing, food and nutrition, farm mechanization etc. India being the pioneer in production of milk and second largest producer of fruits and vegetable can further refine its agricultural export by linking with domestic and international industries and by transforming agriculture from production-oriented to profit-oriented.

This calls for a novel approach, thus, there is a need of Gender sensitive value chain which is women centric. The Inputs will be provided by industries i.e., the specification of production accordingly all sectors should channelize their input like varieties, agro-inputs, subsidies, bank loan etc. Marketing will also be easy as these industries buy back the produce; basically the concept of contract farming is required to be revolutionized on a larger scale with involvement of all stakeholders in a successful convergence mode focusing primarily on women farmers.

Institutional Mechanism for Bridging Gender Gap and Promoting Women Entrepreneurship

The Women Empowerment and Gender Sensitization Model was designed and implemented in Sankilo and Tentapur villages of Cuttack district with the involvement of over forty participating farm women during 2019-22 and is being carried forward in an entrepreneurial mode since then. The village was selected on the basis of gender-sensitiveness of the locale and interest of the farm households for action research. The gender-centric approach was adopted in familiarizing the households with the activities through concurrent meetings, gender sensitization programmes, gender gap analysis and PRA studies were undertaken by involving both male and female key informants separately.

The main objective of the developed Model is to promote Women Empowerment and Gender Sensitization by bridging the gender gap. Therefore, existing gender sensitivity level was accessed and critical areas where gender disparity exists were identified which served as the vital gender gap indicators and help in designing a suitable Gender Sensitive Extension Model as well as guide in formulating a schematic work plan for action research in bridging the gender gap for promoting Women Empowerment and Gender Sensitization.

A baseline survey of participating farm women was carried out through a well-developed interview schedule to understand the women and gender issues. The critical gender gap indicators pertaining to five fundamental pillars of holistic development *viz.*, Social, Health and Nutrition, Economic, Environmental and Technological (SHEET) facets were identified and prioritized.

A Gender Sensitive Extension Model was designed to promote gender friendliness to the existing extension services. The model focused on Gender Sensitive Extension as the central core of any developmental programme. Here, gender sensitive means extending the extension services through a gender lens i.e., considering women farmers as significant as men and extending the extension services by considering the strength, weakness, opportunity and threat (SWOT analysis) of women farmers of the region. The adoption of technologies and tools was women friendly, inputs and training programmes was as per the interest and suitability of both men and women. The pillars

of the model were ‘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’.

With the objective to optimize gender friendly technologies for promoting empowerment of rural women, a *three-tier approach* for addressing all farming income groups was framed for conducting action research as per the needs of the farming community, available resources and market preferences. The small and marginal women farmers who have limited resources and often face the issues of extremely low income generated from their farming were addressed with ‘*Gender Sensitive Agri-Horti Cropping System Model*’, in order to enhance their annual income from farming through popularization of profitable cropping system model. The next tier comprised of medium women farmers, who were addressed with their requirement of enhancing their annual income in addition to nutritional enrichment in their diet through the concept of ‘Nutri-Farms’. In this approach nutritional security of women farmers, which is a pertinent gender gap indicator was attempted to be mitigated. The last tier emphasized on empowering women farmers through promotion of ‘agri-entrepreneurship’. The concept adopted was gender sensitive and a whole family approach as in most cases women farmers did not have their own land. Hence, the technological interventions were formulated as per the need, constraints and interest of women farmers in agreement with their male counterparts. It was a whole family approach as there was division of labour as per their expertise and convenience. SWOT analysis of women farmers was also considered in formulating the various cropping system models. Under this Model, demonstrations of HYVs and bio-fortified varieties were conducted.

A Women Farmer Producer Organization (WFPOs) i.e., “*Ananya Farmer Producer Company Limited*” has been established to strengthen the Agri-entrepreneurial approach of the identified farm women cluster. The gender-centric approach to promote agri-innovations through the developed model enabled in creating a gender friendly atmosphere, which promoted active participation of women farmers. Additionally, the model ensured improvement in livelihood and enhancement in nutrition. The socio-economic status of women in the region and their access to resources were also improved. The women farmers were more empowered to take farm related decisions. Conclusively, the inception of the agri-innovations synthesized a kind of awakening among the farm women of the region and created a motivation among them to upscale their farming to a new dimension and serve as a catalyst to empower other unreached farm women. The model could be instrumental for other stakeholders and extension beneficiaries who aim to address the 3E concept of women empowerment i.e., promoting entrepreneurship, bringing gender equity and realization of empowerment.

Way Forward

Access to productive resources is critical for enhancing women’s economic choices. Since, formal credit institutions rarely lend to this weaker sex, special institutional arrangements has become necessary to extend credit to those who have no collateral to finance their enterprise. In order to have access to credit, social, institutional and government support is required. More than half of the farm labour is contributed by farm women. Moreover, as evident from several literatures, they

have also proven their competencies over time and again to manage efficiently and effectively at par with the male members of the society, provided they were supported socially, economically, technologically and institutionally. There is a need to identify their hidden capacities and entrepreneurial abilities and link them to the market. If they can be made technologically competent and socio-economically empowered, they could be the efficient drivers in achieving accelerated agricultural growth and development of the country in general and in boosting family income in particular. Organizing women into groups has been proved to be a good intervention. It can transform women from the status of ‘beneficiaries’, into ‘clients’, who are in a long-term can have a reciprocal relationship with the institutions meant to serve them.

Conclusions

- ❑ While we talk of empowerment of women in family farming, the discussion invariably focuses around access to and control of women over productive assets and their effective use for sustainable livelihood and income.
- ❑ Creating and sustaining competitive and equitably-oriented value chains that help small-scale farmers, especially women, will require explicitly examining gender issues and proactively integrating gender components into value chain analysis and development strategies.
- ❑ It is inferred from the findings that, the farmwomen could be the efficient drivers of national agricultural growth and development, if they can be made technologically competent and socio-economically empowered through development of gender sensitive entrepreneurial approaches. This, in turn, would make Indian agriculture more sustainable.

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Achieving Food and Livelihood Security and Enhancing Profitability through Integrated Farming Systems Approach : Case Studies

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Agriculture has been the backbone of human civilization for thousands of years, providing food and other resources for human survival. However, traditional agricultural practices have often resulted in negative impacts on the environment, such as soil degradation, water pollution, and loss of biodiversity. Current agricultural concerns include diminishing growth rates, factor productivity, food production, hunger, dwindling net cultivable area, environmental degradation, groundwater depletion, rising production costs, low farm revenue, and unemployment. India's population increased 1.76 percent to 1210.2 million in 2011 and is anticipated to reach 1530 million by 2030. Foodgrain consumption is anticipated to climb from 250 million to 345 million tonnes by 2030. Given the decline in per capita land availability from 0.5 ha in 1950-51 to 0.15 ha by the turn of the century, and a projected further decline to less than 0.1 ha by 2020 and beyond, it is critical to develop strategies and agricultural technologies that enable adequate employment and income generation, particularly for small and marginal farmers, who account for more than 80% of the farming community. Agrarian distress is caused by dwindling landholdings in the absence of alternative income-generating options. Some researchers advocate for an agricultural systems approach to research and development in order to promote poverty reduction, food security, competitiveness, and sustainability. Integrated Farming Systems (IFS) which follows system approach that combines multiple farming activities, such as crop production, livestock rearing, horticulture, aquaculture, and forestry etc, in a synergistic and sustainable manner seems to provide the plausible solution to the continuous increase in demand for food production, sustainability and stability of income for the farming community especially resource poor small and marginal farmers.

Key Components of Integrated Farming Systems approach

Integrated Farming Systems approach is described as “A judicious mix of two or more components using cardinal principles of minimum competition and maximum complementarity with advanced agronomic management tools aiming for sustainable and environment friendly improvement of farm income, family nutrition and ecosystem services”. Preservation of biodiversity, diversification of cropping/farming system and maximum recycling is the base for success of the farming systems approach. In general, farming system approach is based on the following objectives:

- Sustainable improvement of farm household systems involving rural communities
- Farm production system improvement through enhanced input efficiency
- Satisfying the basic needs of farm families along with nutritional improvement

- Raising the family income through optimum use of resources and proper recycling within the system

There are synergies and complementarities between different enterprises that form the basis of the concept of IFS.

The integrated farming systems approach is considered to be the most powerful tool for enhancing profitability of farming systems, especially for small and marginal farm-holders to make them bountiful. In fact, the past experience has clearly evinced that the income from cropping alone is hardly sufficient to sustain the farmers' needs. With enhanced consumerism in rural areas, farmers' requirements for cash have also increased to improve their standard of living. Therefore, farmers' income and food requirements would have to be augmented and supplemented by adoption of efficient secondary/ tertiary enterprises like animal husbandry, horticulture (vegetables/ fruits/ flowers/ medicinal and aromatic plants), apiary, mushroom cultivation, fisheries etc. However, these integrated farming systems will be required to be tailor-made and designed in such a manner that they lead to substantial improvement in energy efficiencies at the farm and help in maximum exploitation of synergies through adoption of close cycles. These systems also need to be socially acceptable, environment friendly and economically viable.

A common characteristic of integrated farming systems is that they invariably have a combination of crop and livestock enterprises and in many cases include combinations of horticulture, apiary, agro-forestry, mushroom etc. Based on resources availability at farm level, under Integrated Farming Systems, enterprises are classified as Primary (contributing more than 50 % of net income), secondary (contributing up to 30 to 40 %), supplementary (contributing up to 10 to 20 %) and complementary (supporting enterprises with each other). Integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming system. The difference between mixed farming and integrated farming is that enterprises in the integrated farming system are mutually supportive and depend on each other. Diversification of farming activities improves the utilization of labour, reduce unemployment in areas where there is a surplus of underutilized labour and provide a source of living for those households that operate their farm as a full-time occupation. Farm household is the basic unit and the operator of the farming system is farmer or the farming family.

Benefits of Integrated farming systems (IFS)

IFS offer several complementary benefits that make them a viable alternative to conventional farming systems. Below are some of the benefits of IFS:

Increased productivity: IFS can lead to increased productivity by optimizing the use of resources such as land, water, and labor. For example, intercropping can increase the productivity of a single piece of land by growing two or more crops at the same time.

Diversification of income: IFS can provide multiple sources of income from different farming activities. For example, a farmer can earn income from crop production, livestock rearing, and aquaculture.

Improved soil fertility: IFS can improve soil fertility by utilizing organic manure from livestock and crop residues. This reduces the need for chemical fertilizers and promotes sustainable soil management practices.

Reduced pest and disease pressure: IFS can reduce pest and disease pressure by promoting biodiversity and using integrated pest management techniques. For example, planting a diverse range of crops can create a natural ecosystem that supports beneficial insects and other organisms that can help control pests.

Efficient use of resources: IFS can optimize the use of resources such as water, labor, and energy. For example, aquaponics uses less water than conventional farming, and multi-story farming maximizes the use of vertical space.

Climate change adaptation: IFS can help farmers adapt to climate change by diversifying their income sources and reducing their dependence on a single crop. Additionally, IFS can help conserve biodiversity and protect natural resources, which are essential for mitigating climate change.

Improved food security: IFS can improve food security by increasing the availability of diverse and nutritious foods. Additionally, IFS can help reduce food waste by using crop residues and other by-products as feed for livestock.

Sustainable livelihoods: IFS can promote sustainable livelihoods by providing farmers with a reliable source of income and reducing their dependence on external inputs. Additionally, IFS can help reduce poverty and improve the well-being of rural communities.

IFS for different agro-ecologies for economic viability and profitability

The Indian Council of Agricultural Research (ICAR) and the Indian Institute of Farming Systems Research (IIFSR) have developed various Integrated Farming Systems (IFS) models suitable for different parts of India (Table- 1). These IFS models are designed to suit the local agro-climatic conditions and the socio-economic context of the region. ICAR- Indian Institute of Farming Systems Research, Modipuram under its All India Coordinated Research Project (AICRP on IFS) and other national programmes in collaboration with SAUs and has so far developed 71 prototype IFS models including 8 Integrated organic farming System (IOFS) models to achieve sustainable livelihood for small and marginal farm households which aided 3-5 times enhancement in farm income having net income of upto Rs 550662 per ha based on Net Income (Rs) with only market inputs excluding labour.

Table 1. Components of scientifically designed farming systems for different agro-ecological conditions

State (Location)	Scientifically designed farming systems	Area (ha)
Assam (Jorhat)	Crop production + horticulture + cow + Fish + Poultry + Apiary + vermicompost + Liquid Manure + Bio Gas	1.00
Bihar (Patna)	Crop + Horticulture + Goat + Poultry + Mushroom + Vermicompost + Boundary Plantation	0.40
	Crop + Horticulture + cow + Fish + Duckery + Vermicompost + Bio gas Unit Boundary Plantation	0.80
Bihar (Sabour)	Crop production + Horticulture + Cow + Goat + fishery + Duckery + vermicompost + Boundary Plantation	1.00
Chhatisgarh (Raipur)	Crop production + Horticulture + Cow + Goat + Poultry + fishery + Duckery + Vermicompost + Biogas + Mushroom	1.00
Goa	Crop production + Cow cross breed + Poultry + fishery + vermicompost + Mushroom	0.50
Gujarat (SK Nagar)	Crop production + horticulture + buffalo + pond + Boundary Plantation	1.00
Himachal Pradesh (Palampur)	Crop production + horticulture + cow + Poultry + vermicompost Mushroom + Boundary Plantation	1.00
Jharkhand (Ranchi)	Crop production + Cow + fishery + vermicompost + Mushroom + Apiary + Boundary Plantation	1.00
Kerala (Karamana)	Crop production + cow + fishery + Azolla	0.20
	Crop production + horticulture + Kitchen Garden + cow + poultry + vermicompost + boundary plantation + terrace garden	0.20
	Crop production + cow + fishery + duckery	0.20
	Crop production + cow +vermicompost	0.20
Karnataka (Siruguppa)	Crop production + Horticulture + Cow+ Buffalo + Goat + Pond + Azolla + vermicompost + Boundary Plantation + Farm House	1.00
Madhya Pradesh (Jabalpur)	Crop production + dairy + Poultry + Vermicompost + Fishery + Mushroom + Kitchen Garden & Floriculture	1.00
Maharashtra (Parbhani)	Crop production + horticulture + cow + buffalo+ Poultry + vermicompost + Boundary Plantation	1.00
Maharashtra (Rahuri)	Crop production + horticulture + cow + Poultry +vermicompost + boundary plantation	1.00

Meghalaya (Umiam)	Crop production + Horticulture + pig+ Poultry + fishery + vermicompost + Boundary Plantation	1.00
Rajasthan (Durgapura)	Crop production + horticulture + cow + Goat + Poultry + vermicompost + Bio Gas	1.45
Tamil Nadu (Coimbatore)	Crop Production + Horticulture + Cow + Goat + Biogas + Vermicompost + Border Plantation	1.20
Tamil Nadu (Thanjavur)	Crop production + horticulture + cow + Poultry + fishery + vermicompost + Boundary Plantation	0.80
Telangana (Hyderabad)	Crop production + horticulture + buffaloes + goat +backyard poultry +vermicompost + FYM + Dwelling unit	1.00
Uttar Pradesh (Faizabad)	Crop production + horticulture + 2 Milch Animals +Fishery	1.01
Uttar Pradesh (Varanasi)	Crop production + Horticulture + Cow + Poultry + fishery + Mushroom + vermicompost + Boundary Plantation	1.00
Uttarakhand (Pantnagar)	Crop production + horticulture + cow + Fishery + Duckery + Kitchen Garden + Boundary Plantation	1.00
West Bengal (Kalyani)	Crop production + horticulture + cow + Fish + vermicompost + Bio Gas + Compost	0.66

IFS for efficient nutrient utilization through recycling

The basic objective of integrated farming systems is recycling of wastes to reduce the cost and also provide eco-friendly production environment. Integrated farming systems have been designed scientifically in different locations through AICRP on Integrated Farming Systems in which various location specific modules such as cropping systems including plantation crops, orchard, dairy, goat, sheep, poultry, fish, pig, apiary, mushroom, biogas and boundary plantation have been integrated with an aim to meet the household demand of food, fodder, feed and fuel besides recycling of wastes to meet the nutrient requirement of different components.

The recycling was done mainly through preparation of vermicompost at all the locations besides adding additional components such as azolla, biogas etc to generate nutrients within the farm as much as possible. On an average, 120 kg of nitrogen, 51 kg of phosphorus and 86 kg of potassium which is equivalent to 260 kg urea, 318 kg of Single Super Phosphate and 143 kg of Muriate of Potash can be recycled from an average area of 1 ha area. Besides, macro nutrients, secondary and micro nutrients are also added through recycling. Maximum recycling of nitrogen (359.40 kg/ha), phosphorus (140 kg/ha) and potassium (398.60 kg/ha) was observed with integration of crop production, horticulture, cow, fish, poultry, apiary, vermicompost, liquid manure preparation and biogas modules at Jorhat (Assam). Although several tools are employed for recycling, integration of vermicompost, liquid manure preparations and biogas are found to be effective tools for recycling of wastes in farming systems.

IFS for Improved Soil Health and sustainability

IFS models developed for different ACRs found to be contributing towards improving soil health in terms of soil organic carbon to the tune of 27% in 7 years duration (Table 2). Sustainable value index also found to be above 0.50 suggesting long term sustainability of these prototype models.

Table 2: Sustainability of scientifically designed IFS models and impact on soil health

ACR (Planning commission)	Improvement (%) in Soil Organic Carbon (SOC)	Sustainable Value Index (based on previous 5 years data)
Western Himalayan Region	63.8	0.7
Eastern Himalayan Region	31.0	0.8
Lower Gangetic Plain	5.9	0.7
Middle Gangetic Plain	12.7	0.8
Upper Gangetic Plain	14.0	0.7
Trans Gangetic Plain	96.2	0.4
Eastern Plateau and Hills	11.1	0.6
Central Plateau and Hills	8.3	0.5
Western Plateau and Hills	11.1	0.7
Southern Plateau and Hills	47.8	0.7
East coast plains and hills	12.3	0.6
West Coast Plains and Hills	49.4	0.7
Gujarat Plains and Hills	4.8	0.6
Islands Region	69.7	0.6

IFS for employment generation and lower GHG emission

These models contributed towards employment generation ranging from 191 to 639 mandays per year and most of the IFS models were neutral or negative in terms of estimated GHG emission i.e. sink greater than source of emission in systems perspective from IFS models (Table 3).

Table 3: Employment generation and climate suitability of scientifically designed IFS models in different ACR

ACR (Planning commission)	Employment generation (family + hired) (man days)	Net CO₂-e (kg)
Western Himalayan Region	410.2	-7049.8
Eastern Himalayan Region	464.5	11.3
Lower Gangetic Plain	328.0	-3012.6
Middle Gangetic Plain	433.3	-1090.6
Upper Gangetic Plain	572.0	-28392.7
Trans Gangetic Plain	280.0	-5451.6

Eastern Plateau and Hills	399.5	-13716.1
Central Plateau and Hills	639.0	159.2
Western Plateau and Hills	526.8	-8947.7
Southern Plateau and Hills	502.2	-6766.9
East coast plains and hills	388.5	-773.1
West Coast Plains and Hills	262.0	-14386.3
Gujarat Plains and Hills	243.5	-3134.9
Islands Region	191.0	-5236.3

IFS for food and nutritional security

A detailed analysis of these IFS models for food security revealed that all the models were surplus in terms of food sufficiency for cereals, pulses, oilseeds, vegetables, fruits, milk and other food groups (Table 4) for an average family size of 5-7 members with about 1.0 ha land holding as estimated by taking into consideration for food requirement of moderate working group as per ICMR guidelines.

Table 4: Food sufficiency for households from IFS models

Locations	32 Locations at 15 Agro-climatic zones
No. of IFS models	46
Production on Equivalent basis (t)	Mean (Range): 26.41 (10.24 – 41.00) SYI:0.60
Household nutrition	<u>Sufficiency (+)/Deficiency (-) (%)</u> Cereals (+)90.3 , Pulses (+)18.5, Oilseeds (+)154 ,Vegetables (+)281.4 , Fruits (+)233.1 , Milk(+)377.6 , Meat/ Fish (+)386.8 , Egg(+)43.5, Mushroom (+)365.2 , Poultry(+)64.8
Recurring cost	Rs 2,87,665
Net income	Rs 208786 (Existing: Rs 122616*) SVI:0.60 (136% % increase)
NRPRI	0.73
No. of months with net income of > 10000 Rs/month	6.83
No. of months having >20 man days as additional employment	9.58
B:C ratio	2.36

Conclusion

IFS is a sustainable approach to agriculture that integrates multiple farming activities in a synergistic and mutually beneficial manner. Integrating farming components requiring lesser space and time is considered a viable option to enhance the farm productivity and reduce the environmental degradation, ensuring a regular income to the farmer. IFS can provide multiple benefits such as increased productivity, soil conservation, biodiversity conservation, water conservation, and climate change adaptation. However, IFS also faces some challenges such as lack of awareness, infrastructure, and market access and designing an IFS requires careful planning, implementation, and monitoring to ensure that it is sustainable and economically viable. Additionally, these models can be customized to suit the local conditions and the needs of the farmers, making them a flexible and adaptable approach to farming. Therefore, it is important to promote the adoption of scientifically designed IFS tested for its productivity, sustainability and resilience through policy interventions, capacity building, and market linkages to ensure its successful implementation and large scale adoption.

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Nutrisensitive Agriculture Interventions for Combating Malnutrition and Enhancing Family Income

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Nutrition-sensitive agriculture is a food-based approach to agricultural development that puts nutritionally rich foods and dietary diversity at the heart of overcoming under-nutrition, over-nutrition and micronutrient deficiencies. It might therefore seem counter-intuitive to suggest that agriculture should become more nutrition-sensitive. After all, agriculture is already the source of most of the food we consume. Yet many people involved in agriculture do not consume enough food or benefit from a healthy diet. Indeed, although 63 per cent of low-income people worldwide work in agriculture – the overwhelming majority of them on small farms – many are at risk of food and nutrition insecurity.

Farmers often must make difficult choices between what they consume and what they sell. Though they may grow nutritious crops and raise livestock, many of them sell most of what they produce, with little or nothing left for household consumption. Many others need to purchase most of their food at the market because they grow only one or a few crops. At the market, their choice of food can depend on many factors. For example, they may need to purchase less expensive (i.e., less nutritious) food due to low earnings, or they may choose less nutritious foods due to a lack of awareness about nutrition. Additionally, not all markets offer a variety of foods, and fluctuations in availability due to seasonality or limited production are also common.

The primary objective of investing in nutrition-sensitive agriculture and food systems is to ensure that acceptable, diverse, nutritious and safe foods, adequate to meet the dietary needs of people of all ages are available and affordable at all times. This can mean, for example, introducing good practices that enable year-round access to a variety of nutritious food – either by making sure producers have the resources to produce the right foods for a healthy diet, or by equipping markets to sell a variety of nutritious foods at affordable prices. It also means preventing food loss and waste by reducing food-borne pathogens through good hygiene practices and improving technology along the value chain. Nutrition-sensitive agriculture also means educating families about nutrition so they can produce, purchase, prepare and consume healthy foods.

Malnutrition

Malnutrition commonly affects all groups in a community, but infants and young children are the most vulnerable because of their high nutritional requirements for growth and development. Another group of concern is pregnant women, given that a malnourished mother is at high risk of giving birth to a LBW baby who will be prone to growth failure during infancy and early childhood, and be at increased risk of morbidity and early death. Malnourished girls, in particular, risk becoming yet another malnourished mother, thus contributing to the intergenerational cycle of malnutrition.

What is sensitivity in agriculture?

Nutrition-sensitive agriculture aims to maximize the positive impact of the food system on nutrition outcomes while minimizing any unintended, negative consequences of agricultural policies and interventions for the consumer.

India has the second-largest arable land area in the world with 140.1 million hectares of net sown area according to the 2017-2018 annual report of the Department of Agriculture, Ministry of Agriculture and Farmer Welfare. Yet, the biggest challenge is to ensure food and nutrition security for the mammoth population amidst natural and anthropogenic adversities. India ranks 101 out of 116 countries on the Global Hunger Index (GHI), and therefore needs to pay urgent attention since three out of the four components of GHI calculations are related to under-nutrition.

NSA interventions such as diversification and intensification of the cropping systems with a combination of cereals/millet, pulses and other crop types, also trees including bio-fortified crops were recommended. The intervention includes integrating allied enterprises like small animals, poultry, and inland fishery as well. Participation in post-harvest value-addition activities, practising good agriculture methods for soil and plant health management including, crop rotation, cover crops were recommended to ensure the production of diverse food with desired nutrition.

Based on the feasibility different nutri sensitive agriculture models can be taken up by farm families to guarantee nutritional security of its members. The expected results of FSN are: Converting the agriculture into nutri - sensitive and income generating agriculture. The pathways through which agriculture can influence nutrition outcomes cover four broad areas: (1) consumption of own production or agriculture as a source of food; (2) income from agriculture; (3) food prices; and (4) aspects related to gender such as the status of women in agriculture and women's nutritional status that directly or indirectly influence food, nutrition and health. Of the different linkages that prevail between agriculture and nutrition, 'cultivation and consumption of own production' is a pathway that can bring about direct changes in food production system enhancing availability and access to food for farming households, particularly the small holders.

ICAR-CIWA Interventions

For creating nutritional awareness among the farm women the ICAR –CIWA took the initiatives to introduce various technologies for enhancing the nutritional status and income generation. Initially nutritional garden, mushroom cultivation, backyard poultry, fishery introduced in their backyard. The interventions were planned such that the nutritional needs of the target families are met round the year. The interventions carried out as per the need, resources availability and willingness of the farm families. For strengthening the knowledge, skill of the farm women, regular training, interaction, home visits conducted in the grass root level.

Nutrigardens

Nutrigardens/kitchen gardens were established in the village by providing vegetable seeds like Amaranthus (*Khada, Leutia*), Okra (*Arka Anamika*), Pumpkin (*Arka suryamukhi*) to the women in the month of March 2022. Perennial plants like Papaya, Mango (*Amrapalli, Dashehari*), Lemon, Guava (*Allahabad safed, Safed jam, Hissar safed, Pant pravat*) 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. Women friendly farm tools and equipments like hand cultivator, secateurs, khurpi, shovel, hand hoe, garden hoe, rose can etc were also provided to the families. The farm families are utilizing the harvest of nutri gardens mainly for own consumption purpose and the surplus vegetables like banana, ridge gourd , bitter gourd , pumpkin ,cucumber , green leafy vegetables are sold by them in the local market .In an average monthly they are getting Rs. 10,000 to 15,000/-.

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. In context to the economics of rural poultry(20 no.s) in intensive system of farming total expenditure was calculated to be Rs .4800/- and total profit was approximately calculated to be Rs . 8520/-.

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. In context to fishery production, in 1 acre area in 1 season the total profit is approximately Rs 1,20,000/- .The total fixed cost for this fishery unit is approximately 2000/- where total variable cost is 9,500/-. 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 nutrismart 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. In general, Paddy straw mushroom is grown in the bed from April to October, where Oyster mushroom is grown in November to March. The farm family can raise 100 beds in their back yard and can earn a profit of Rs. 25,000/- from Paddy straw mushroom and Rs. 7500/- from Oyster mushroom.

Intervention Effects:-

At the initial stage a survey was conducted with a structural questionnaire to study the need, constraint, resource availability, malnourished status, dietary pattern etc of the respondents. The main interventions were focused towards establishment of nutria garden, backyard poultry, fishery and mushroom cultivation. It is observed that the percentage increase in nutria garden is highest i.e., 224.6% followed by poultry i.e., 183%. It is also observed that not only the adoption of different technology enhanced but also their income rose. Their daily consumption of vegetables, mushrooms, fish and poultry products has increased in their dietary pattern.

Conclusion

Over the last decade, there has been a lot of excitement, interest, and investment in using agriculture to improve nutrition. The amount of research on the subject has grown tremendously, as has the quality of the evidence. The link between outcomes of nutrition and larger agricultural and food systems is undeniably true, and it has the ability to combat hunger and malnutrition. Globalization, trade, the food industry, and urbanization are all becoming closely interlinked with one another and with food systems across countries, regions, and the globe. It is questionable how the food and agriculture sectors can help to mitigate the "globesity" trend of rising overweight and obesity. At the moment, very few countries have effectively confronted this problem. So proper implementation of nutri-sensitive agriculture is the way that shows a ray of hope to combat malnutrition at the global level

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Women Agripreneurship through Fish Farming Systems and Post Harvest Processing

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Fisheries, the sunrise sector of Indian economy, contributes to nutrition, income and employment to millions of people in the country. In 2021-22, India produced 16.2 million MT of fish with 12.1 Million MT and 4.2 Million MT from the inland and marine sector respectively. Inland freshwater fish landings alone accounted for 11 Million Metric tonnes (DoF, 2022). In India, a total of around 28 million people are involved in fisheries activities (both marine and Inland) of which 44% are women. When the sector is taken as a whole, 28% of women are involved in full time fisheries activities and 19% are involved in part time activities Bihar has the highest number of fisherwomen population (23%) followed by Uttar Pradesh and West Bengal. Of the total fisherwomen involved in the sector, 21% of them are engaged full time in the fisheries activities. The exact nature of the work in which women are involved differs with culture, region and also between rural and urban areas. Their area of involvement can be divided into fishing and preharvest activities, processing and marketing, labour in processing and aquaculture. The mechanization in the sector and the seasonality in the operations have been compelling women in fisheries to adopt livelihood options. Feminisation in agriculture has also led to the growth in the number of women farmers pursuing agripreneurship as a natural progression as well as a strategic choice. These women contribute not only to their families' sustenance but also to the nation's food security. But women entrepreneurship in India is yet to pick up the pace. It is substantiated by the fact that women own only 20% of all enterprises in India. Around eighty percent of these enterprises are micro units which are mostly concentrated in the informal sector. To support the development of women agripreneurship, high-impact initiatives should be adopted for female entrepreneurs in the agriculture sector.

Types of enterprises in Agriculture and allied sectors

While promoting entrepreneurship, one may consider different types of enterprises in agriculture:

- Production enterprises/ family enterprises: Examples of Production enterprises/ family enterprises are crop production, Dairy husbandry, Goatery, Backyard Poultry, Aquaculture, Horticulture, vermi compost, value addition etc.
- Service providing enterprises: To optimize the productivity from agriculture by family enterprise, different types of services like input procurement and distribution, hiring of implements and equipment like tractors, seed drills, sprayers, harvesters, threshers, dryers and technical services such as installation of irrigation facilities, weed control, plant protection, harvesting, threshing, transportation, storage, etc., are required at the village levels. In the fisheries sector also different types of services like seed, feed, fertilisers, medicines, hiring of nets, aerators etc are also required. In marine fisheries sector, net mending is an important service providing enterprise for women.
- Input producers enterprises: Entrepreneurship can be developed for providing critical inputs at the village level like seed, bio-fertilizers, bio-pesticides, vermin-compost, soil amendments, plants of different species of fruits, vegetables, agricultural tools, irrigation accessories, production of animal feed concentrate, mineral mixture and complete feed, production of farm made fish feed. There are good opportunities to support sericulture, fishery and poultry as well, through promotion of critical service facilities in rural areas.

- Processing and marketing enterprises: The efficiency of post-production management requires higher scale of technology as well as investment. Such enterprises can be handled by forming cooperatives at the village levels like sugar cooperatives, dairy cooperatives, poultry cooperatives, fruit growers' cooperatives, fisheries co-operatives etc. However, the success of such ventures is solely dependent on the integrity and competence of the leaders involved

Entrepreneurial opportunities for women in fisheries

In freshwater aquaculture, culture of ornamental fish in the backyards of households, carp seed production, carp culture, murrel culture, magur culture and integrated fish farming are some of the technologies which could be adopted by rural women. These involved low capital investment and optimum utilization of natural resources available in the proximity of their households. Rural women inhabiting brackish water areas could indulge in aquaculture activities like shrimp farming, crab fattening, milk fish culture, bhekti culture etc. Mariculture technologies that possess potential for women's participation include mussel farming edible oyster farming, pearl oyster farming and pearl production, clam culture, lobster farming and fattening, sea cucumber culture, marine finfish culture, ornamental fish culture, seaweed culture, open sea cage farming etc. The aquaculture technologies like fry production, composite fish culture, integrated fish farming and ornamental fish culture have been studied in women perspective by ICAR-CIWA. Fry production was found to be a good proposition for farm women as the demand for good quality seed is always high. Inability of women to procure fry from long distance, inconvenience in transporting large numbers of fry over long distance, high mortality of fry during transportation, high cost of transportation and packing, unavailability of fry of desired species at the right time were some of the constraints faced by the rural women prior to the implementation of the project. The beneficiaries were thoroughly trained on the package of practices for carp seed rearing. Women were highly enthusiastic in adoption of the technology as they could utilise their backyard ponds for fry production. The project not only helped the rural women in production of quality seed for fish farming but also served as an additional income source. ICAR-CIWA has also trained many farm women on the different management practices in composite farming practices so that they become competent in taking up aquaculture as a livelihood and entrepreneurial option. The intervention of polyculture of Indian Major Carps with Minor Carps (*Puntius gonionotus*) was readily adopted by women as it is a short term crop and the higher market price when compared to IMC of 2-00-300g size. With the gradual shrinking of land holding, integration of land-based enterprises such as dairy, fishery, poultry, duckery, apiary, field crops, vegetable crops and fruit crops within the bio-physical and socioeconomic environment of the farmers can make farming more profitable and dependable (Behera et al.,2004). For example, the rice fish farming system can annually produce around 16 to 18 t of food crops, 0.6t of fish and prawn, 0.55 t of meat, 8000-12,000 eggs besides flowers, fuel wood and animal feed as rice straw and other crop residues from one hectare of farm. The net income in the system is about Rs. 76,000 in the first year. Subsequently this increases to around 1, 30,000 in the sixth year (Poonam et al, 2018). This system thus increases farm productivity by about fifteen times and net income by 20 folds over the traditional rice farming in rainfed lowlands. The rice fish system also generates additional farm employment of around 250 – 300 man-days/hectare/year. ICAR-CIWA has also taken steps to popularise the integrated fish

farming techniques by giving priority to farmer's choice and resource availability. Women were eager to adopt poultry cum fish farming as they could utilize the kitchen waste as feed for poultry as well as fish. The location of the poultry shed and pond near to their household helped them to keep watch and ward of the resources thus reducing the cost of labour. The continued sale of eggs and meat decreased the economic burden of their family and ensured their nutritional security. Demonstration of low cost indigenous technology for ornamental fish production was given to rural women and efforts were made to facilitate marketing of ornamental fishes produced by women managed production units. Integration of fish cum horticulture could be adopted by women farmers to supplement their family nutrition and income. The top, inner and outer dykes of ponds as well as adjoining areas can be best utilized for horticulture crops. Pond water is used for irrigation and silt, which is a high-quality manure is used for crops, vegetables and fruit bearing plants. The success of the system depends on the selection of plants. They should be of dwarf type, less shady, evergreen, seasonal and highly remunerative. Dwarf variety fruit bearing plants like mango, banana, papaya, coconut and lime are suitable, while pineapple, ginger, turmeric, chilli are grown as intercrops. Plantation of flower bearing plants like tuberose, rose, jasmine, gladiolus, marigold and chrysanthemum provide additional income to women farmers. Grass carps can be stocked @ 1000/ha and addition of common carps are beneficial for utilizing faecal debris. In mixed culture of grass carps along with rohu, catla and mrigal, in 50: 15: 20: 15 ratio at a density of 5000 fish/ha. This integrated system fetches around 20-25% higher return compared to aquaculture alone.

Service providing activities like mobile water quality testing labs, supply of feed, medicines, chemicals and farm implements (net, aerators, tubes, air stones, air valves, filter cloth, bags, lead weight and tube rolls) could also be chosen as entrepreneurial options by women. Agritourism, defined as "farming related activities carried out on a working farm or other agricultural settings for entertainment or education purposes" is yet another lucrative option for women farmers to diversify their income sources.

Around the globe, women's most prominent role in fisheries is in post-harvest, processing and marketing. In India, women form around 90% of the workforce who are involved in curing/processing. Value addition of food plays a major role in employment generation, entrepreneur ventures and boosting exports from a country. The popularity of fish products in human diet is on the rise due to the international recommendation to lower the total level of dietary fat. Also the economic growth and urbanization is changing the consumption pattern of people from traditional to processed and high value products. Value addition in fish could range from a simple display of hygienically dressed and iced fish to preparation of dry fish, mince based ready-to-cook or ready-to-eat products or byproducts like fish silage. The value added fish products are rapidly occupying the shelves of supermarkets in India pointing to the increasing domestic market demand of the products. Studies have reported that consumers of the northern states of the country are willing to pay more for value added fish products (Sabat et al., 2008) provided that they have access to products of assured quality. But fisherwomen remain unaware of these changing consumer needs and their access to the advanced technologies is limited. One of the effective means to bring the fisherwomen to the mainstream is to equip them with formal training in

advanced and hygienic processing techniques, marketing and development of entrepreneurial skills. Empowerment of fisherwomen and formation of self help groups also have led to the increased small scale level production of value added items in recent times. As per the study conducted by MS Swaminathan Research Foundation, production of fish value added items have been helping in livelihood enhancement of fisherwomen of Nagapattinam District in Tamil Nadu, India (Selvaganapathy & Krishnan, 2015). Among fisherwomen of Kerala, value added fish producers were found better empowered (46.78%), followed by retailers (45.09%), vendors (43.92%) and dry fish makers (43.42%) (Salim & Geetha, 2013).

Improving household income and fish availability through participation of women in homestead aquaculture-: A case study

Homestead integrated aquaculture has immense potential towards alleviating poverty and undernourishment. In order to have sustainable and equitable impacts through small holder aquaculture innovations, a focus on gender being included at the very start of the design and dissemination is required. The present case study showcases the impact of gender inclusive interventions in improving the participation of women in homestead aquaculture thereby improving the household fish and vegetable availability and income. Conservation of the diminishing stock of indigenous small indigenous fishes by deliberately farming them along with the Indian Major carps was also a focus of the study. A gender inclusive approach was adopted in the capacity building of women on scientific aquaculture management practices. Twenty four homestead ponds of areas ranging from 0.17-0.22 Ha in Puri District, Odisha covering a total area of 4 Ha from four villages were selected to undertake participatory action research. The ponds were stocked with Indian Major Carps @10000/ha and small indigenous fishes like *Amblyphrynogon mola* and *Puntius spp* @25000/ha. Several women friendly interventions like gill nets (12mm) a passive fishing gear and trellis system around pond bund for growing climber vegetables were introduced in the villages with an aim to improve the participation of women in homestead integrated aquaculture. As a result of the interventions the fish production increased from 0.75t/ha/yr to 2.48 t/ha/yr. The farm families could earn a gross income of 3.2 lakhs/ha with a B:C ratio of 1.84. The involvement of women in harvesting of small fish using passive gear like gill nets and traps resulted in regular fortnightly availability of around 750g of small micronutrient rich fish to rural families. The utilisation of pond bund for growing vegetables following the cropping calendar resulted in production around 790kg vegetables from per hectare pond area. The study showed that women can immensely contribute to increase and stabilize family income and to improve family nutrition by participating in homestead integrated aquaculture. The research also proved that polyculture of Indian Major Carps with small indigenous fishes by following the scientific management practices will result in better yield, improved fish availability to the house and better management of the household resources (Tanuja et al., 2023).

Rural women entrepreneurship through value addition of fish: a case study

Women entrepreneurship through production of value added fish products and byproducts was developed by ICAR-CIWA through the following approaches

- Development Innovative value added products from fish/shellfish

- Consumer survey to assess the marketability
- Skill training of rural women on preparation and packing of value added fish production
- Development of master trainers
- Establishment of Common resource Centre/Custom Hiring Centres in villages
- Popularisation of the products through Melas and exhibitions
- Facilitation for obtaining legal licenses (FSSAI and Trade license) and branding
- Market linkage with retail fish supply chains
- Online marketing of products
- Continued hand holding

Consumer preference for the value added fish products was assessed by conducting a survey of consumers in the peri-urban areas of Bhubaneswar. All the consumers were interested in consuming one or other forms of value added products from fish. Twenty percent of the consumers suggested that they are a good alternative to similar meat products. Consumers (30-36%) were willing to buy the value added products if they are safe and available locally in reasonable prices. As per the consumer preference study, taste followed by price, appearance and health factor was the most important attributes determining the consumer acceptability of value added fish products (Tanuja et al., 2020). A products were also popularized through various exhibitions in order to increase the consumer awareness. The fisherwomen were selected for skill training based on their socio economic status, level of participation in fish processing, motivation and willingness to adopt new processing technologies. In order to ensure the horizontal spread of the technologies, forty women (2 from each SHG) were selected as master trainers who will act as future resource persons or point of contact for further trainings in rural areas and updation on technologies. The master trainers were given the skill trainings on the aspects of hygienic handling of fish, solar drying of fish, preparation of value added products like prawn pickle, fish cutlets, fish momos, fish papad, fish silage etc who further trained the producer groups in the villages. They were also trained on the importance of attractive packaging and labelling of their products, entrepreneurship development, management, branding & marketing and group dynamics by faculties from organizations which provide such capacity building programmes.

A group of interested women ventured into starting the enterprise on value added fish products after gaining the necessary skills and knowledge on production, packing, labeling, licensing and marketing of the products. They were given series of trainings on the preparation of the value added products like prawn pickle, fish pickle, prawn chutney powder and fish papad. The products for the enterprise were selected based on the criteria of raw material availability, ease of preparing (with limited capital asset requirement) and long shelf. A production site was identified in their village. A common facility Centre/ Custom hiring centre was established in the village which would serve as a community resource for women involved in processing of fish. Since inputs are very crucial for any enterprise, the CHC was established with facilities like processing equipments, necessary utensils, packaging machine and packaging materials. They were facilitated in obtaining FSSAI license under the trade name “Fishlikes”, as it is one of the most important pre-requisite for marketing of any food product. They were facilitated to obtain the trade license from the Municipal Corporation. The women were further supported in their

endeavour by creating market linkage with fish retail stores located in different parts of Bhubaneswar city, which works in PPP mode with the Odisha Government. This was the first of its kind of initiative in Odisha. The marketing initiative which started with one retail store spread to 12 more stores in Odisha and to the neighbouring state of West Bengal. The women could make a profit of Rs 150/kg and 170Rs /kg from prawn pickle and fish pickle respectively. By shifting to hygienic production of solar dried fishes they could earn a profit of Rs 70/kg of the product. The enterprise is an income source to 10 rural women who also have gained confidence to apply for Government schemes promoting Women entrepreneurship. Through this project, the women were also made capable to utilize fish waste that remains after processing to be processed into fish silage and marketed as organic manure. The production of fish by products like fish silage and silage based poultry feed and manure can help in alleviating environmental pollution caused by the piling of fishery waste in and around human habitations.

Conclusion

The future of women agripreneurship is promising. As more women are enabled to break free from traditional constraints and embrace their entrepreneurial aspirations, our societies will benefit from increased innovation, economic growth, and social progress. However, realizing this vision requires concerted efforts to address gender biases and stereotypes, provide equal opportunities and foster supportive environments. There is no dearth of technologies and the ecosystem of our country favors women agripreneurship development. By empowering women entrepreneurs, we unlock a world of talent, ideas, and solutions that will shape the future for generations to come.

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Strengthening Livelihood Security of Rural Women through Small Scale Poultry Farming

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Livestock production makes a significant contribution to the livelihoods of the poor and offers substantial scope for expansion to alleviate poverty. 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. Having evolved from the backyard, Poultry sector in India has witnessed a phenomenal growth and transformed itself to a vertically integrated and organized dynamic agri-based industry. Poultry egg and meat is important animal protein sources and essential in providing balanced diets for nutrition and health. An egg provides 6 to 7 gm wholesome protein with balanced amino acid to the human diet. Poultry farming in rural areas could be a viable option for addressing malnutrition among children and women in India. As per the recommendations of the Nutritional Advisory Committee, the per capita requirement of egg is 180/year. But the present availability is 79 only (DAHD, 2019). Thus, the poultry sector has to grow 3 to 4 folds to meet the nutritional requirement. Family poultry (FP) is an integrated component of nearly all rural, many peri-urban and some urban households and provides valuable protein and generates extra income.

India has nearly 70% of its population living in rural areas. Most of the commercial poultry production in India is concentrated in urban and peri - urban areas. Just 30% population living in urban and peri-urban areas consumes about 75-80 % of eggs and poultry meat. Non-availability of poultry products and low purchasing power of the rural people devoid them of access to the highly nutritious products like egg and meat, thereby, resulting in malnutrition. The role of family poultry in poverty alleviation, food security and the promotion of gender equality in developing countries is well documented (Guèye, 2000). Though generally considered secondary to other agricultural activities by smallholder farmers, poultry production makes an important contribution to supplying local populations with additional income and high quality protein. Poultry farming in rural areas could be a viable option for addressing malnutrition among children and women. The lack of basic infrastructure and poor socioeconomic condition of people in the rural area are major bottlenecks for adopting commercial poultry production. Popularization of backyard poultry farming is the need of the hour to ensure increasing access to protein and nutritious food at an affordable price in rural India (Panda et al., 2020).

Why Small Scale Poultry Production?

Rural poultry Production is an important livelihood component of rural tribal's, providing valuable animal protein source through egg and meat and economic upliftment by providing subsidiary

income. There is also growing evidence to demonstrate the role of rural poultry farming in enhancing the food and nutrition security, reducing the livelihood vulnerability and insecurity and promotion of gender equity (Panda et al., 2020). 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. Backyard 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.
- ❖ 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 and thus promotes gender equity.
- ❖ Has a potential to fight poverty and malnutrition and provide scope for high employment generation and solving gender issues in employment

Globally there are three main systems of rural poultry production. They are as follows

1. Scavenging system

Under this system of production the birds are allowed to scavenge outside during day time and temporary shelters are provided during night to protect from predators, adverse weather and to provide laying shelter. The birds largely subsist on scavenging in gardens, village alleys and surroundings of the farms by feeding on crop residues, green forage, insects and worms. No formulated balanced supplementary feed is given to the birds, but they are accessed to kitchen waste as and when available. Sometimes the birds are offered small amount of grain. In this system of production few birds (10-20) are kept by the family which are mostly taken care by women along with other household chores. It is not an occupation but a supplemental household activity.

2. Semi-scavenging system

In the semi-scavenging system of poultry production birds are raised partly under an intensive system of management and partly under free range system. The scavenged feed accounts for a substantial part of the total feed consumed. This system requires good poultry housing, feeding, proper vaccination and medication. This system needs substantial input cost. Low input and low cost birds with improved productivity are recommended for this system. In this system of production around 50 birds are reared.

3. Small-scale intensive system

In the intensive system of production, the birds are reared under confinement. The birds are reared with full feeding, standard management practices, disease control and proper. Commercial high performing genotypes (Commercial strain of broilers and layers) are recommended for this production system. The flock size may thus vary from 500 to 5000 depending on the economic status of the family.

Important Aspects of Rural Poultry Production

While going for rural poultry production, it is essential to understand the local production system, their limitations and opportunity, the circumstances under which such traditional system came into existence and how they can be improved further. The important points to be considered are adoption of appropriate technology, utilization of locally available resources, proper health management, training of farmers and proper marketing system.

Development of appropriate variety

The indigenous/native breeds of fowl is the choice for rural poultry production as they are hardy, resistance to common diseases, heat tolerant and do not need special attention as compared to exotic breeds. These native breeds have also acquired considerable adaptability to the local climatic environments due to several years of natural selection. Some indigenous breeds possess few unique genes like necked neck and frizzle gene which help in better heat dissipation under tropical conditions. Dark meat chicken (Kadaknath) is a highly valued chicken at some regions for its nutritive properties is assumed to alleviate bone and kidney disease and also human lactation. Because of coloured plumage, long shank bone and alertness, these birds can camouflage characters to protect themselves from predators.

Due to low productivity of native breeds of chicken, a need to develop suitable germplasm for rural / backyard production with improvements in the economic traits in the existing native breeds or the development of new stock with infusion of native blood was felt. The productivity of these stocks should be 120-150 eggs per annum and around 1kg meat in 10-12 weeks of age. 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.

Table 1. Chicken varieties developed for rural poultry production

Variety	Type	Developing Agency
Giriraja	Dual	KVAFSU, Bangalore
Girirani	Egg	KVAFSU, Bangalore
Vanaraja	Dual	ICAR-DPR, Hyderabad
Gramapriya	Egg	ICAR-DPR, Hyderabad

Krishibro	Meat	ICAR-DPR, Hyderabad
Srinidhi	Dual	ICAR-DPR, Hyderabad
CARI Debendra	Dual	ICAR-CARI, Izatnagar
CARIBRO Dhanraja	Meat	ICAR-CARI, Izatnagar
CARI Nirbheek	Egg	ICAR-CARI, Izatnagar
CARI Shyama	Egg	ICAR-CARI, Izatnagar
Narmadanidhi	Dual	JNKVV, Jabalpur
Kalinga Brown	Egg	CPDO, Bhubaneswar
Rajasree	Egg	SVVU, Hyderabad
Kamrupa	Dual	AAU, Guwahati
Pratapdhan	Dual	MPUAT, Udaipur
Jharshim	Dual	BAU, Ranchi

Low cost feed formulation utilizing of locally available resources

In poultry, feed accounts for 65-70% of total cost of production. Therefore, feeding of adequate amount of balanced and wholesome feed is important for optimum production. Feed should be formulated to contain optimum nutrient concentration obtainable at reasonable cost for maximum growth, production and efficiency of feed utilization. In the backyard poultry keeping, it is difficult to know the activity of the birds for their picking up habits and availability of feed ingredients. It is therefore suggested to provide some diets to satisfy their nutrient requirements for optimum production for egg and meat. The availability of common feed ingredients for poultry is becoming a scarce as sizable human population depends on grains like maize, sorghum and other coarse millets for their sustenance. It has become necessary to identify the alternative feed resources available locally and evaluate their nutritional value for poultry. This will not only help in reducing the cost of production but also proper utilization of the local produce.

Research conducted at ICAR-CIWA revealed Azolla leaf meal can be incorporated up to 10% in the diet of Vanaraja laying hens without affecting the growth and egg production. Azolla feeding in laying hens give dark yellow colour to the egg yolk. The cost of feed can be reduced by Rs. 2/ kg by including 10 % dried Azolla meal in poultry feed. Cassava root meal can be totally substituted with maize without affecting the production performance of Vanaraja laying hens.

Table 2. Effect of dietary incorporation of Azolla meal on production performance and egg quality of laying hens

Parameters	Azolla meal (%)			SEM	P value
	0	5	10		
Egg production (%)	50.09	52.76	51.13	1.81	0.845

Egg weight (g)	61.62	61.62	60.50	0.60	0.692
Feed efficiency (g feed/g egg)	4.41	4.36	4.59	0.22	0.914
Haugh unit	75.38	75.39	74.41	1.04	0.161
Albumen (%)	58.35	56.86	57.29	0.37	0.249
Yolk (%)	32.70	34.27	34.07	0.34	0.121
Eggshell (%)	8.95	8.85	8.63	0.12	0.572
Eggshell thickness (mm)	0.372	0.381	0.378	0.005	0.452

Proper health care

A healthy flock is necessary for successful poultry production. For effective poultry health management, three components are very important such as bio-security, vaccination and medication. Prevention should be the approach as the cost of medication is relatively high and once disease occurs, the productivity is affected and profit margins are reduced despite effective treatment.

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

Table 3. Vaccination schedule for Rural Poultry

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

Training and Extension service

The lack of knowledge, experience and sufficient exposure to poultry rearing are the major bottlenecks for successful poultry production by farm women. Training for the backyard poultry keeping will help the farmers to know some of the important tips related to the poultry management and disease control in the flocks. Training programs at village level targeting the stakeholders, women and youth should be organized for effective implementation of the rural poultry farming. Providing extension services including management, vaccination, disease diagnosis, market information and other inputs like supply of chicks, quality feed etc. is the need of the hour. "Learning-by-doing" training, exchange visits for backyard poultry producers, and follow-up sessions have all demonstrated to be successful ways for building capacity. KVK's should organize more programs to show the efficacy of new technologies and create awareness among small and marginal farmers.

Proper marketing system

Several problems such as lack of proper transportation facilities, fluctuation in market prices, market distance, lack of storage facilities and lack of grading and packaging are major bottlenecks for efficient marketing. 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.

Conclusions

Rural poultry production has been broadly considered as a quickest way to ensure food security, generate employment and income, and promote women's empowerment at a relatively low investment. 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. The areas are of particular importance to achieve sustainable rural/small scale poultry production are development of genetic resources appropriate to the specific conditions of production, utilization of local feed resources through different feeding techniques taking into account the potential impact of climate change, availability of quality vaccines and well-trained vaccinators, a good marketing system and access to extension services. Appropriate government policies are essential for successful implementation of rural/backyard/family poultry development programmes from different sectors.

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Livelihood security and farmwomen empowerment through Dairy farming

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Livestock based production system is an integral component of agriculture in rural economy. Nearly 70% of the population residing in rural areas is engaged with traditional systems of animal husbandry. India is the world's largest milk producing country with a share of about 16 per cent in world's total milk production and rank 1st in milk production with a production level of 132.4 million tonnes of milk growing steadily at a compound annual growth rate of about 6.5 per cent (Anonymous, 2012-17). The major share of the credit for India's position as largest milk producing country in the world and the significant increase in the per capita availability of milk in the country is largely contributed by rural women dairy farmers. Dairy farming does not demand heavy labour and provides good opportunity for women to develop this activity as an enterprise and ensures steady cash returns throughout the year by selling milk, milk products, farmyard manure and biogas using agricultural by-products. Such mixed farming ensures an excellent nutrient recycling and represents a key solution for enhancing dairy production and safeguarding the environment through efficient utilisation of resource.

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

Role of Women in Dairy farming

Dairy farming in India is a female dominated enterprise. Women constitute about 69% of workforce engaged in livestock sector. Most of the farm activities such as fodder collection, feeding, watering, health care, management, milking and household-level processing, value addition and marketing are performed by women. Although women play a significant role in dairy farming, their contribution is not yet recognised and they always remain invisible workers. In India, majority of dairy farm women participated in the care of newborn calf, milking, cleaning of animal shed, cleaning of utensils, weaning and management of calf, preparation of cow dung cakes and construction of animal sheds but their participation was least in maintenance of farm records. Involvement of farm women in the care of newborn calf and cleaning of utensils and shed (100%), compost making (73%), milking of animals (70%) and weaning and management of calf (67%) is more (Lahoti *et al.*, 2012). Fodder management, sale of milk and health care of animals were important areas where farm women played a major role in decision-making. The participation of

farm women was least in the economic activities like taking loans, purchase and sale of animals and choosing animals for dairy. Patriarchal type of society, illiteracy of women and low knowledge and skill along with less contact with progressive farmers, credit linkage with finance institutions resulted low level of participation in decision-making. Despite their considerable involvement and contribution, significant gender inequalities also exist in access to technologies, credit, information, inputs and services probably because of inequities in ownership of productive assets including land and livestock. The rapidly increasing demand for dairy products creates opportunities for empowerment of women. Women face greater constraints than men in accessing natural resources, extension services, marketing opportunities, financial services and exposure to zoonotic diseases through dairy farming as well as in exercising their decision-making power. Therefore, there is a need to correct gender bias in dairy sector, research and service delivery system to enhance the effectiveness of women-oriented livestock development programs.

Improving livelihood security of rural women : Issues and Approaches

➤ **Breeding of Dairy animals**

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

➤ **Health care of animals**

The health of dairy animals should be monitored through preventing the entry of diseases into the farm. Construction of boundaries/fencing, avoid direct contact of visitors with animals, taking bio security measures in place to minimise the risk of spread of infectious diseases, isolation of sick animals suffering contagious and zoonotic diseases should be emphasized for maintaining health of the herd.

➤ **Vaccination schedule of animals in a dairy farm**

Disease	Animal	Vaccine	Dose	Immunity	Time of vaccination
FMD (Foot and Mouth disease)	Cattle and Buffalo	Polyvalent FMD vaccine	3ml S/C	1 year	February and December
Haemorrhagic Septicaemia (HS)	Cattle and Buffalo	HS vaccine	5ml S/C	6 months and 1 year	May - June
Black Quarter (B.Q)	Cattle and Buffalo	BQ vaccine	5ml S/C	6 months and 1 year	May - June
Anthrax	Cattle and Buffalo	Anthrax spore vaccine	1ml S/C	1 year	May - June

Brucellosis	Female cattle and buffalo calf aged 4-8 months only.	Brucella vaccine	2ml S/C	1 year	-
Theileriosis	Cattle and calves above 2 months of age	Theileriosis vaccine	3ml S/C	1 year	-
Rabies post bite vaccination	Cattle and buffalo	Rabies post bite vaccination	1ml S/C	1 year	0,3,7,14,28 and 90 days

➤ **Safe milk and value addition to milk and milk products**

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

➤ **Feeding of balanced ration to animals**

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

supplemented along with concentrate mixture in the animal's diet which is very essential need for dairy farm women to get optimum production.

➤ **Fodder resource management**

Fodder production is a major component of the integrated farming system and efforts need to be made for increasing the forage production in a holistic approach of integrated resource management. Leguminous fodder enriching the soil can be grown in mixtures with grasses in grasslands. Indigenous legumes such as clovers (*Trifolium pratense*, *Trifolium repens*), *Medicago denticulata*, *Melilotus alba*, white clover, red clover have proved successful apart from Lucerne and Berseem.

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

➤ **Conservation of fodder resource**

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

➤ **Improving quality of crop residues and Agro industrial byproducts**

Crop residues especially jowar, bajra, maize stovers, wheat and paddy straw are used as staple diet for dairy animals in our country are highly fibrous in nature with low crude protein and high energy content. But, their lingo-cellulose complex is more resistant for rumen microbial enzymes and reduce the bioavailability of energy source (cellulose and hemicellulose) to animals. Various processing methods like physical (chaffing, chopping, soaking, grinding, pelleting etc.), alkali treatment (sodium hydroxide, calcium hydroxide, urea etc.) and supplementation of trace minerals which improve the rumen fermentation pattern, digestibility and nutritive value of crop residues. Biological treatment with white rot and brown rot fungi also improve the nutritive value of crop residues and agro industrial byproducts. The feeding value of crop residues and agro industrial byproducts can be improved if they are blended into complete feeds. Complete feeds with desired ratio of roughage, concentrate, molasses and other agro forest based non-conventional feeds including top feeds improve the feed palatability, voluntary DM intake, avoids refusal of unpalatable portion, reduces wastage, increase bulk density thereby reducing transportation cost. The common formulation of standard compact feed block is wheat straw / cellulosic waste/ tree leaves - 55-60 %, concentrate mixture - 30-35 %, molasses - 10%, mineral mixture - 1% and salt - 0.5% (Singh and Singh, 2007)

➤ **Dairy farming in Integrated farming system**

Integrating crops and livestock serves primarily to minimize risk and not to recycle resources. Crops and livestock interact to create a synergy, with recycling allowing the maximum use of available resources. Crop residues can be used for animal feed, while livestock and livestock by-product production and processing can enhance agricultural productivity by intensifying nutrients that improve soil fertility, reducing the use of chemical fertilizers. A high integration of crops and livestock is often considered as a step forward, but small farmers need to have sufficient access to knowledge, assets and inputs to manage this system in a way that is economically and environmentally sustainable over the long term. An integrated farming system consists of a range of resource-saving practices with integrated resource management that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment. However, technologies and management schemes that can enhance productivity need to be developed to upgrade conventional agriculture along with preserving the natural resource need to be strengthened.

➤ **Community-based extension approach in Dairy farming**

Dairy farm women need to create a horizontal networking to have a platform to share their ideas and strategies for their overall upliftment. In order to provide green forage, year-round alternate land use Agroforestry systems need to be developed on private or community lands in the vicinity of villages. The community lands, civil and panchayat lands, serve as potent source for grazing and hay production but do suffer from lack of management. "Every body's property is no one's responsibility", applies well to these areas. However, legume and fodder tree/ shrub species and access to fodder minikits programmes need to be prioritised for production of good biomass. Management of natural forest by the community could be improved substantially, ensuring ecological stability and reducing biotic pressure on existing resources.

➤ **Cooperation of government - NGOs for feminization of dairy sector**

Feminization of dairy industry lays in the formation of village level women self help groups (SHGs). Concerted efforts of these SHGs, Govt and NGOs are required to fight against the constraints in each aspect of dairy farming practices. Government and milk federation must take corrective action for formation of village level cooperative societies, so that farmers get proper market for their milk with reasonable cost. In addition to this dairy development department must conduct skill-oriented long term training programs for production of value added milk products, so that they get more prices, from their raw material (milk). Local banks should encourage the rural women for dairy business by easily availability of loans with reasonable interest or providing subsidies to dairy farmers. The animal husbandry department should conduct vaccination/deworming/health care programme with the help of scientists to improve knowledge among farmers about importance of schedule vaccination, deforming and health care of dairy animals and also conduct training programme for milk producers of study area about better management of milch animals coupled with importance and techniques of clean milk production. Government as well as NGOs must take initiative for proper functioning of artificial insemination centres. Veterinary and animal husbandry officers, district dairy development officers and scientists must aware the farmers regarding scientific feeding practices to dairy animals through conducting training. If all suggestive measures are undertaken implementing various govt. schemes then only the study area will get momentum in feminization of dairy sector.

➤ **Empowering Women through Improved Dairy farming**

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

➤ **Role of Cooperatives in Dairy development**

India is the world's largest producer of milk due to the policy initiatives of Government of India (GOI) and contributions by various institutions of animal husbandry and allied sectors. During the late 1960s, the GOI initiated major policy changes in the dairy sector to achieve self-sufficiency in milk production. Producing milk in rural areas through producer cooperatives and moving processed milk to urban demand centres became the cornerstone of government dairy development policy. This policy initiative i.e. Operation flood, gave a boost to dairy development and initiated the process of establishing the much-needed linkages between rural producers and urban consumers. The performance of the Indian dairy sector during the past three decades has been very impressive. India has transformed itself from a milk deficit to a milk surplus nation. Presently, the per capita availability in India (444g/day) is far above the requirement(300g/day). Being the largest milk producer in the world, India's per capita availability of milk is still lower than the recommendation of ICMR. The socioeconomic and demographic changes, rising income levels, urbanization and changing food habits and lifestyle, have also reinforced growth in demand for dairy products. Further, on the supply side, technological progress in the production and processing sectors, institutional factors, and infrastructure played an important role to the increased milk production in the country. In late 1980s, National Dairy Development Board placed a major emphasis on women's education as part of our co-operative development programme, an activity designed to strengthen the role of women members in the control and governance of the dairy co-operatives through ANAND pattern. Men were educated about the role of women in dairying and about 6,000 out of the 70,000 dairy co-operative societies in India are women's societies (Sheela and Ramegowda, 2013). Because of their direct involvement in animal husbandry, women also know much more about the care and feeding of dairy animals, identifying first signs of oestrous in cattle and buffaloes, disease and pest problems. Women's dairy co-operatives perform better than men's because women are less political, more loyal to the cooperative concept, more inclined to co-operate with each other and to place their common interests and concerns above the superficial differences of religion, caste and political affiliation. Dairy co operatives provide organizational frame work which enables the members of the community to handle tasks that enhance production and productivity, marketing and value addition, employment generation thus enhancing incomes and meeting social needs. India's dairy cooperatives can easily be replicated

through better management that has foresight and constantly innovates to compete and search for excellence. The white revolution of India is now discussed all over the world for the wide span of development it has engineered. However, to improve production and generate livelihood support to the rural poor for upliftment of their economy, need based scientific ways of animal based production systems need to be intensified at farmers' door step.

Dairying in India is a female dominated enterprise. Selection of breed, compounding balanced feed using locally available ingredients, feeding during pregnancy, health care and banking and insurance were the most preferred area in dairy farming. Dairying is most likely to be effective as 'a pathway out of poverty for rural women and enable them to compete with commercial producers provided the organisations planning and implementing livestock development programmes are sensitive towards the needs, resources, production systems and perceptions of the families and extension service is strengthened and targeted to the underprivileged families particularly the women. Action plans should be agreed and implemented based on the outcomes of the iterative interactions amongst the social groups and the technical teams regarding the ways to increase productivity and profitability and to improve the non-market functions of dairy farming at household, community and village levels. Success in dairy farming improved the socio-economic status and the position of the farm women in their home and village which ultimately leads to women empowerment through creating awareness and skill based capacity building, leading to greater participation, greater decision making power, control and transformation of action through forward and back ward linkage facilitating proper marketing and building dairy business in entrepreneurship mode. Following the leadership role women in Dairy women cooperatives will play a key role in curbing malnutrition and poverty in our country.

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Seed enterprises and women empowerment

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Gender dynamics in seed systems for women seed users and producers

Underlying causes of gender inequality in seed access are not confined to the household and family but are reproduced across a range of institutions, including the community, state, and market. Social Relations Framework enabled the examination of power issues, gender dynamics, and social change in relationships, communities, and institutions, and assessment of the potential for gender transformation through seed systems and revealed that gender relations have strong institutional dimensions, and encompass recognition, gender division of labor, access to and control over resources, decision-making, and social and gender norms. Reach-Benefit-Empowerment Framework (Johnson et al. 2018) in the context of seed systems emphasizes that seed interventions need first to *reach* women and address barriers to reaching them; once reached, women can potentially *benefit* from the use of seed and this could contribute to their *empowerment*. We can consider women's involvement, benefits, and empowerment in seed systems from two angles: women as seed users and seed producers. A seed system that recognizes the differentiated needs and preferences of women and men farmers as seed users ensures the availability of good quality seed of preferred crops and varieties through appropriate and effective delivery channels. It provides the first step on the pathway toward empowerment by reaching women farmers. Women farmers' access to quality seed can be enhanced through creating awareness and providing access to information about the seed and its availability. For seed systems to reach women, quality seed also needs to be affordable and measures need to be in place to support women to overcome the barriers to mobility and networking. These actions have the potential to expand women's access to resources and opportunities and result in positive benefits in the form of increased productivity, higher incomes, and food security. Only when women have access to and control over inputs, resources, knowledge, skills, and decision-making can seed systems contribute to women's empowerment.

Livelihood and empowerment through seed systems

- a) Requires social and institutional structures that create enabling conditions where women's contributions are valued and rewarded. Gender transformative approaches can influence the social context, creating an enabling environment for gender equality and women's empowerment. When seed systems are empowering, the equal rights of men and women to seed are acknowledged and opportunities are equally available to men and women as seed users and as producers.
- b) Livelihood improvement and empowerment requires that both men and women farmers are represented when decisions affecting operations of seed systems are discussed and implemented.
- c) It requires that women farmers are able to make strategic decisions related to their ability to access, utilize, and benefit from seed.

Gender concerns in imparting livelihood to women through seed production

Seed production is inherently associated with better access to inputs, including knowledge, land, fertilizer, machinery, and credit. This means that women seed producers usually have access to good quality seed to multiply and to associated inputs and resources through networks and institutions. By controlling seed production, it is expected that women producers will generate benefits. When they also have agency over the use of the seed they produce and these benefits (e.g. higher incomes that they control), women seed producers are empowered.

Seed availability

Availability of seed is influenced by the type of delivery channel or seed system (as described above). The formal seed sector generally sells certified seed through a limited number of officially recognized seed outlets. It often focuses on seed from formal breeding programs and a few crops of high commercial value. This sector has generally been less successful in marginal, more variable, low-potential areas; seed often does not reach certain social groups. As a result, crops and crop varieties with low market value, that are important for smallholder farmers' household food security, are left out. These crops and crop varieties often are under women's control, sometimes referred to as "women's crops." Sometimes, the varieties available may not be relevant or well suited to the complex and gendered needs and preferences of smallholder farmers. The prevalent seed sector faces challenges in reaching women smallholder seed users and meeting their preferences and needs. Smallholder farmers continue to rely to a large extent on informal seed sector seed. Women play a central role in these systems in seed exchanges, selection, production, and storage, contributing to enhancing nutrition and maintaining crop diversity. Farmer-managed systems reach women more easily as they circumvent the barriers of mobility and cash to buy seed. These are critical in maintaining agro-biodiversity and contribute to resilience and diversity.

Seed affordability

Seed affordability is not gender-neutral. Lack of money to purchase seed is a major constraint for women, affecting both the quality and volume of seed use which increases their dependence on farmer-managed systems. Women use other means to access quality seed in communities, such as seed exchange, casual labor supply, labor exchange, gifts, seed loans or money loans. As women and men have overlapping as well as different needs from the same crop, willingness to pay is guided by different drivers. The social determinants and gendered differences of farmers' willingness to pay for particular traits and actual ability to pay often remain unaddressed. Hence, gender dynamics is crucial in determining women's use and control over seed mediated by women's access to resources, including knowledge and skills and by social norms that influence decision-making.

Accessing seed information

Seed information channels in communities are anchored in local social networks and community processes that are often gendered. Women, who generally have higher mobility, are more able to access information from the public arena as their low literacy levels do not affect

access to informal services. For open-pollinated varieties and vegetative propagated planting materials, awareness-raising and information-sharing can be conducted very effectively through participatory processes, such as field demonstrations, farmer field schools, and participatory varietal selection. While such efforts are often small in scale, the information and experience gained is high as farmers interact intensively with other seed system actors. For women, these processes are often very beneficial: they interact freely, unconstrained by social norms of interaction with men, who are non-family members.

Decision making

Women's decision-making power to acquire and use seeds is important given their roles as household managers and custodians of seed, in particular in farmer-managed systems. Women mostly don't get the proper benefit share and thus could not save enough to invest in new technologies and practices of seed production and use. Gender differences in control of seed in the household appear to vary with the crop and variety and are related to market orientation. Usually women manage seed selection, processing, and storage for food crops but not for cash crops. Women can exercise their decision-making power in farmer-based seed systems, which offer women significant access to and control and use of the desired crops and varieties. They tend to rely on saved seed, which gives them self-reliance in seed, crop diversity, and nutrition. These are three realms that are largely under women's control. Being able to save their own seed means women can ensure diversity in crops and food, both now and in the future. They can also ensure crop characteristics meet their own specific needs, including sowing at the optimal time. Women's engagement in seed management, including their decision-making, is a factor that positively affects seed system outcomes for women. In addition, women are able to accumulate seed capital and bargaining power within the household.

Livelihood enhancing women entrepreneurship on seeds of food crops

Seed production can be beneficial for women as an enterprise, and can at the same time strengthen their key roles in seed systems. Women seed producers can harness profit and gain economic empowerment so that they feel more food-secure and can gain a sense of entrepreneurship. Seed systems can create and expand spaces for women's economic participation by being a part of community based seed entrepreneurs with seed operations that start at the local level with one or a few crops and then expand to other areas and more crops. Women are increasingly participating in the formation and management of small seed enterprises that deliver better-quality seed compared with the farmer-managed systems. This will engage them in seed marketing, women's access to and control over the desired varieties will create a novel opportunity for being the producer and consumer of their own produced seed with increasing the availability of quality seed in the locality and beyond. With capacity building and community mobilization the efforts and related outcomes will prove beneficial in addressing the constraints and challenges women entrepreneurs face.

Challenges and opportunities for women seed entrepreneurs

The weak economic position of women, limited access to production factors, and intra-household dynamics hamper women in their efforts to become entrepreneurs. Farm plot size, land

used, soil fertility, ox ownership, access to markets, credit, and extension services had significant effects on outcomes realized by women-headed households from participation in local seed businesses. Women seed entrepreneurs face challenges as a result of limited access to finance and seed processing machinery, inability to attract and retain skilled workers, and delayed payments. These are further complicated by societal bias toward women in business. The heavy work burden of women owing to domestic and other care further constraints their participation. Lack of time affects women's participation in seed production, limited opportunities for networking or participating in community reduces the marketing scope and will result in control over smaller income. However, their engagement in seed and grain production of food crops can enhance their capacities, income, and assets, and reduce their vulnerability. Given the gender asymmetries in ownership of assets and access to resources/ land and financial capital, women are often unable to invest in the agriculture sector.

The evidence on women's benefit and empowerment outcomes as a result of engagement in seed systems is slightly more tangible when looking at women seed producers. The engagement of women as producers appears to hold high potential to expand economic opportunities. Nonetheless, efforts to promote sustainable and viable women led small, medium and large scale seed enterprises are ready to contend with gender inequities in access to resources, particularly capital and market linkages. Gender norms that affect mobility, access to networks for information, and market linkages are being eased out. Suitable gender friendly seed system interventions can enhance women's livelihood. Access to good quality and relevant plant seed can increase productivity, resilience, nutrition, and food security and, potentially, enhance benefits and lead to livelihood security of women. Access to good seed of multiple varieties can be a useful strategy to respond to changing climatic conditions, increasing farmers' resilience and enable women to realize their full potential as farmers and seed producers in their own right.

Approaches for involving women in seed production of food crops

Participatory varietal development

- Farmwomen are organised into groups of 5-10 members.
- They are given exposure on the ways and methods used for conserving varieties.
- They are exposed to in situ germplasm centres where a number of landraces of different food crops planted in different land types.
- The farmers interact with each other, see crop performance and assign a score based on criteria such as yield, resistance to pests and diseases, suitability to land, drought tolerance etc.
- Organizing training programmes will help in educating farmwomen on maintaining seed purity like seed treatment, nursery raising, isolation distance maintenance, rouging, controlled harvest, threshing, processing, labelling and testing.
- After series of experiments for characterization and purification, upgraded and elite germplasm of promising local cultivars will be given for seed production.

- Organic methods of cultivation will be followed.
- Worthy crop landraces based on certain criteria will be selected by participatory method and saved in community seed banks.

Biodiversity conservation

Farmwomen have access to a range of food crop landraces which are drought resistant, pest and disease resistant and nutritionally rich. Some of them are in large scale cultivation in the locality and are quite popular among farmers. Combined with better crop production practices, farmers have been able to realize improved yields from these landraces. Farmers are producing and using quality organic inputs like vermicompost, vermiwash, natural pest repellents and have knowledge of indigenous methods which are considerably reducing their costs of production and also dependence on external inputs. Uses of organic inputs also enhance the soil fertility and water holding capacity. Hence, conservation and sustainable use of those can be the first step for giving entry to farmwomen for a viable robust local seed system.

Community level seed production

Sustainability of seed conservation programme requires a mechanism at the community level for seed selection, seed production and exchange and to establish an independent seed security system at the village level. A seed saver committee can be formed to ensure quality seed production, management of seed exchange and establish market linkages.

Seed production and seed selection methods are assured by seed saver committee through field visit wherein they promote suitable methods to participating farmers. Seed saver committee has an authority of monitoring seed plots for quality seed production. The committees are capable of managing *in situ* conservation centres of food crop landraces. To have wider spread, around 10 youth are to be trained for dissemination of these technologies in different villages and source seed production. Field exposure and field days are to be conducted regularly. Community-level seed exhibition is an important tool for increasing awareness of the farming communities about crop diversity in their area and the need for conservation. Community seed fairs, seed exhibitions and field days will help reach up to farmwomen and establish a seed system.

Developing network of community seed banks will help in further reaching out to larger groups of farmers. Further, the network could facilitate better access to markets through collectivization and value addition. However, this also calls for improved storage facilities at the community level. Though farming communities are involved in conservation and sustainable use of land races, they require some support to safeguard these resources. Registration of farmer's varieties under PPV & FR Act becomes important. Also further studies at chemical and molecular level are needed for validation of people's knowledge about nutritional values and for DNA finger printing and bar coding of crop landraces.

Nurturing diversity in home gardens

Women communities have diverse food resources in their backyards which are rich sources of nutrition and healthy food. They have traditionally been establishing a complex backyard garden at each household. They are small plots next to houses of families, which include multiple, multi layered and multipurpose indigenous trees, plants, herbs and shrubs. The home gardens mostly consist of seasonal and nutritious vegetables, medicinal plants grown during monsoon as well as few perennial big trees on borders. The trees and vegetable types are local. The produce of this small plot is sufficient to meet nutrition and food security needs of a family for entire year. So, for increasing the sovereignty farmwomen can use part of the land or the whole backyard garden for production of seeds, which can be utilized in the community for cultivation or further multiplying the seed.

Way Forward

Promising methods to support women's entrepreneurship include-

- ✓ Gender-specific laws and strategies
- ✓ Integrated loan and training programs
- ✓ Alternative credit assessment strategies.
- ✓ Targeting groups and individual seed producers as individual production is also seen to encourage better performance.
- ✓ Community mobilization for acquisition of inputs and basic infrastructure, training, and joint marketing.
- ✓ Building organizational and financial management capacity to sustain collective action.
- ✓ Developing interventions that promote women seed producers and entrepreneurs
- ✓ Flexibility in planning to include unpaid care responsibilities and taking into account social norms that affect women
- ✓ Strengthening institutional mechanism and promoting collaboration among family and community members.

High value vegetable cultivation: avenue for horti-preneurship

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Entrepreneurship is the process by which individuals or a group of individuals design/envisage and manage a new business idea/enterprise, realize the market risks and earn the profit. Horti-preneurship is the community-oriented, environmentally sustainable and market led development of horticultural business. It offers promising opportunities for entrepreneurs for generating income through the production and value addition of various horticultural crops and inputs. The entrepreneur must have technical, financial and managerial expertise in the horticultural sector to establish an entrepreneurial approach in the sector. Sustainable increase in per capita income, urbanization, changing lifestyles and agri-food market liberalization resulted in rapid changes in the food basket in favour of high-value food commodities such as vegetables, fruits and animal source foods (Kumar and Joshi, 2017). High value crops (vegetables, fruits, condiments, spices and plantations) are those which provide noticeably higher productivity and net income per unit of resource consumed for their cultivation as compared to widely grown cereals. Diversification towards high value or horticultural crops offer an effective approach towards agriculture based livelihoods security, food and nutritional security through supply of micronutrients and roughages, more income and profitability, poverty alleviation, employment generation, judicious use of resources, higher potential for value addition and sustainable agricultural development (Joshi et al., 2006; Singh and Mathur, 2008; Bigsten and Tengstam, 2011; Singh, 2013; Birthal et al., 2015; Michler and Josephson, 2017). High value vegetable (HVV) crops cultivation gaining popularity among farmers especially for small and marginal farmers due to their short growing cycle, high market demand, more profit, required low levels of farm mechanization and more employment generation

Dimensions of horti-preneurship through high value vegetable cultivation

- **Quality planting material (QPM) production:** Quality planting material is the production of uniform, healthy, disease free planting material raised through seed or vegetative methods. Quality planting material is an essential input in horticulture for better adaptability to adverse environmental conditions. Guaranteed performance in terms of higher yield and quality of crops could be achieved with reliable planting material and good management practices. Nursery-raised plants of appropriate quality in terms of genetic makeup, varietal purity, robustness, and being free from diseases and pests are of primary importance of horti-preneurship through QPM. Entrepreneurship in quality planting material production offers a bright future to the youth.
- **Hi-tech production of HVV:** Protected cultivation offers a favorable environment to the high value vegetable crops to obtain its maximum potential even in adverse climatic conditions. Hi-tech cultivation also helps in maintain the quality of produce as it provides protection against biotic and abiotic stresses. Greenhouses, rain shelters, plastic tunnels,

polyhouses, insect-proof net houses, shade nets etc. are used as protective structures. High value vegetable (HVV) crops like tomato, chilli, coloured capsicum, parthenocarpic cucumber, lettuce, broccoli, melon etc. are cultivated under polyhouses both for cultivation as well as hybrid seed production. Therefore, mass employment generation in the rural and peri-urban areas and entrepreneurial prospects among educated youths can be achieved through Hi-tech production of HVV.

- **Organic farming:** The market demand for organic foods is gaining popularity especially in the niche market. Organic farming is gaining wide attention among entrepreneurs as it improves the quality of produce and subsequent high price in the market, as well, it is labor intensive and provides an opportunity to increase rural employment. It offers a remunerative carrier to an entrepreneur to start business but care must be taken to follow the guidelines of organic farming critically.
- **Bio-inputs production:** Bio-fertilizer & bio-pesticides are the promising alternatives to manage environmental pollutions and an integral part of organic production. Though potential application of bio-pesticides in environmental safety is well known, it has gained interest in view of the growing demands for organic food. This sector provides great business opportunities to horti-based entrepreneur.
- **Vertical farming & soil less cultivation:** Vertical farming is growing crops in vertically stacked layers under controlled environment to produce more crops per unit area. Vertical farming involves soilless farming techniques such as hydroponics, aquaponics, and aeroponics. Vertical farming provides entrepreneurial opportunities in urban areas to grow high value exotic vegetables and can grab the niche market.
- **Mass propagation through tissue culture:** Production of true-to-type plants through micro propagation techniques technique is also a profitable entrepreneurial avenue for young educated youth. Vegetative propagation of disease-free, high quality vegetable crops such as tubers and bulbs can be done in a short period as compared to conventional methods.
- **Micro-irrigation:** The high value vegetables are mostly cultivated under protected conditions and drip irrigation is used for irrigating the crops. Now-a-days educated youth starting up businesses in the domain of providing irrigation and allied services and earn good profit.
- **Beekeeping:** Beekeeping entrepreneurship providing employment to rural educated youths in collecting, processing and marketing of bee products like honey, pollen and beeswax, venom and royal jelly. Bee pollination is essential for seed production of high value vegetables (radish, cabbage, turnip, carrot, onion cauliflower, gourds etc.) under protected condition. So, beekeeping offers an promising enterprise.
- **Horti-tourism:** Young educated youths in groups and farmers in community approach can set up horti-tourism in the peri-urban areas. Horti-tourism can attract many tourists to take glimpses of various horticultural crops, off-season vegetables, exotic vegetable crops, protected cultivation and vertical farming.
- **Packaging of HVV:** The fresh-cut packaging revolution is most noticeable in bagged salads, where the moisture controlled plastic bags created a whole new category. The trend

toward fresh-cut packaging is in response to the increase in demand of grab-and-go eating patterns among consumers. A fresh-cut packaging type that is getting more popular is steam able packaging. As ready-to eat foods get more popular, consumers are flocking to vegetables that can be steamed in the packaging that can include cut vegetables, such as broccoli florets or green beans, or whole foods like microwavable sweet potatoes etc.

- **Value-added product development:** High value vegetable (HVV) crops are highly perishable, therefore to reduce postharvest losses; value-addition and processing are recommended. Vegetable processing industries provides service opportunities for young generations and especially women in the processing and value addition enterprise. It creates better remuneration to the grower, reduces the price-spread and provides quality food products to the consumers. Agro-processing units are considered as the biggest component of linking horticulture to industry and with the deployment of technology and e-commerce, there is the possible mingling of the three sectors to create efficient horti-preneurship model for the country.

Challenges in entrepreneurship development through HVVs

- ❖ Lack of infrastructure facilities
- ❖ More investment for cultivation under controlled environment
- ❖ Lack of financial assistance
- ❖ High risk of crop failure
- ❖ Lack of proper marketing value chain
- ❖ Interference of middlemen for marketing of their products
- ❖ Lack of technical know-how
- ❖ Lack of expertise in IT
- ❖ Poor quality of products due to lack of availability of standard tools and equipment and poor quality of raw materials

Conclusions

Diversification towards high-value crops can be a promising strategy to enhance farmers' income security, risk-bearing ability and sustainability. The high value vegetable crops can also be grown round the year, including off-season fetching high market price resulting in increased profitability. Multi-storied vertical farms under protected conditions in the peri-urban areas are catching on in many developed countries, to meet their requirement of fresh produce. The community approach will promote common production from farms to be aggregated and linked in a viable manner to the country's markets. With declining size of landholdings in agriculture, the focus has to be on resource efficiency, dynamic cropping patterns, climate smart agriculture and intensive use of ICTs. away from cereals towards high-value agricultural crops due to higher incomes and urbanization in India. Global value chain, changing lifestyles and consumer preferences have shifted towards the high demand of high value horticultural products. Horti-preneurship in current

context would provide a economically viable and ecologically sustainable livelihood and significant employment generation to the rural educated youth.

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Enhancing Farm Women's Employment and Income through Fruit Crops-based Farming Systems

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Women farmers are significant contributors to the horticulture sector and play a central role in both on-farm and off-farm activities. Their contributions often exceed those of their male counterparts, especially in tasks that are time-consuming, labour-intensive, and often categorized as 'unskilled.' Unfortunately, the extent of their involvement is often underestimated, leading to a noticeable gender gap. Farm women form a substantial support system for the horticulture sector, and it is imperative to recognize their strengths, address their challenges, provide them with more opportunities, and alleviate the barriers they face. Socio-economic constraints and issues have limited their recognition as 'farmers,' often labeling them as mere 'agricultural workers.' Closing the gender gap in horticulture and encouraging women's employment and income generation would require the gender-friendly farming systems, technologies and their dissemination through gender-sensitive extension methods. As the trend of increasing feminization in agriculture continues, it is essential to empower women with advanced horticultural technologies aimed at enhancing their skills and reducing the burden of labour. This not only promotes sustainable livelihoods and improves nutrition but also contributes to the holistic development of the horticulture sector.

In India, where the economy is primarily agrarian, approximately 54.6% of the total workforce is engaged in agricultural and allied sector activities. On a global scale, women constitute 36.7% of the workforce in agriculture, whereas in India, this figure stands at 26.1% (FAO, 2021). Data from the Agriculture Census in 2015-16 reveals that only 11.72% of the total operated agricultural land in the country was under the management of female operational holders. Globally, less than 20% of landholders are women. In rural areas, the gender pay gap can be as high as 40%. Rural women often bear a disproportionate burden of unpaid care and household work, which often goes unrecognized and unrewarded. These women are also at a heightened risk of experiencing abuse, sexual harassment, and various forms of gender-based violence. Climate change further compounds the vulnerability of rural women, exposing them to discrimination, exclusion, and exploitation. Gender inequalities extend to women's limited access to essential productive resources, including land and water, as well as inputs that enhance productivity, such as credit, fertilizers, seeds, and other agri-inputs. Access to research, education, and extension services also remains a challenge (FAO, 2011). Improving women's access to resources like land and livestock, as well as education, financial services, extension services, technology, and rural employment, can significantly enhance their productivity. This, in turn, would lead to gains in terms of agricultural production, food security, economic growth, and overall social well-being. Promoting gender equality and empowering women in agriculture is not just a matter of principle; it is a fundamental requirement for agricultural development and ensuring food security (FAO, 2011).

Significance of enhancing farm women's employment and income

Enhancing farm women's employment and income in the agriculture sector is particularly important for promoting women's participation in agriculture, addressing gender disparities and encouraging farm women empowerment. Women in agriculture, particularly in rural areas of developing countries, often face high levels of poverty. Increasing their income can help reduce poverty, improve their living conditions, and support their families. Improved income from agriculture can lead to better access to nutritious food, which can have positive effects on the health and nutrition of women and their families. Enhanced income from agriculture can support investments in education, benefiting not only the women themselves but also their children. Educated women are more likely to make informed choices about health, family size, and economic opportunities. Economic independence in the agriculture sector empowers women to participate in decision-making processes, both within the household and the community, leading to increased self-esteem and influence over their lives. Climate change poses a significant challenge to agriculture. Empowering women with knowledge and resources can help them adapt to changing climatic conditions. Many women in agriculture exhibit entrepreneurial skills. Enhancing their income can lead to the growth of agricultural businesses and related enterprises.

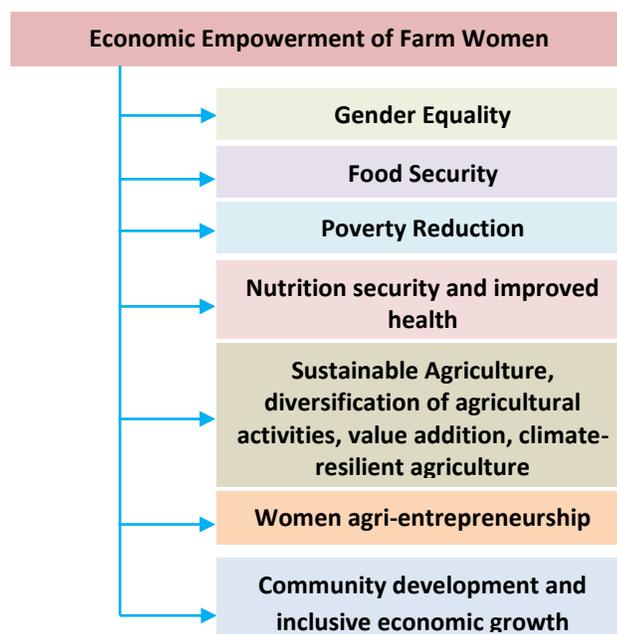


Figure 1. The Impact of Economic Empowerment on Farm Women

Farming systems as a holistic source of income

Farming systems are comprehensive and integrated approaches to agricultural production that take into account various aspects of farming to optimize productivity, sustainability, and economic viability. These systems consider the interactions between different elements of a farm, such as crops, livestock, agro forestry, and other agricultural practices, to achieve the best results. Farming systems can help generate farm income and employment in several ways. Farming systems often

involve diversifying the range of crops and activities on a farm. This diversity can create additional income streams, reduce risk, and provide employment opportunities in various agricultural tasks. Crop rotation and integration with livestock can improve soil fertility, reduce the need for external inputs, and enhance farm productivity. Livestock farming provides not only meat, milk, and other products but also manure for fertilization. Integrating trees into farming systems can lead to the production of timber, fruits, or other tree products. This can diversify income sources and provide employment in tree management and maintenance. Farming systems often require labour for various tasks, such as planting, harvesting, weeding, and animal care. This creates employment opportunities for both family members and hired labour. Small-scale agribusinesses, such as organic food production or agro tourism, can generate income and employment in rural areas. Sustainable farming systems aim to improve resource use efficiency and reduce input costs, thereby enhancing farm profitability. Farming systems can include value addition activities like processing, packaging, and marketing of agricultural products. These activities can add value to the farm produce and generate income. For example, processing fruits into jams, juices, or dried fruits can increase their market value. Through various farming systems, linkages with local markets, wholesalers, or value chains can be established, which can lead to better marketing opportunities and income generation for farmers. By adopting and optimizing farming systems, women farmers can increase their income and employment opportunities while contributing to sustainable agriculture and rural development.

Fruit-based farming systems are agricultural systems that focus primarily on the cultivation of fruit-bearing plants, such as fruit trees and shrubs. These systems may involve the integration of various fruit crops into the farming landscape to create diversified and sustainable agricultural practices. Fruit-based farming systems offer a sustainable and profitable approach to agriculture, as they allow for income diversification, market-driven crop selection, and the promotion of healthy and nutritious food options. These systems can also be tailored to local conditions and farming objectives, making them adaptable to a wide range of agricultural settings.

The UN and FAO both describe farming systems represented by *conventional food and materials flow* through the system via numerous specialized actors, including farmers, aggregators, distributors, retailers, and other service providers such as ordering, delivery, and account management. Farming involves interactions between humans (farmers and employees), machinery (tools, equipment), technology (automatic irrigation and sensing), and the natural environment (climate, soil, water, wildlife, and microbe). Modern farming systems must address a myriad of challenges, including sustaining livelihoods, preserving biodiversity, mitigating emissions, and adapting to climate change. Traditional farming practices in various nations encompass diverse crops such as cereals, tree crops, and vegetables, as well as a variety of agricultural activities like livestock rearing, aquaculture, and beekeeping, all coexisting within a single agricultural operation. A farming system emerges from intricate interactions among several interrelated elements, encompassing land, labour, capital, and management.



Figure 2: Integrated Farming System Model (Source: Jadoun *et al.*, 2023)

Categories of Integrated Farming System

1. **Crop-livestock farming system:** A crop-livestock farming system is an integrated agricultural approach in which crop cultivation and livestock rearing are combined on the same farm. This system involves the simultaneous or sequential production of crops and livestock, where the outputs of one component can benefit the other.
2. **Crop-livestock-fish farming system:** Agricultural systems known as crop-livestock-fish farming, or integrated crop-livestock-fish farming, represent a holistic approach to farming. They combine the cultivation of crops, the rearing of livestock, and the practice of fish farming within a single agricultural setting. This approach entails the concurrent or successive production of crops, livestock, and fish with the goal of efficiently utilizing resources and elevating the overall productivity of the farm.
3. **Crop-livestock-poultry-fish farming system:** A Crop-livestock-poultry-fish farming system is an inclusive agricultural system that combines crop cultivation, livestock rearing, poultry farming, and fish farming within the same agricultural operation or on the same piece of land. This system involves the synchronized or sequential production of crops, livestock, poultry, and fish, with the aim of optimizing resource use, enhancing overall farm productivity, and diversifying sources of income.
4. **Crop-poultry-fish-mushroom farming system:** A Crop-poultry-fish-mushroom farming system is an integrated agricultural approach that combines the cultivation of crops, poultry farming, fish farming, and mushroom cultivation within a single agricultural operation or on the same piece of land. This integrated system involves the concurrent or sequential production of crops, poultry, fish, and mushrooms, with an objective of maximal utilization of existing resource utilization and improvement in total farm output.
5. **Crop-fish-poultry farming system:** A Crop-fish-poultry farming system, often referred to as integrated crop-fish-poultry farming, is a multifaceted agricultural approach that

combines crop cultivation, fish farming, and poultry farming within a single agricultural operation or on the same piece of land.

6. **Crop-livestock-fish-vermicomposting farming system:** A Crop-livestock-fish-vermicomposting farming system is an integrated agricultural approach that combines crop cultivation, livestock rearing, fish farming, and vermicomposting.
7. **Crop-livestock-forestry farming system:** A Crop-livestock-forestry farming system, also known as agroforestry, is an integrated agricultural approach that combines crop cultivation, livestock rearing, and tree or forestry components within the same agricultural operation or on the same piece of land.
8. **Agri-silvi-horticulture system:** An Agri-silvi-horticulture system, often referred to as agro-silvicultural-horticultural system, is an integrated and sustainable agricultural approach that combines agriculture (agri), tree cultivation (silvi), and horticulture within the same land.

Some of the Fruit based cropping models for enhancing the income opportunities of farm women are as follows:

1. **6-F Horticulture Model:** The 6-F Horticulture Model is an integrated system with combination of crops to maximize production and profitability of the production system. 6-F indicates- Food, Fodder, Fuel, Feed, Fibre and Finance through inclusion of nutrient-rich horticultural crops viz., seasonal vegetables, short-duration fruit crops, plantation crops, flowers, aromatic plants, root and tuber crops and fodder crops. The farm income is enhanced through reduced input cost due to efficient bio-resource mobilization by interdependent systems. It features a sustainable production system and strengthened livelihood opportunity through crop-diversification, multiple cropping, and intercropping approaches.
2. **Multi-storey cropping models:** A multi-storey cropping model, often referred to as multi-storey farming or multilayer farming, is an agricultural system that involves the cultivation of multiple layers of crops within the same vertical space. In this model, crops are grown in layered arrangements. This innovative approach maximizes the use of available space, solar radiation, irrigation water and can be particularly useful in areas with limited land resources for enhancing crop production.

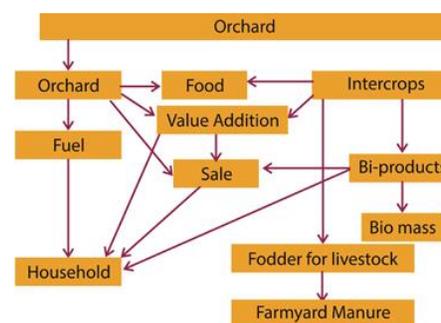


Figure 3: Horticulture-based cropping model for Gender Mainstreaming



Figure 4: Multi-storey cropping model

Crop components	
Top storey crop	Coconut
Second storey crops	Papaya, banana and guava
Ground storey crops	Pineapple, cowpea, turmeric, elephant foot yam

3. Plantations and Intercropping models:

Fruit-based intercropping models involve the cultivation of fruit trees alongside other crops or plants within the same agricultural system. These models promote the efficient use of land and resources, enhance biodiversity, and can provide multiple sources of income for farmers. It can be of following types:

- ✓ *Fruit Tree and Annual Crop Intercropping*: This model involves planting fruit trees, such as citrus, mango, or guava, alongside annual crops like maize, beans, or vegetables. The fruit trees provide shade and contribute to long-term income, while annual crops offer short-term income and nutrient cycling.
- ✓ *Fruit Tree and Perennial Crop Intercropping*: In this model, fruit trees are intercropped with perennial crops like coffee, cocoa, or tea. The perennial crops are grown under the canopy of the fruit trees, making efficient use of space and providing both short-term and long-term income.
- ✓ *Agro-forestry with Fruit Trees*: Agro-forestry systems incorporate fruit trees, such as mango, cashews, avocados, and apples, into a diverse mix of forest trees and crops. The integration of fruit trees enhances biodiversity, improves soil fertility, and offers various products for sale or consumption.
- ✓ *Fruit Tree and Medicinal Herb Intercropping*: Fruit trees are grown alongside medicinal herbs and plants. This model allows for sustainable cultivation of medicinal herbs in the shade of fruit trees and provides multiple sources of income.
- ✓ *Fruit Tree and Vegetable Intercropping*: Fruit trees can be intercropped with vegetables, such as tomatoes, cucumbers, or pumpkins. The fruit trees provide shade and support vertical growth, while the vegetables yield short-term income.
- ✓ *Fruit Tree and Legume Intercropping*: Leguminous crops like peanuts, soybeans, or pigeon peas are intercropped with fruit trees. The legumes fix nitrogen in the soil, benefiting both the fruit trees and the legume crop.
- ✓ *Fruit Tree and Groundcover Intercropping*: Groundcover plants like clover, grasses, or cover crops are grown beneath fruit trees. These groundcover plants help control weeds, reduce erosion, and provide forage for livestock.
- ✓ *Fruit Tree and Beekeeping Intercropping*: Fruit trees are intercropped with beehives, promoting pollination and honey production. The fruit trees and honey complement each other in terms of income.

- ✓ *Fruit Tree and Silvopastoral Intercropping*: In this model, fruit trees are incorporated into silvopastoral systems, combining tree crops, livestock grazing, and fruit production. This can increase the overall sustainability of the agricultural system.
- ✓ *Fruit Tree and Flower Intercropping*: Flowers are intercropped with fruit trees, benefiting pollinators and enhancing the aesthetics of the orchard. The flowers can be sold for additional income.

Fruit crops-based intercropping models developed at ICAR-CIWA	
Guava based cropping model	Okra, Cowpea, Turmeric and Pineapple
Mango based cropping model	Okra , Cowpea, Marigold, Radish
Minor fruit based cropping model	Marigold, Cowpea, Tube Rose, Fodder Grasses (<i>Stylosanthes</i>)
Coconut based cropping model	Turmeric, Colocasia, Cowpea, Elephant Foot Yam
Cashew nut based cropping model	Pineapple, Tapioca, Okra, Lemon Grass, Congo Grass

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Non Timber Forest Products (NTFP's): an important income contributor for the forest dwellers of Jharkhand

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Forests provide timber and several products for many uses at household and industry (Appiah, 2009). It is observed that Non-Timber Forest Produce (NTFP) collection and selling is a critical livelihood option for indigenous people. NTFPs collection is the one of the main sources of subsistence livelihood for hinterland households dwelling across India. Around 1.6 billion people throughout the world are reported to collect, consume and trade NTFPs (Shanley et al., 2015). About 80 per cent people across developing countries are found to use plants for food and nutritional security (Dash et al., 2016) and traditional medicine (FAO, 2020). More than two billion people in the world use biomass-based fuels, mostly fuelwood for cooking and heating purposes. Research on the role of NTFPs in income generation has been reported to contribute to 20– 60 per cent of the rural household income (Dash et al., 2016, Naguyen et al., 2020) of forest fringe communities globally. In India, the annual contribution of NTFPs to income corresponds to US\$2.7 billion, supporting more than 55 per cent of the total employment in the forest sector. One third of India's rural population is reported to derive substantial household incomes from NTFPs (Pandey et al., 2016). NTFPs contribute to about 20 to 40% of the annual income of forest dwellers (89 million tribal people) in India and about 80% of forest dwellers depend on forests for 25 to 50% of their food requirements. The forest fringe communities use NTFPs for diverse purposes like medicinal, edible fruits, vegetables, oilseeds, ornamental, cottage industry, fuel wood, fodder, dyes, tannins, narcotic, drinks, housing materials, agricultural implements, weapons, fibres, furniture items, packing materials, matches, sports goods, lac, floss etc.

Coverage of study

Jharkhand has a rich natural resource base, with forest area of the state estimated around 23,605 km². 23 blocks from 7 Districts (Gumla, Simdega, West Singhbhum, East Singhbhum, Latehar, Garhwa, Chatra) were identified by Jharkhand State Livelihood Promotion Society, under Rural Development department for the detailed value chain assessment of Lac, Tamarind, Honey, Jackfruit, Tasar, Karanj, Kusum, Ashwagandha, Shatavar, Kalmegh, Sal leaf, Mahua, Plash flower and Custard Apple. Traidcraft India was assigned the task of conducting study during June-November 2018.

Agro climatic Zone	Districts	Number of Blocks Selected
Western Plateau Zone	Gumla	5
	Simdega	3

	Latehar	3
	Garhwa	1
	Chatra	1
South Eastern Plateau Zone	W. Singhbhum	6
	E. Singhbhum	4
Total	7	23

Methodology

Following research methodology was used for selecting survey clusters for the quantitative socioeconomic assessment, that includes ensure all the Agro-climatic zones with higher forest coverage, districts with more than 30% forest coverage and covering all the major NTFP clusters / Blocks.

Within each district representative blocks were purposively selected considering: presence of, NTFP availability and PVTG/vulnerable population. As each block has nearly 80-100 hamlets (villages). Hence 10 villages per block was selected. In Each village around 100 households were found, hence 10 forest dependent households per village were covered and finally 2471 HHs data were captured as part of the study. These households were having higher dependence on NTFP for consumption, processing and sale, further the socially or economically vulnerable groups-were also prioritized in sample selection process. all Sample Households from 23 blocks, across 7 Districts participated in Focus Group Discussions (FGDs) and Value Chain Assessment study of NTFPs. These blocks were reported to have higher-than-average Forest Coverage of 30%.

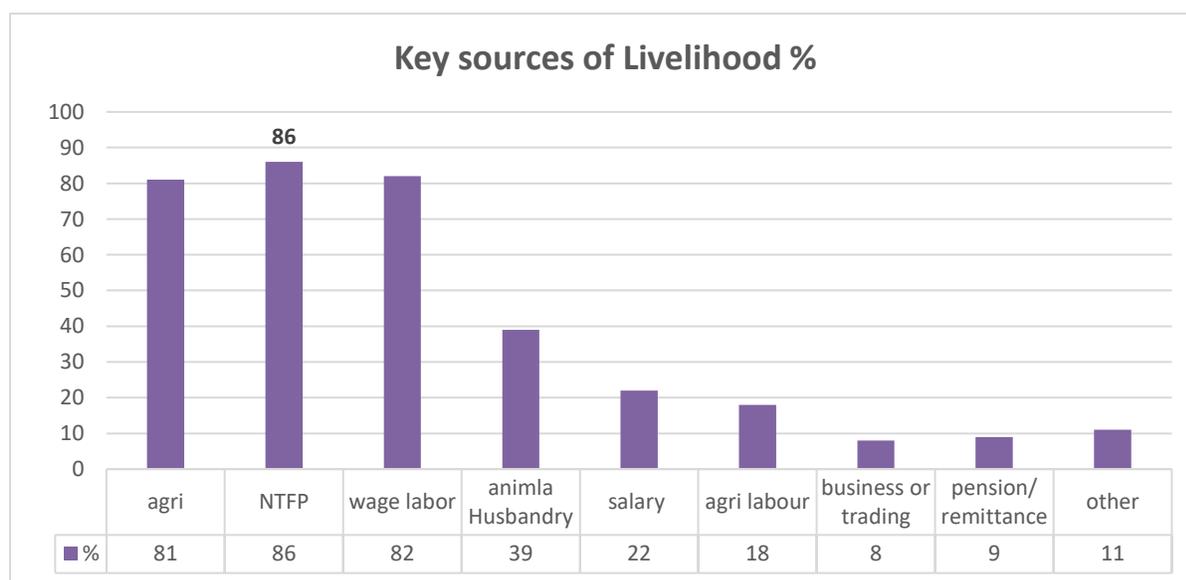
The study team made following during qualitative assessment phase: 1. Conducting the Socioeconomic Household surveys of 10 HHs in each village by the enumerator 2. Conducted PRA exercises (basic various tools such as Chapati / Venn Diagram, Seasonality Assessment, Matrix Ranking etc.) to collect knowledge and opinions of forest dependent communities on role of NTFP in their income basket. Other methods including Focus Group Discussion, Interviews etc were also used for validating the same. 3. Meeting local market players in these blocks and conducting surveys leveraging market players 4. Additionally, the researchers also collected value chain specific field details (production, seasonality, collection, processing, and marketing) of these 5-7 blocks for select 14 NTFPs.

Experts of Traidcraft steered the market assessment study of various NTFP commodity for facilitating implementation of innovative strategies and methodologies in the areas of Livelihoods and Enterprise promotion, Market Engagement, Value Chain Development, Institution Building and other Development Research. A comprehensive household survey sheet was developed by the study team to collect relevant data on existing livelihood and income sources for the forest dependent households and contribution of NTFPs in household income. 92 enumerators were identified and trained on household survey techniques and a mock survey was conducted as a pilot exercise. Each enumerator completed around 30 HH Surveys in 3 assigned villages.

Findings

93% HHs reported engagement in Collection and Sale of NTFPs, with avg. HHs engagement was for atleast three NTFPs; Mahua, Tamarind and Lac were reported as the top 3 NTFPs in terms of engagement of HHs; Karanj, Jackfruit and Kusum are the next 3 NTFPs in the list. Simdega, W. Singhbhum and Gumla reported intense NTFP engagement due to presence of large quantity of NTFPs like Lac, Mahua and Tamarind, NTFP Collection was found to be highly oriented towards income generation (~90% HHs reported marketable Surplus and Sale of NTFPs), NTFPs income contribution towards HH Income ranged from 19 to 31% across districts with an overall average of 25 %, overall average HH Income was reported as Rs. 62,281/-, HHs with higher NTFP income contribution in the overall HH income turned out to be poorer of the lot implying that NTFPs are very critical for the poorest of the poor.

Nearly 85% respondents belonged to ST and SC categories and 8% belonged to other backward classes, Majority of the respondents belonged to 30 to 50 Years age category. Paddy, Pulses, Maize, Vegetables and Oilseed are the major crops cultivated by HHs. Kharif is the main season. Vegetables and pulses are the main crops of Rabi season. While all these crops are consumption oriented, Vegetables and Oilseeds are more commercially oriented crops and higher % of HHs are involved in Sale of these crops.



Agriculture, NTFP, Wage Labour and Animal Husbandry were reported as the 4 major sources of livelihoods for the HHs. Salary, Agriculture Labor, Business/Trading, Pension/Remittances were cited as other minor livelihood sources to earn HH income. Interestingly 26 NTFPs were reported as the income source where the greatest number of HHs are engaged. Also, most of the HHs reported more than one income sources with an overall average of 4 income sources per HH for the population across Jharkhand. Nearly 81% HHs reported engagement with more than 1 NTFP. Nearly 57% HHs reported involvement with more than 2 NTFPs. This indicates very high and intense engagement of HHs with an average of 3 NTFPs per HH. High Correlation Coefficient of

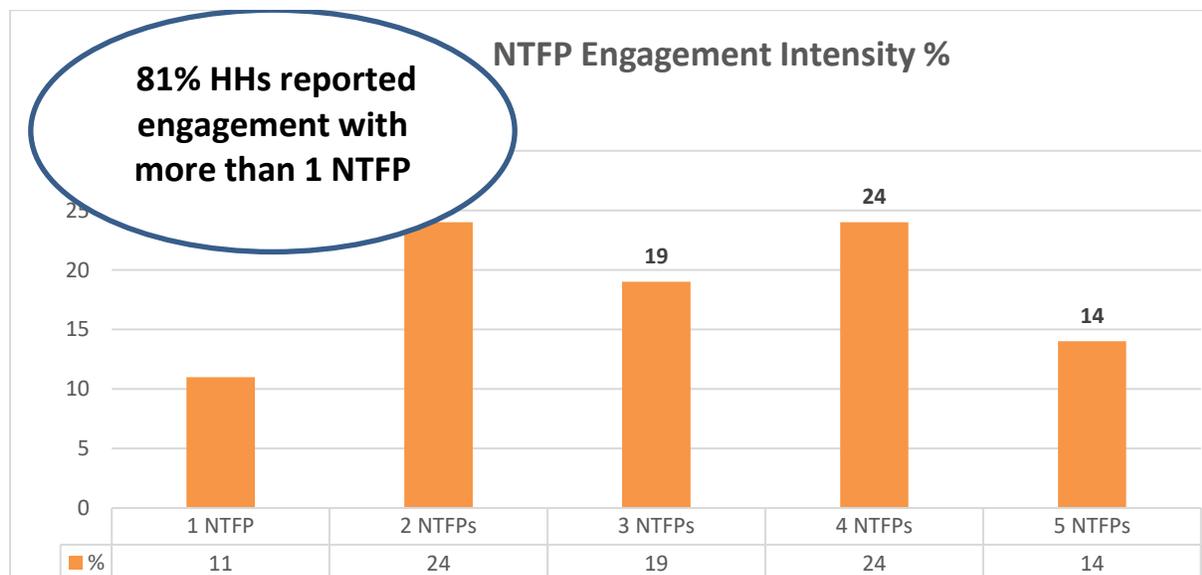
0.93 between Sample Size and NTFP engagement responses indicates that presence of NTFP as a livelihood option is good/ common across these districts.

NTFP Collection is highly oriented towards income generation as 90% of the HHs reported marketable surplus and selling the NTFPs for income, Custard Apple, Jackfruit, Tamarind and Mahua- reported good HH consumption however majority households reported that NTFP engagement is meant largely for additional income generation.

Collection of NTFPs was reported from both close to homes (Jackfruit, Custard Apple, Lac & Tamarind) and from faraway places (Honey, Shatawar, Sal Leaf). Collection is done by entire family mostly for all NTFP Value chains. A significant % of HHs reported basic processing of NTFPs they collect and sell. Processing was found to be low in Jackfruit and Custard Apple where secondary processing is complex and investment heavy. Majority of the HHs reported Mahua, Lac, and Tamarind as one of the top 3 NTFPs in terms of economic importance and they are the most preferred NTFPs for engagement.

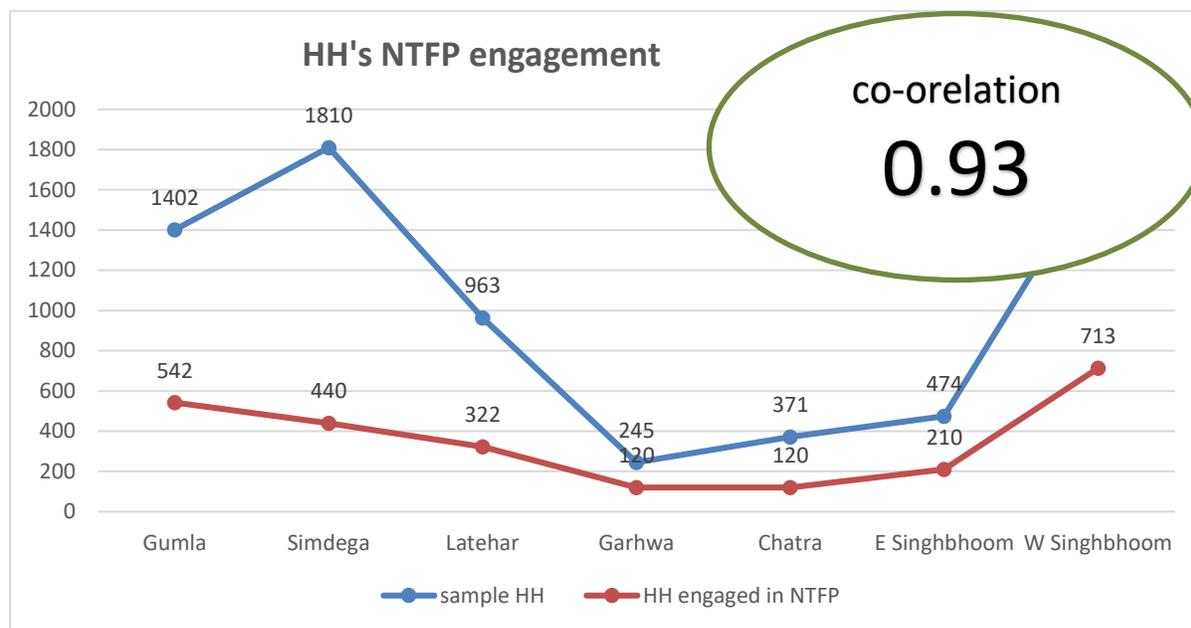
Majority of the HHs use the local weekly market to sell the NTFPs. Outside village traders typically offer better price than Local/Weekly Market and Village Traders. While except in few cases the prices offered at Weekly Market are better than those offered by the Village Traders.

Lac is reported as the NTFP with highest average annual HH income contribution of more than Rs. 10K. Tasar, Sal Lead and Mahua are the other 3 NTFPs with average HH income contribution in the range of 6-7K. Tamarind is the next one with average annual HH income contribution of Rs. 3-4K while Chirounji's contribution was reported as Rs. 2-3K. Most others including Jackfruit, Karanj, Kusum Shatawar and Custard Apple have their annual income contribution in the range of Rs. 1-2K. Palash's annual contribution to HH income is minuscule at less than Rs. 1K. However, honey, Aswagandha and Kalmegh have high promises of good return.



As most of the HHs are engaged in 2-4 NTFPs the total income contribution of NTFPs into the overall Annual HH Income ranges from 19 to 31% across different Districts with an overall

average of 25%. Hence it is quite significant, as no structured Value chain intervention was initiated for all these NTFP commodities (except Tamarind and Lac)



Districts with higher average NTFP engagement also reported higher average annual HH income from NTFP. Correlation coefficient of 0.82 indicates a strong correlation between these two data sets. It indicates NTFP engagement of households has backing by market players in those area/districts.

Conclusion

As most of the HHs are engaged in 2-4 NTFPs the total income contribution of NTFPs into the overall Annual HH Income ranges from 19 to 31% across seven Districts. Hence it is quite significant, as no structured Value chain intervention was initiated for all these NTFP commodities till the time of conducting the study 2018 (except Tamarind and Lac). Hence a huge scope exists to conserve forest by appropriate utilization of different NTFPs.

Actual forest dwellers generally earn their livelihood within the periphery of the eco-system they live. They are not the exploiter of the forest and its eco-system. Rather they maintain the forest eco-system for generation. Over exploitation of natural resources by greedy timber contractors brings the eco-system in danger. These forest dwellers need further support to save their nature and livelihoods as a forest dependant and conserving community. They can save the ecosystem even at the cost of the quality of their life. Mostly there are two types of communities reside in villages, who need support for livelihood promotion. On one hand, there is a forest community deprived of all government schemes and benefits for remoteness and on the other hand another community which are always front runners in getting benefits of government schemes. Second

category can get support on their own. Difference between these two communities is clearly observed for their remoteness and dependency on forest resources for food consumption and livelihood. Hence the study was for forest dependant community for creating various livelihood project & community enhancement activities after conducting the value chain analysis of different NTFPs.

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Women Friendly Climate Smart Technologies for Resilient Farming System

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A farming system refers to the complex interplay of various elements, practices, and components involved in agricultural production. These systems encompass the methods, resources, and techniques used to cultivate crops and raise livestock, as well as the economic, social, and environmental aspects of farming. Different farming systems can vary significantly based on factors such as geographic location, climate, culture, and available resources. Farming systems can vary widely around the world, from traditional subsistence farming to highly mechanized, commercial agriculture. The choice of a particular farming system depends on the unique circumstances, goals, and resources available to each farmer or farming community. Here are some of the key components and aspects of a farming system:

- **Climate and Weather:** Climate plays a significant role in shaping farming systems. Farming practices and crop selection are often adjusted to suit local climatic conditions.
- **Inputs:** The inputs used in farming, including fertilizers, pesticides, and seeds, are important components. Sustainable farming systems may focus on reducing chemical inputs and promoting organic or regenerative practices.
- **Crops and Livestock:** The primary components of a farming system are the crops and livestock that are cultivated or raised. This includes the selection of specific plant and animal species, varieties, and breeds.
- **Land Use:** The way land is used and managed is a fundamental aspect. This includes decisions related to land preparation, soil management, crop rotation, and irrigation practices.
- **Technology and Tools:** Farming systems employ various technologies and tools, such as tractors, plows, seeders, and irrigation systems. Modern farming often involves the use of advanced machinery and equipment.
- **Labor:** The availability of labor, whether it's family labor, hired workers, or machinery, is a critical factor in farming systems. Labor-intensive vs. mechanized systems vary depending on the region and resources available.
- **Market:** The economic aspect of a farming system includes considerations of market access, pricing, cost management, and the overall profitability of the farm. This also relates to the scale of production and the integration of farming into the larger economy.
- **Environmental Sustainability:** Sustainable farming systems take into account environmental factors, including soil conservation, water management, and the use of renewable resources to minimize negative environmental impacts.
- **Diversification:** Some farming systems diversify by incorporating multiple crops or integrating crop and livestock production. This can improve resilience and reduce risk.

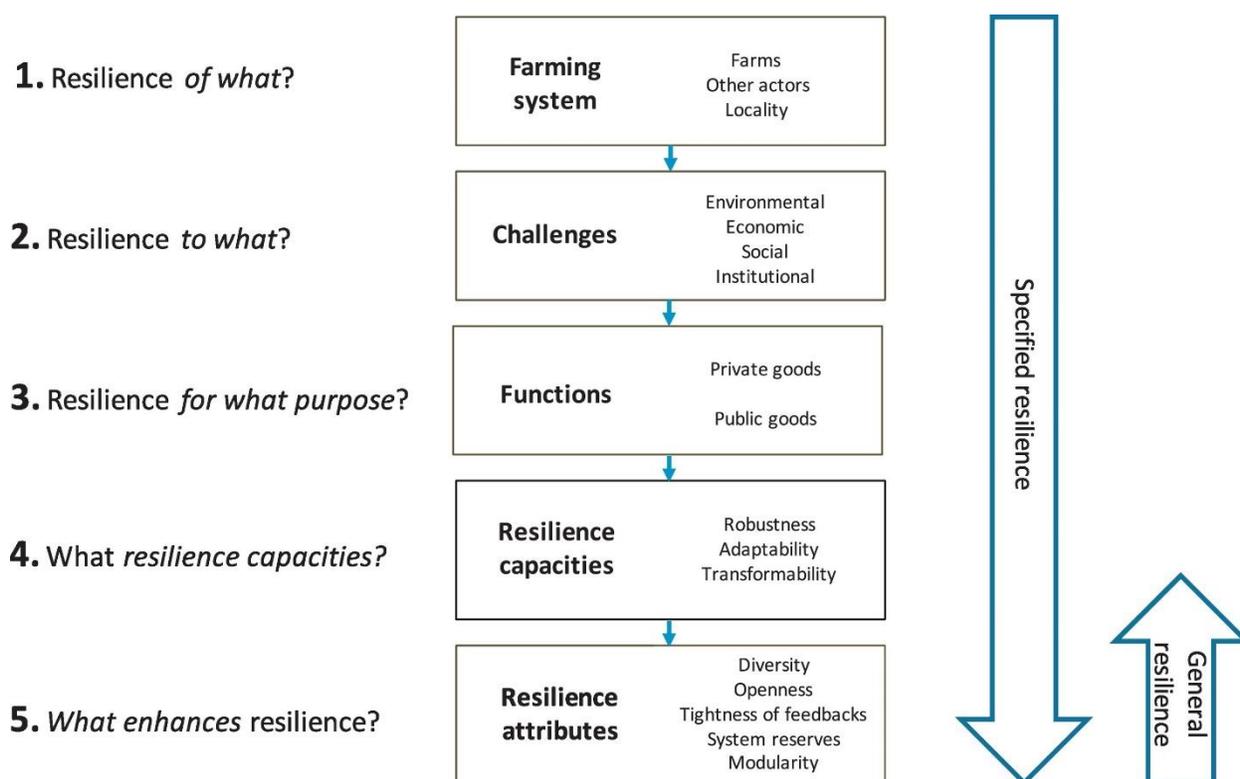
- **Social and Cultural Factors:** Cultural practices; traditions, and social structures can influence farming systems. For example, communal farming in some regions is shaped by social customs.
- **Extension Services:** Access to research, knowledge, and extension services can enhance farming systems. New techniques and technologies developed through research can be integrated into farming practices.
- **Risks and Resilience:** Farming systems must address and mitigate risks, such as pests, diseases, extreme weather events, and market fluctuations. Resilience strategies can help farmers cope with unexpected challenges.
- **Government Policies and Regulations:** Government policies, subsidies, and regulations can have a substantial impact on farming systems. They may influence what crops are grown, how land is used, and how farming is managed.

A resilient farming system is one that is capable of withstanding and adapting to various challenges and changes while maintaining its ability to produce food and other agricultural products. Resilience in agriculture is crucial because farmers often face a range of uncertainties and risks, including climate change, pests, diseases, market fluctuations, and resource constraints. Here are some key elements of a resilient farming system:

- **Biodiversity:** Diverse crops and livestock species can help mitigate the risk of crop failure or livestock diseases. Crop rotation, intercropping, and the use of multiple crop varieties can enhance resilience.
- **Sustainable Farming Practices:** Sustainable agriculture practices, such as organic farming, reduced tillage, and the use of cover crops, help maintain soil health and reduce environmental impacts. Healthy soils are more resilient to extreme weather events and can support higher yields.
- **Climate Adaptation:** Implementing strategies to adapt to climate change are critical for resilience. This may include adjusting planting dates, selecting heat- and drought-resistant crop varieties, and investing in irrigation systems or water management practices.
- **Diversified Income:** Relying on a single crop or product can make a farming system vulnerable to market fluctuations. Diversifying income sources through activities like agroforestry, beekeeping, or value-added products can increase economic resilience.
- **Risk Management:** Farmers can use various risk management tools, including insurance, savings, and access to credit, to cope with unexpected challenges.
- **Access to Information and Technology:** Access to information about weather forecasts, market trends, and the latest agricultural technologies can help farmers make informed decisions and adapt to changing circumstances.
- **Social Networks:** Strong social networks and cooperation among farmers can provide support and resources during difficult times. Cooperative farming and knowledge sharing are examples of community-based resilience strategies.
- **Efficient Resource Use:** Using resources efficiently, such as water, energy, and nutrients, is essential for sustainable and resilient agriculture. Conservation practices can help reduce waste and optimize resource use.

- **Infrastructure and Post-Harvest Facilities:** Adequate infrastructure, including roads, storage facilities, and transportation options, can reduce post-harvest losses and improve market access.
- **Government Policies and Support:** Supportive policies and programs from governments and international organizations can play a significant role in building agricultural resilience. These may include subsidies for sustainable practices, disaster relief, and research and extension services.
- **Research and Innovation:** Ongoing research and innovation in agriculture can lead to the development of new technologies and practices that enhance resilience, such as drought-resistant crops and disease-resistant livestock.

A resilient farming system is one that can adapt and thrive in the face of changing conditions and challenges, ensuring food security and sustainable livelihoods for farmers and communities. It often involves a combination of strategies, both at the farm level and through broader policies and collaborations, to build resilience in the agricultural sector.



Framework of resilient farming system

Climate resilient agriculture (CRA) enables agricultural communities adapt to climate change while simultaneously sustaining crop yield and also contributes to mitigation of adverse effects by adopting suitable practices, developing policies and institutions and creating needed finances. The CRA is a unique strategy to manage landscapes, including crops, livestock, forests, and fisheries, that addresses the associated concerns of food security and climate change. CRA strives to address many positive objectives at the same time, such as higher production, increased resilience, food and nutritional security, livelihood security, and lower emissions. Several mitigation technologies

and strategies like mid-season drainage; intermittent irrigation; improving soil organic matter; promoting aerobic decomposition organic matter; straw incorporation to soil during off-season; adaptation of suitable rice cultivars with high productive tillers, more root-oxidation activity and higher harvest index; and application of farmyard manure (FYM) and biogas slurry instead of unfermented organic matter. The details are as follows:

1. Adapted cultivars

Cultivation of higher nutrient efficient crops and cropping systems would be an important component of the adaptation under climate change scenario. In addition, cultivation of short duration and drought tolerant rice varieties such as Vandana, Tulsi, Rajshree and Rajendra Mahsuri, Rajendra Sweta and Swarna in flood-prone Rice based Production System.

2. Integrated nutrient management

Inorganic fertilizer is a key driver to enhance the rice productivity. However, in past few decades, rice productivity has stagnated or decreased despite of application of higher rate of chemical fertilizers. Recognizing the issues integrating organic and inorganic fertilizers management strategies has been promoted to capture the potential of rice to increase the production and productivity. The soil health card (SHC) contains crop-specific recommendations for nutrients/ fertilizers needed for farms, allowing farmers to increase production by applying suitable inputs.

3. Site-specific nutrient management (SSNM)

It is a method of giving nutrients to crops only when they are needed. Fertilizer management is the key driver of GHGs emissions from rice-based cropping systems. Primarily, the doses of N fertilizer influence both the CH₄ and N₂O emissions. The SSNM reduces fertiliser waste by limiting high fertiliser rates and eliminating fertiliser application when the crop does not require nutrient inputs. Studies revealed that the higher doses of N application can decrease the total CH₄ emissions by 30-50% in rice. The higher N fertilizer application reduced CH₄ emission, but increased N₂O emission over control (where no N was applied).

4. Water management

Proper water management is the important factor which control the GHG emission from rice-based cropping system. Several water management options such as alternate wetting and drying (AWD), intermittent irrigation, regular drainage periods in mid-season, and controlled irrigation through the crop growth stages minimize the GHG emissions than the traditional flooded rice condition. The intermittent irrigation reduces the GHGs emission from 15-54% as compared to traditional flooded rice. Further, mid-season drainage could sharply reduce the GHGs emission up to 27-72%.

5. Direct Seeding of Rice

Direct seeding of rice (DSR) is a good option to mitigate CH₄ emission from rice system. Methane is emitted from rice soil when it is continuously flooded/ submerged during growth period in traditional (puddled) transplanted rice. However, the DSR can be grown as aerobic crop, which does not require continuous submergence, thereby, CH₄ production could be reduces drastically. As the DSR reduces the CH₄ emission significantly (16-54%) it considerable reduces the GWP, even up to 75% compared to the conventional transplanted rice system.

6. Use of rice straw amendments

Higher rice grain production leads to huge production of straw/residues, which are mostly left/wasted on the field. As the application organic manure is gradually decreasing, there is a need to recycle the straw to compensate the carbon losses from the fields. Moreover, open field rice straw burning by the farmers generates causes air pollution, GHGs emissions, and adversely affects the biodiversity. The alternative application of straw as straw-compost and field-incorporation enhances the CH₄ emission by providing the labile carbon as a substrate for methanogenic activity; however, those practices enhance the soil carbon-build up and sustain crop yield with moderate GHGs intensities.

7. Use of industrial waste

Industrial waste like phosphogypsum (by-product of phosphoric acid industry) and basic slag (by-product of steel industry) are the specific soil amendments, which could reduce the GHGs emissions from rice-based systems. The phosphogypsum (PG) suppresses the methanogenesis and reduce CH₄ production in rice ecology. There have been concerns about the PG use in agriculture because of the chances of heavy metals contamination in soil and subsequent uptake crops.

8. Adaptation rice cultivars

Rice cultivars having shallow root systems, more productive tillers, higher root oxidation activity, better harvesting index, emit less CH₄ as compared to other rice cultivars. The adaptation of rice cultivars with less GHGs emission potential should be site specific. It is an easily adaptable option with existing varieties. The short-duration vegetation also improves the soil quality by increasing the soil carbon contents.

9. Application of formulation

The CH₄ emission from rice-based systems directly influenced by the methanogens and methanotroph communities. The methanogens are CH₄ producing soil archaeobacteria, which contributes approximately 14% of the total GHGs emissions in the soil environment. Previously efforts on organic and inorganic nutrients management, use of soil amendments (like biochar, phosphogypsum and basic slag) have made to mitigate the CH₄ emissions from rice production systems.

10. Cropping system

Adoption of appropriate crop rotation e.g. sweet sorghum-rice drastically reduced CH₄ emissions and non-CO₂ GHG emissions as compared to rice-rice and corn-rice cropping sequence. Carbon credit to the subsistence practioners of agroforestry mainly in poor agro-ecologies of the world could serve very beneficial not only for their livelihood but also to promote and adopt the C sink strategy for a better future.

Summary

The CRA strengthens food and nutritional security and delivers environmental benefits. Moreover, CRA technologies such as use of precision agriculture (laser levelling, site-specific nutrient application, precise water application/ management), high yielding crop varieties, crop residue

addition (i.e. retention/ incorporation/in-situ recycling), increased plant populations, multifunctional landscape management and sustainable soil management practices (conservation tillage/regenerative agriculture/conservation agriculture) need to be adopted for higher crop productivity and better farm income. The combined use of organic residues with varying biochemical composition could be an efficient carbon management strategy to increase carbon sequestration soil. The integrated application of balanced application of NPK along with straw emerged as the optimum management option to mitigate net GWP and increase the grain yield and NUE in the existing rice-wheat cropping system, with highest C sequestration and lowest GHG. DSR is another emerging technology which not only proven to enhance carbon efficiency ratio and carbon sustainability score but also capable of emitting lesser amount of GHGs. Direct seeded rice + zero tilled wheat along with residue retention proved to be a potential technology having lowest GHG emissions, emitting half as much as the traditional approach. However, technologies developed but not adopted by farmers need to be refined and re-assessed in fields for better adoptability and income generation. Proper institutional mechanisms need to be built up and a community/group approach may be followed in transfer of technology. Besides, use of information technology (IT) and information communication technology (ICT) be strengthened and promoted for faster dissemination of farmer-friendly technologies.

Entrepreneurial Innovations in Animal Husbandry in Changing Climatic Scenario

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An entrepreneur is the economic agent who unites all means of production such as land, labour and the capital, thus produces a product with profit. Innovation, risk bearing ability and organised aptitude are components of an entrepreneur. He/she identifies the opportunity in the market. He/she brings unique ideas. Entrepreneurship can also be done in group mode. Those farmers have similar goals and objectives and a willingness to share the benefits and risks. Ownership and control of the enterprise are divided among the group members. The demand of animal products is increasing. Therefore, there are a lot of scopes of entrepreneurship in animal husbandry. But the major challenges in animal husbandry are climate change and shrinking animal resources. Therefore, the entrepreneur needs to address these challenges judiciously. Climate change is a big challenge in front of agricultural sector worldwide. The environmental changes such as high ambient temperature, unanticipated rainfall, high relative humidity, wind speed and solar radiation are directly and indirectly affecting the livestock productivity. At the same time livestock sector is also affecting global climate change through green house emission. The negative effect of climate on animal is expressed as reduced growth, poor reproductive performance, poor quality and quantity of milk and meat production and animal immunity and health. The livestock production system needs to be made climate resilient through producing climate resilient fodder, improving feeding strategies to address heat stress, constructing proper housing for livestock animals, using various breeding techniques to make livestock more climate friendly, ensuring safe water for livestock, ensuring necessary veterinary care to protect the animals from drought induced parasites and diseases, ensuring access to market, capacity building of farmers and local institutions etc. Therefore, adaptation and mitigation of the detrimental effects of extreme climate events plays important role to counter the impact of climate on livestock production.

- **Climate resilient feeding**

Heat stress has direct as well as indirect impact on animal productivity. Exposure of animals to high temperature, humidity and hot wind directly expose the animal to extreme heat stress. Indirectly the availability of quality and quantity of feed, fodder and water gets affected which diminish the performance of livestock. Modifications in some feeding methods including alteration of diet composition, shifting feeding time or frequency and adding some health beneficial agro forestry species in the animal diet along with conservation of surplus feed and fodder of flush season for lean seasons of various agro-ecological zones or establishing community fodder bank can be a befitting measure to combat the effects of climatic stressors. These measures can decrease the risk from variations of climate by encouraging higher intake or compensating low-feed consumption, decreasing excessive heat load, reducing animal malnutrition and mortality and reducing the feed insecurity during dry seasons respectively.

1. Feed supplementation to combat nutrients deficiency in dairy animals
Protein and minerals are essential for proper metabolic function of lactating, pregnant and heat stressed animals. Proper metabolic functions ensure better bioavailability of absorbed nutrients to improve growth of calves, increase milk production, improve reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity status and help animals overcome heat stress. Mineral mixture and uromin licks prevent the deficiency of different minerals in dairy animals. The results of these feeding reveal improvement in both the production as well as reproductive health of the dairy cows.
2. Silage making for preservation of green fodder
Silage making is a sustainable climate resilience solution that can ensure the fodder availability during lean periods.
3. Azolla Production:
Cultivation of azolla as an alternative fodder during lean period is an excellent option to combat climate uncertainties. Azolla is rich in protein and particularly during lean periods, it helps provide balanced nutrition to the livestock.
4. Total mixed ration (TMR)
It is efficient method of nutrient delivery in large ruminants. It provides balanced nutrient in right quantity with higher bio-availability. It enables better feed intake, reduces feed wastage, maintains stable rumen environment and improves digestibility. It contains chopped green fodder, cereals, cereal by-products, protein rich feed, minerals, vitamins, salt and feed additives. This is economical and saves labour.
5. Compressed complete feed block (CCFB)
Complete Feed Block, an innovation in feeding management of dairy animals for incurring higher profit. Apart from being an economically viable technique, it has multiple advantages like easy transportation, cheaper storage, correcting multi-nutritional deficiency, easy handling. It reduces feeding cost as locally available feed ingredients can be utilized major component are forage and concentrate. It can be stored for almost a year and therefore is helpful in seasons of fodder scarcity. This convenient, nutritional and economic TMR can be carried to the areas with natural calamity for feeding the distressed animals.
6. Hydroponic fodder farming
Growing population and frequent natural calamities make livestock secondary for access of the natural resources like land and water. Hydroponic fodder production is a technique of growing fodder without soil by using mineral solution in water medium. This technique efficiently increases the water use efficiency during drought and reduces the pressure of fodder deficit for dairy animals during drought situations. It saves labour, space, time and nutritious fodder is available by this system round the year.

- **Climate resilient health management**

Vector breeding and pathogen growth gets intensified as a result of climate change. That is why the frequency along with intensity of disease incident heightens along with occurrence of some new diseases. Rearing of heat tolerant breeds along with routine deworming, timely vaccination and nutri-dense feeding management can reduce the occurrence of diseases.

• **Innovations in Livestock Management**

1. Integrated Livestock Farming (ILF):

It is a unique way of utilization of space, time and resources for higher productivity and more economic return. It helps to overcome the limitations of traditional dairy farming i.e. space, time, labour and by-products of animals. The concept behind ILF is no wastage i.e. efficient utilization of resources for higher productivity. Examples of ILF are crop+dairy. In all these the waste output of one system acts as input for the other. So there is cost reduction and higher return.

2. Use of ICT:

Use of sensor-based neck collars helps in monitoring the daily activities, walking, rumination, quantity of feed and water intake as well as heat stress detection. Through use of information and communication technology (ICT) many countries have started doing precision farming for enhancing farm efficiency and minimizing use of resources at the farm. Apart from all these value addition and market linkage of farmers through mobile apps can increase the visualization of producer and link them with the market.

3. Innovations in stress management

Animal sheds should be lighted, spacious and well ventilated. The heat, moisture, and odours created by livestock, i.e. harmful to both animal and operator health must be removed by adequate air exchange. Use of fans, exhausts, coolers, sprinklers, foggers and air conditioners as per the need of animals for reducing the heat load of animals is now a commonly adapted approach in dairy cattle management. Automatic waterers are some cutting-edge innovations that not only save time and labour but also prevent water wastage.

4. Innovations in waste management

Shaping livestock waste like dung, urine, wool etc. to commercial goods like pots, diya, bio-fuel, CNG, bio-fertilizer, root guards etc. can also make livestock farming lucrative. Cowdung is also a threat to climate. Therefore, proper management of cowdung and cow urine can harvest wealth from waste.

5. Innovations in milk marketing:

Livelihood improvement helps in providing livelihood security round the year i.e. in shock or in any environmental distress also. Dairy cooperatives facilitate women to improve their skills and knowledge through several extension activities, facilitate them for milk marketing and show them the realm of dairy business ecosystem. The proposed model highlights the challenges of women dairy farmers in the dairy value chain. Its women-centric, participatory and dynamic approach made it a popular option for livelihood improvement of women dairy farmers.

Conclusion

Animals are traditionally kept by poor and marginal farmers primarily for income, nutrition and employment along with social security. Population growth, urbanization and increasing per capita incomes are stimulating a rapid growth in demand for animal-based products in India. Hence, there is an immense scope of entrepreneurship in animal husbandry. Livestock rearing has changed its identity from a mere item of self-sustenance to a key for entrepreneurial venture. It has now

become a symbol of health and wealth. Proper management of animals with innovations can reap more profit even under challenge climate change.

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Rural women entrepreneurship through processing and value addition of millets

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Millets, encompassing various grains like sorghum and pearl millet, have been a staple in human diets for millenia, offering exceptional nutritional benefits such as fiber, proteins, vitamins, and minerals. Their gluten-free nature and low glycemic indices make them a valuable dietary option, particularly for those with gluten sensitivities and diabetes. Adaptability to challenging environments, resilience to climate change, and soil health enhancement underscore their importance in sustainable agriculture. Beyond traditional uses, millets' culinary versatility has led to the development of diverse products, creating market opportunities. Recognizing their potential addresses malnutrition and supports sustainable farming, setting the stage for exploring millet processing's role in empowering rural women through entrepreneurship, fostering economic growth, and community development.

Brief overview of the importance of rural entrepreneurship for economic development.

Rural entrepreneurship plays a pivotal role in holistic economic development by addressing various facets of rural life. It serves as a catalyst for job creation, wealth generation, and poverty alleviation, impacting income distribution and social dynamics. Utilizing local resources fosters sustainable development and reduces dependency on external sources, contributing to the resilience of rural economics. Entrepreneurship triggers infrastructure development, innovation, and technology adoption, modernizing rural areas. Market access and global integration open avenues for growth, providing exposure to diverse markets. Social empowerment, especially for women, through skill development and leadership roles, enhances community resilience. The table below summarizes key aspects of rural entrepreneurship's impact.

Key Aspect	Impact on Rural Development
Employment Generation	Absorbs surplus labor, reduces unemployment, and underemployment
Wealth and Income Generation	Stimulates wealth creation and improves living standards
Utilization of Local Resources	Harnesses abundant natural resources and traditional skills
Poverty Alleviation	Uplifts communities by creating opportunities for income generation
Infrastructure Development	Spurs the need for improved transportation, communication, and energy infrastructure
Innovation and Technology Adoption	Drives innovation and modernizes rural economies

Market Access and Global Integration	Facilitates market access, linking rural economies globally
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In essence, recognizing and supporting rural entrepreneurship is crucial for fostering inclusive and sustainable economic growth, leading to positive changes in rural communities' overall quality of life.

Emphasis on the role of women in rural areas and the potential of millet processing for empowerment.

Women in rural areas play a pivotal yet often overlooked role in agriculture and household management. Recognizing and enhancing their participation in economic activities, particularly millet processing, holds the key to empowering women and fostering broader community development. Despite being primary contributors to agriculture, women face challenges in resource access. Millets, rich in nutrition, offer an avenue for women to contribute to household food security.

Millet processing becomes a livelihood option, allowing women to diversify income sources, create marketable goods and become entrepreneurs. Skill development programs empower women with essential capabilities. By participating in the entire millet value chain, women gain market access and enhance economic viability. Entrepreneurial activities challenge gender roles, promoting social and cultural empowerment. The economic empowerment of women through millet processing contributes to community development, as they reinvest earnings in family education and well-being. Emphasizing women's role in millet processing is a holistic approach, recognizing their multifaceted contributions and creating an enabling environment for entrepreneurial success.

Significance of Millets

Millets, ancient grains with a rich history in human diets, offer a plethora of nutritional benefits. They are a robust source of macronutrients, providing proteins for tissue growth, complex carbohydrates for sustained energy release, and dietary fiber promoting digestive health. Additionally, millets are a micronutrient powerhouse, containing vitamins and minerals crucial for energy metabolism, bone health, and immune function. Being gluten-free, millets serve as a safe alternative for those with gluten sensitivities, and their low glycemic index makes them particularly suitable for individuals with diabetes. With antioxidant properties, heart health benefits, and a satiating effect aiding in weight management, millets emerge as a holistic dietary choice. Their diverse amino acid profile, especially in varieties like finger millet, further enhances their nutritional value. Integrating millets into a balanced diet not only meets but also contribute to global public health by offering a versatile and nutrient-packed grain option.

Challenges Faced by Rural Women

Rural women encounter formidable challenges that hinder their participation in entrepreneurship, perpetuating gender inequalities. Gender-based violence and societal stigma, particularly for those challenging traditional roles, act as deterrents. Environmental challenges, intensified by climate change, further constrain opportunities for women engaged in agriculture and entrepreneurship. Additionally, limited access to education, technological disparities, and a

dearth of entrepreneurial role models create barriers to entry. Fear of violence, safety concerns, and climate-induced risks impede women's mobility and business engagement. Overcoming these challenges demands a comprehensive approach, including policy changes, community awareness, and targeted support mechanisms. Empowering women in entrepreneurship requires dismantling structural barriers, fostering inclusivity, and implementing gender-sensitive policies to cultivate an environment where rural women can thrive as entrepreneurs.

Millet Processing and Value Addition

Millet processing involves a range of techniques that transform raw millet grains into diverse, value-added products. These methods enhance the nutritional content, shelf life, and culinary versatility of millets, contributing to their widespread consumption. Here's an elaboration on various processing techniques and value addition methods for millets:

1. Cleaning and Sorting:

Before processing, millet grains undergo cleaning to remove impurities like stones, dust, and other foreign particles. Sorting is done to eliminate damaged or discolored grains, ensuring the quality of the final product.

2. Milling:

Dehulling: The outer layer (hull) of millet grains is removed through milling, exposing the edible kernel. This process is crucial for making the grains suitable for human consumption.

Polishing: After dehulling, millet grains may undergo polishing to improve appearance and reduce roughness.

3. Grinding:

Flour Production: Millet grains can be ground into flour using various methods, including traditional stone mills or modern electric mills. Millet flour is a versatile ingredient used in baking, making flatbreads, and preparing porridges.

Meal Preparation: Coarser grinding produces millet meal, suitable for preparing traditional dishes like porridge and couscous.

4. Pearling:

Pearling involves the removal of the bran layers from millet grains, resulting in pearled millet. This process improves cooking time and texture, making pearled millet suitable for quick-cooking products.

5. Flaking:

Millet grains can be flattened through a flaking process, creating thin flakes. Flaked millet is used in cereals, granola bars, and other snack products. Flaking can be achieved through rolling or extrusion.

6. Popping:

Popping millet involves subjecting the grains to high heat, causing them to expand and puff up. Puffed millet is commonly used in breakfast cereals, snack bars, and confectionery.

7. Fermentation:

Fermentation of millet can produce various products, including fermented porridges, sourdough bread, and alcoholic beverages. Fermentation enhances nutritional content, improves digestibility, and imparts unique flavors.

8. Extrusion:

Extrusion involves processing millet flour under high pressure and temperature to create extruded products such as puffed snacks, chips, and breakfast cereals. This method enhances texture and flavor.

9. Baking:

Millet flour can be incorporated into baked goods like bread, muffins, cookies, and pancakes. Baking not only enhances the nutritional profile of these products but also introduces millets to a wider consumer base.

10. Germination:

Soaking and allowing millet grains to sprout initiates germination. Sprouted millet has increased nutrient content, improved digestibility, and a unique flavor. It can be used in salads, sandwiches, or as a base for grain bowls.

11. Value-Added Products:

Millet-based Snacks: Various snacks such as millet chips, popped snacks, and energy bars can be produced to cater to consumers seeking convenient and healthy snack options.

Millet-based Beverages: Millet grains can be used in the production of beverages, including millet-based milk alternatives, smoothies, and ready-to-drink products.

12. Instant Mixes:

Ready-to-cook products, such as millet-based dosa (pancakes), idli (steamed cakes), and upma, cater to consumers looking for quick and nutritious meal options.

13. Infusions and Extracts:

Ground millet or millet flour can be used to make millet tea, providing a caffeine-free alternative with potential health benefits.

These processing techniques and value addition methods not only enhance the appeal and accessibility of millet products but also contribute to the diversification of diets and the promotion of millets as a sustainable and nutritious food source. Entrepreneurs and food processors play a crucial role in leveraging these techniques to create innovative millet-based products that meet consumer preferences and contribute to the growth of the millet industry.

Economic opportunities associated with millet processing and value addition.

Millet processing and value addition present a myriad of economic opportunities that can contribute to the development of rural economies, empower local communities, and foster sustainable agricultural practices. Here's an elaborate discussion on the economic opportunities associated with millet processing and value addition:

1. Diversification of Income Sources

Engaging in millet processing allows farmers and entrepreneurs to diversify their income sources beyond traditional crops. By adding value to millets through processing, individuals can create a range of marketable products, contributing to a more stable and resilient income.

2. Job Creation:

Establishing millet processing units, such as mills and small-scale enterprises, generates employment opportunities in rural areas. Jobs are created across the entire value chain, from cultivation to processing, packaging, marketing, and distribution.

3. Entrepreneurship Development:

Millet processing empowers individuals, especially women, to become entrepreneurs in their communities. Small and medium-sized enterprises (SMEs) focusing on millet-based products can contribute to local economic development and provide a platform for entrepreneurial growth.

4. Market Access and Expansion:

Value addition through millet processing enhances market access for farmers and processors. Diverse millet-based products cater to a broader consumer base, potentially reaching urban markets and creating opportunities for export.

5. Income Enhancement for Women:

Women, often central to millet cultivation and processing, stand to benefit economically through enhanced income. Economic empowerment of women has a positive impact on household well-being, as women typically reinvest their earnings in education, health, and the overall development of their families.

6. Skill Development and Training:

Millet processing involves various skills, from crop management and harvesting to processing techniques and product development. Training programs and capacity-building initiatives create opportunities for skill development, enhancing the expertise of individuals involved in the millet value chain.

7. Investment Opportunities:

The growth of the millet processing industry attracts investment opportunities, both from public and private sectors. Investments in processing infrastructure, research and development, and marketing can catalyze the expansion of the millet industry.

8. Export Potential:

High-quality millet-based products have the potential for export, contributing to foreign exchange earnings. Meeting international demand for healthy and sustainable food options positions millet-processing enterprises as global players.

9. Promotion of Sustainable Agriculture:

Millets are inherently resilient and environmentally sustainable crops, requiring less water and fewer chemical inputs compared to major cereals like wheat and rice. The promotion of millet cultivation for processing aligns with sustainable agricultural practices, contributing to environmental conservation.

10. Value Chain Integration:

Integrating the millet value chain, from cultivation to processing and marketing, creates synergies and strengthens collaboration among stakeholders. This integration enhances efficiency, reduces post-harvest losses, and ensures a steady supply of quality raw materials for processing units.

11. Promotion of Agro-Tourism:

Millet-processing units, especially those adopting sustainable and traditional processing methods, can become attractions for agro-tourism. Visitors may be interested in experiencing the entire millet value chain, from cultivation in the fields to processing and tasting the final products.

12. Government Initiatives and Policies:

Supportive government policies and initiatives, such as subsidies, incentives, and market access programs, can further enhance economic opportunities in millet processing. Governments can play a vital role in creating an enabling environment for the growth of the millet industry.

In summary, the economic opportunities associated with millet processing and value addition are multifaceted. They encompass income generation, job creation, entrepreneurship development, and the promotion of sustainable agriculture. Leveraging these opportunities requires a collaborative effort involving farmers, entrepreneurs, government bodies, and the private sector to unlock the full economic potential of millet cultivation and processing.

Case Study: Millet Sisters, India:

In India, a group of women farmers formed an organization called "Millet Sisters" to promote millet cultivation and processing. The initiative is based in Karnataka, a state with a strong tradition of millet consumption. The Millet Sisters not only cultivate millets but also process them into various value-added products such as millet flour, snacks, and traditional dishes. Through their enterprise, these women have not only enhanced their income but also played a crucial role in reviving interest in millets within their community.

Empowering Rural Women through Entrepreneurship

Millet entrepreneurship emerges as a transformative force for rural women, offering a range of positive impacts across economic, social, and nutritional dimensions. Economically, it provides women with income-generating opportunities, fostering financial independence and reducing dependence on single livelihoods. Skill development and capacity-building associated with millet entrepreneurship enhance women's capabilities and personal development. The incorporation of nutrient-dense millets into local diets improves dietary diversity, addressing malnutrition, and promoting better health. Socially, successful millet entrepreneurs gain community recognition, challenging gender norms and becoming role models for younger generations. Community-wide benefits include local economic growth, infrastructure development, and increased participation in governance. Millet entrepreneurship enhances women's autonomy in decision-making, builds resilience to climate change through sustainable farming, preserves cultural heritage, and creates educational opportunities. By recognizing women's unique contributions in millet value chains, this inclusive and resilient agricultural approach fosters improved economic conditions, elevated social status, and sustainable community development. A success story from India exemplifies the positive outcomes, where women entrepreneurs producing millet-based snacks not only enhance their livelihoods but also contribute to local economic development and promote millets as modern and nutritious food choices.

Recommendations and strategies for further promoting and supporting rural women in millet entrepreneurship.

Empowering rural women in millet entrepreneurship requires a comprehensive approach addressing challenges and fostering sustainable growth. Initiatives should focus on education and training, ensuring women have access to resources, and developing processing infrastructure while promoting technology adoption. Market access and marketing support, facilitated by establishing linkages and enhancing branding, are crucial. Encouraging networking through women's cooperatives and industry partnerships enhances collaboration and collective strength. Policy advocacy for gender-inclusive policies, incentives for millet processing, and research and

development investments are vital. Health and nutrition education, digital literacy, climate-resilient agriculture training, and access to healthcare are essential components. Recognizing achievements through awards contributes to positive role modeling. Implementation of these strategies by governments, NGOs, and the private sector can holistically uplift rural women, fostering economic development, food security, and sustainable agriculture. The potential of millet-based entrepreneurship lies in its capacity to empower women, contributing significantly to both economic and social development in rural communities.

Conclusion

In summary, millet-based entrepreneurship emerges as a transformative force for the upliftment of rural women, offering avenues for economic prosperity and social development. Through cultivation, processing, and value addition of millets, women can diversify income sources, becoming primary breadwinners and contributors to household economic development. Beyond financial gains, engagement in millet entrepreneurship facilitates skill development, nutritional improvement, and challenges gender norms, fostering social recognition and gender equality. The ripple effects extend to community development, cultural preservation, and environmental sustainability, positioning millet-based entrepreneurship as a dynamic field ripe for innovation. This transformative journey towards economic self-sufficiency and resilience not only empowers current generations but also lays the groundwork for a more equitable and prosperous future for women in rural areas. Recognizing and nurturing the potential within millet-based entrepreneurship is crucial for fostering a legacy of empowerment and sustainable development in rural communities.

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Economic empowerment of farm women through improved post harvest technologies and value addition of horticultural crops

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Women have always played the key role of conserving the basic life support system such as land, water, flora and fauna. They have protected the health of the soil through organic recycling and prompted crop security through the maintenance of diversity and inherent struggle (Das, 2015). Women's contribution to agriculture, whether it is in subsistence farming or commercial agriculture, when measured in number of tasks performed and time spent is greater than that of men. A micro study conducted in Indian Himalayas found that, on a hectare farm, a pair of bullocks work for 1064 hours, a man for 1212 hours and a woman for 3485 hours (Shiva FAO, 1991). In the plantation sector women are the crucial labourers (Shivaram, 1988). Depending on the region and crops, women's contributions vary but they provide crucial labour from planting to harvesting and post-harvest operations. Despite working hard, spending longer hours and crucial contribution to agricultural production, their role has not been acknowledged. They are paid less or even left as unpaid workers. 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*). Therefore, in order to achieve over all sustainable development of agriculture, it is necessary to recognize the important role of women in agriculture and to address the problem faced by them. The role of women should be properly recognized and documented. Due to gender discrimination, women farm workers do not get sufficient attention, which results in low socio-economic status of women. Despite significant roles played by women workers, they are neglected. So there is a need to look into the problem of women worker in farming sector from the grass root level.

Women's empowerment is the process of empowering women. Empowerment raises the status of women through education, awareness, literacy, and training. Women's empowerment equips and allows women to take life-determining decisions. They may get the opportunity to redefine gender roles, which in turn provide them more freedom to pursue desired goals. Women empowerment is a significant topic of discussion in development and economics. Economic empowerment allows women in controlling and getting benefit from resources, assets and incomes. It also grows ability to manage risks and improves well-being. It refers to women's ability to make strategic life choices

which had been previously denied them. The world, nation, business, communities and groups may benefit from women empowerment. It enhances the quality and the quantity of human resources available for development.

1.0 What is women empowerment?

Empowerment is a “social action process that promotes participation of people, organizations, and communities in gaining control over their lives in their community and larger societies” (Stein, 1997).

Empowerment means

- having control, or gaining further control;
- having a say and being listened to;
- being able to define and create from a women’s perspective;
- being able to influence social choices and decisions affecting the whole society (not just areas of society accepted as women’s place)
- being recognized and respected as equal citizens and human beings with a contribution to make (Griffen, 1987)

India is celebrating and commemorating the progressive 75 years of India after independence with ‘Azaadi Ka Amrit Mahotsav’ and promulgating mission of warranting women as “Empowered women Empowered Nation”. India is an agrarian economy with about 54.6 percent of total workforce engaged in agricultural and allied sector activities (Census 2011). Women are extensively engaged in the activities pertaining to agriculture and allied sector. The workforce participation rate for rural females is significantly higher at 41.8 percent against urban women participation rate of 35.31 percent (MoSPI, 2017).

Indian Food Processing Industry- Growth opportunities post the COVID-19 pandemic estimates that, going forward, this sector will reach USD535 billion by 2025 at a CAGR of 15 per cent, which indicates significant potential for increasing farmers’ income through processing. The sector also aims to add 9 million jobs by 2024. Thus, the sector can potentially be the solution India needs to double farmer’s income, especially to farm women at large. 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. 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.

In rural communities, agriculture and allied sector is the primary source of livelihood that includes 80 percent of all economically active women, out of which 33 percent constitute agricultural labour force and 48 percent are selfemployed farmers. Rural women are engaged at all levels of

agricultural value chain; i.e., production- pre-harvest, post-harvest processing, packaging, marketing to increase productivity in agriculture. As per Pingali et al. (2019), the ratio of women to men working in agricultural sector has increased over the time and made greater amount of contribution to GDP per capita. They are the momentous demographic group for sustainable food system (FAO, 2011). It is projected that women-oriented reforms, ensuring equal access to resources, skill development and opportunities in agriculture would increase agricultural output in developing countries between 2.5 and 4 percent (FAO,2011). In recent announcement under AatmaNirbhar Bharat, earmarking funds were allocated to mainstream the women engaged in agriculture development and equal provision of rural services. Thus, 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.

Indicator of Women Empowerment

Syed Hashemi (1996) developed eight empowerment indicators where to be empowered-

- Mobility
- Economic security
- Ability to make small purchases
- Ability to make larger purchases
- Involvement in major decisions
- Relative freedom from domination by the family
- Political and legal awareness
- Participation in public protests and political campaigning

3.0 Defining value addition

Value addition is defined as an activity that agricultural producers may utilize to produce a new commodity by changing its present place, time, and from one set of characteristics to other characteristics that are more preferred in the marketplace to obtain higher returns. Value addition is key to offsetting the poor positioning of any agricultural product in the market, building up the quality and branding, improving income, and increasing employment. It is aimed to increase the year around availability and shelf-life of the commodity, improve off-farm employment opportunities, enhance the technology transfer and capacity building needs of the workers, increase the trade and economy of the country, and get a pathway out of the poverty.

The value addition is determined by calculating the difference between the raw product's value, cost, and other inputs and comparing it with the returns of the value-added products. It is important to determine the agricultural products that can be value-added which can support the market and enhance the income of the agricultural producers. In addition, there is a need to build up the technology and skills needed (technology transfer and capacity building) for product innovations. On-farm value addition activity offers an alternative for diversification and rural development in the event of increasingly deregulated agricultural markets. In response to the global progress in

agricultural production, many farmers have turned to participate in the value-added activities of agricultural crops to ensure their survival in the intense competition in the global markets. The value can be conceived in terms of cost-benefit consequences occurring in relations between the parties involved (Corsaro and Snehota, 2010). The benefits of value-added products include providing better nutrition to children and mothers; greater income for producers; access to new markets; and new processes to improve packaging and storage to reduce waste and ensure greater food safety. Value addition in agriculture is needed for the profitability of the farmers, to empower the farmers and weaker sections of the society, to provide safe, quality and branded food to the consumers, to reduce post-harvest losses, reduction in import and increasing exports, encourage the growth of subsidiary industries. Value added product can be any product that has been the subject of additional actions or combined with additional products to increase the overall value of the product value added products are an important aspect of the agricultural sector. Value addition in agriculture is needed for the profitability of the farmers, to empower the farmers and weaker sections of the society to provide safe, quality and branded food to the consumers to reduce post-harvest losses, reduction in import and increasing exports, encourage the growth and subsidiary industry.

Need for value addition

- To improve the profitability of farmers.
- To empower the farmers and other weaker sections of society especially women through gainful employment opportunities and revitalize rural communities.
- To provide better quality, safe and branded foods to the consumers.
- To emphasize primary and secondary processing.
- To reduce post harvest losses.
- Reduction of import and meeting export demands.
- Reduce the economic risk of marketing.
- Increase opportunities for smaller farms and companies through the development of markets.
- Diversify the economic base of rural communities.

Economic empowerment through value addition of horticultural crops

Horticulture is an essential branch of agriculture. It involves the production and utilization of horticultural crops, which include fruits, vegetables, spices, flowers, ornamental plants, and medicinal herbs.

- It integrates various disciplines such as plant physiology, plant breeding, plant pathology, entomology, soil science, and post-harvest technology.
- The primary objectives of horticulture are to enhance crop productivity, improve crop quality, and diversify agricultural practices.

Importance of Value Addition in Horticulture:

- Horticulture deals a large group of crops having great medicinal, nutritional, health promoting values.

- India as second largest producer of fruits and vegetables, only 10 per cent of that horticultural produce is processed, but other developed and developing countries where 40-80 per cent produce is value added.
- Horticultural crops provide varied type of components, which can be effectively and gainfully utilized for value addition like pigment, amino acids, oleoresins, antioxidants, flavours, aroma etc.
- Post harvest losses in horticultural produce are 5 to 30 per cent which amounts to more than 8000 crore rupees per annum. If we subject our produce to value addition the losses can be checked.
- Horticultural crops are right material for value addition because they are more profitable, has high degree of process ability and richness in health promoting compounds and higher potential for export.

Value Addition in Fruits

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 1.0% of the total fruits and vegetables produced are processed in the 3000 food industries. Although India is the second largest producer of fruits and vegetables only 2% is being commercially processed and wastage is estimated to be very high. Table 1 shows list of value added products from different fruits.

Table 1 Value added products from fruits

Fruits	Value added Products
Apple	Juice, Jam, Jelly, Cider, Wine, Pulp, Osmotically dried rings, Canned Apple, Vinegar, Carbonated Juice, Apple seeds for nurseries, Pectin
Apricot	Pulp, Squash, RTS, Jam, Appetizer, Dried Apricot, Osmotically dried apricot, Oil, Apricot oil-based cream, etc
Plum	Pulp, Squash/Appetizer, RTS, Chutney, Jam, Wine/Brandy, Plum sauce, seed oil
Peach	Canned Peach, Pulp, Jam/Chutney, Wine, Kernel oil
Pear	Canned pear, Pulp, Jam, Apple per blend, Sand pear candy, Vermouth
Mango	Pulp, RTS, Squash, Powder (Amchur), Slices in brine, Pickle, Toffee, Pulp/Juice from in-situ mangoes, Pectin from just ripe fruits
Banana	Juice, Ripe banana powder, Value addition of banana peel
Grapes	Raisins, Juice, Carbonated juice/RTS, Wine, Munakka
Litchi	Juice, Squash, Canned Litchi, Nectar/RTS, Carbonated drink
Guava	Jelly, Cheese, Toffee, Nectar, Canned Guava, Squash, Vinegar

Pineapple	Juice, Squash, Jam, Candy, Pickles, Chutney, Canned in slices, Osmotically dried rings, Vinegar, Nectar, Sauce
Aonla	Jam, Candy, Syrup, Pickle, Chutney, Dried shreds, Ayurvedic medicines (Triphala, Chyawanprash etc.
Pomegranate	Juice, Squash, Syrup, Anardana
Papaya	Jam, Candy, Nectar, Pickle, Sauce, Canned Papaya, Tutti- Frutti
Bael	Nectar, Squash, Canned Bael, Cider
Ber	Candy, Canned Ber, Jam
Citrus fruits	Juice, Pickle, Marmalade, Squash, Cordial, Barley Water, Candy

Value Addition in Vegetables

Vegetables are rich and cheaper source of carbohydrate, protein, fat, vitamins and minerals. The underground 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 are 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 shows list of value added products from different vegetables.

Table 2 Value added products from vegetables

Vegetables	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, Dried Cabbage
Cauli flower	Dried cauliflower, frozen cauliflower, cauliflower pickle, etc.
Carrot	Jam, Candy, Carrot shred, frozen carrot, carrot powder, soup powder.

Peas	Dehydrated peas, frozen peas, pickle, soft drinks, etc.
Cassava	Fried chips, hot fries, crisps, nutrichips.
Amaranth	Package dry leaves, Dry powder
Beetroot	Juice, Powder, Chips
Beans	Canned and dried beans, Roasted and puffed beans
Pumpkin	Jam, Pickle, Seeds as salty snacks
Bottle gourd	Candy
Ash gourd	Sweets (Petha), Canned and dehydrated slices, Candy

Diversified Value-Added Products in Horticulture

- Osmotically dehydrated fruits - pineapple, mango, aonla, sapota and papaya
- Dehydrated fruits - grapes, fig, anardana from pomegranate
- Dehydrated vegetables, culinary pastes (vegetable pastes) - onion, garlic, chilli, ginger
- Intermediate process products/ semi-processed products - mango pulp
- Tomato products - tomato whole concentrate, puree, ketchup
- Fermented products from vegetables, raw mango slices in brine for pickle production
- Banana chips
- Watermelon rind candy
- Cider – Anola, Guava
- Banana flower pickle
- Banana fig
- Biscuit from Banana flour
- Value-added food products from Cassava-based composite flour
- Cassava Mini- Papad
- Ethanol from Cassava

Value addition in spices

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.

Spices not only help imparting taste, flavour, aroma and colour but also act as a preservative by preventing the spoilage of various food and beverage products. They are huge reservoir of essential oils and aromatic constituents which are of great demand in pharmaceutical and cosmetic industries, both in national and international trade. They also possess nutritional, antimicrobial, antioxidant and pharmaceutical properties and, hence, regarded as one of the most functionally important food ingredients. Efforts are, therefore, directed towards enhancing area, increasing productivity and improving quality of spices. However, in today's scenario, real challenges confronting us not only on how to sustain the productivity of spices but also on how to minimize their losses. Post harvest management of spices appears to be more crucial here. Most of the freshly harvested spices are very high in their moisture content, highly perishable and susceptible to microbial contamination. Steps like harvesting at optimum stage, proper transportation to processing units, cleaning, blanching, treating with recommended chemicals, dehydration, packaging and storage or processing leading those to value added products etc. are very much crucial so far as reduction of post harvest losses are concerned. The irony is that due to lack of proper knowledge, awareness and improper technology dissemination, the post-harvest management, especially in the developing countries is still not up to the mark. Therefore it is necessary to process the spices by exploiting both classical and innovative post-harvest technology to ensure their long term preservation and optimum utilization.

Value addition in 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 such as Bael (*Aegle marmelos*), Jack fruit (*Artocarpus* spp), Custard apple (*Annona squamosa*), Wood apple (*Feronia limonia*), Jamun (*Syzygium cumini*), Aonla (*Emblica officinalis*), Star fruit (*Averrhoa carambola*) and Malabar Ebony (Kendu) (*Diospyros melanoxylon*) etc grown throughout the state spanning over northern to southern Odisha. 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.

Role of Self Help Groups in Empowering Women

Women comprise half of human resources they have been identified as key agents of sustainable development and women's equality is as central to a more holistic approach towards establishing new patterns and process of development that are sustainable. The contribution of women and their role in the family as well as in the economic development and social transformation are pivotal. Participation in income generating activities helps in the overall empowerment of women. The SHGs had major impact on social and economic life of rural women. It empowers women and trains them to take active part in the socio-economic progress of the nation and make them sensitized, self-made and self-disciplined. In this regard Pattanaik (2003) has stated that SHGs are continuously striving for a better future for rural women as participants, decision-makers and beneficiaries in the domestic, economic, social and cultural spheres of life. But due to certain constraints like gender inequality, exploitation, women torture, various SHGs is not organized properly and effectively. The SHGs have inculcated great confidence in the minds of rural women to succeed in their day-to-day life. The SHGs bring out the capacity of women in molding the community in right perspective and explore the initiative of women in taking the entrepreneurial ventures. Makandar & Mulla (2013) argued that women's participation in SHGs enabled them to discover inner strength, gain self-confidence, social, economic, political and psychological empowerment and capacity building. Participation of women in SHGs makes a significant impact on the empowerment in social aspect also. SHGs helps women come out in open and discuss their problems. SHGs also helps to bring about awareness among rural women about savings, education, health, environment, cleanliness, family welfare, social forestry, etc. again SHGs could be linked to literacy programmes run by government and it could be made an integral part of SHG activities. Raised literacy level could be helpful for the SHG members to overcome cognitive constraints and to understand government policies, technical understanding and gaining required skills.

Empowerment should be extremely induced so that women can exercise a level of autonomy. There should also be 'self-empowerment' so that women can look at their own lives. The process of 'learning by doing and earning' would certainly empower rural women. More and more rural women need to be involved in self-employment. Self-employment in agriculture, village and small industries and retail trade and services should be expanded. Self-employment is also conducive to the development of individual initiative and entrepreneurial talent and offers greater personal freedom. The added advantage is that the institution of family remains undisturbed. The emergence of self-help groups in this context is a welcome development. The groups would provide a permanent forum for articulating their needs and contributing their perspectives to development. Self-help group should be developed as an institution for financial intermediation as well as people's network rather than a vehicle for credit disbursal only. Self Help Group is able to

overcome most of the practical problems encountered in the implementation of the various income generating programmes for the economic empowerment of women. The SHGs are a viable alternative to achieve the objectives of rural development and to get community participation in all rural development programs. The possible outcomes of women's entrepreneur through SHGs at household level are self-employment, sustainable livelihoods, enhanced social dignity and better status of women. SHG would lead to benefits not only to the individual women and women's groups but also for the family and community as a whole through collective action for development. Empowerment is not just for meeting their economic needs but also for more holistic social development.

Rural women play a vital role in farm and home system. She contributes substantially in the physical aspect of farming, livestock management, post harvest and allied activities. Her direct and indirect contribution at the farm and home level along with livestock management operation has not only help to save their assets but also led to increase the family income. She performs various farm, livestock, post harvest and allied activities and possesses skills and indigenous knowledge in these areas. The women were empowering themselves technically to cope with the changing times and productively using their free time and existing skills for setting and sustaining enterprises. They were engaged in starting individual or collective income generation programme with the help of self-help group. This will not only generate income for them but also improve the decision-making capabilities that led to overall empowerment.

Women Empowerment through Entrepreneurship

Following are the impact of entrepreneurship development on women empowerment:

1. Through entrepreneurship development self confidence level of women are increased and gave them a prosperous future.
2. Now rural women are engaged in small scale entrepreneurship programs with the help of Self Help Groups by which they were economically empowered and attaining very good status in family and community.
3. Entrepreneurship also helps to bring about awareness among rural women about savings, education, health, environment, cleanliness, family welfare, social forestry etc.
4. Micro enterprise is the best tool for rural women as it enables them to add to the family income and as such it provides family members to a better life style, including education for the children and improvement of family health.
5. Some aspects of household decision making are reported to have changed as a result of women's contribution in family income. Most of the men now consult with their wives in important family matters.
6. Promoting entrepreneurship through microenterprise approach enables eradicating the rural poverty in developing economies to a larger extent.

Empowering Women Farmers: Skill and Capacity Building

Several Inter-ministerial initiatives of Government of India have helped women farmers in receiving access to resources to enhance their livelihood, social and economic gains. The Ministry of Agriculture and Farmers' Welfare and Ministry of Rural Development through various schemes have encouraged participation of rural women farmer. The Mahila Kisan Sashaktikaran Pariyojana (MKSP) scheme was launched by Ministry of Rural Development to impart skill development and capacity building programmes for rural women. This scheme was introduced as a sub component of DAY-NRLM (Deendayal Antyodaya Yojana — National Rural Livelihoods Mission) and implemented through State Rural Livelihoods Mission (SRLM) across India. Under DAY-NRLM scheme, trainings on use of latest agriculture, allied techniques, agro-ecological best practices are being imparted to women farmers through the community resource persons and extension agencies. Specific women farmer training programmes on topics like household food security by kitchen gardening and nutrition gardening; design and development of low/minimum cost diet; designing and development for high nutrient efficiency diet; Processing and cooking; Gender mainstreaming through SHGs; Storage loss minimisation techniques; Value addition; Women empowerment; Location specific drudgery reduction technologies; Rural Crafts; and Women and child care are organised through extension bodies (Ministry of Agriculture and Farmers' Welfare, 2021). These training programmes have opened avenues for new livelihood opportunities for rural women.

Parallel research projects on introduction of new interventions in streamlining women engagement in farming sector, technology testing and refinement, gender sensitive extension approaches, and reduction etc. are led by ICAR-Central Institute for Women in Agriculture, Bhubaneswar for enhancing participation of women in agriculture. Over the years, rural women participation in training sessions has been increased to many folds. Also, gender-specific interventions and its adoption are encouraged through these trainings and awareness camps. Pradhan Mantri Kaushal Vikas Yojana (PMKVY) implemented by Ministry of Skill Development and Entrepreneurship provides several short duration skill training programmes viz. Short-Term Training (STT) and Recognition of Prior Learning (RPL), etc. for rural youth and women to earn their livelihood. Government schemes viz. The Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY) is a placement linked skill development program for wage employment for rural youth. Also, Farmers Producer organisation (FPO) and women self-help groups (SHG's) played significant role in dissemination of these programmes amongst rural women. The Mahila Shakti Kendra (MSK) developed by Ministry of Women and Child Development has empowered rural women through community participation and raising awareness on girl education, maternal care and health etc. Biotech-Krishi Innovation Science Application Network (Biotech-KISAN) Programme was initiated by The Department of Biotechnology (DBT) provide scientific solutions to farmers in north east region to link available innovative agriculture technologies to the farm with the small and marginal farmers, especially women farmers of the region (Ministry of Science and Technology, 2021).

Reforms for Social Empowerment: *Sabka Saath, Sabka Vikas*

The participation of rural women in workforce can be encouraged by providing safety, security, good health, education, skill development and equal rights. Prime step for empowering women is conservation of sex ratio percentage in the population and preventing female-infanticides in the country. In this pursuance, Beti Bachao Beti Padhao scheme has provided a significant mass mobilisation drive towards elimination of gender discrimination and improved sex ratio at birth. Girls' rights and opportunities for higher education were promoted under Sukanya Samridhi Yojana. Various schemes/programmes for holistic empowerment of women and development of children viz. Beti Bachao Beti Padhao, Pradhan Mantri Matru Vandana Yojana (PMMVY), Scheme for Adolescent Girls, Pradhan Mantri Mahila Shakti Kendra scheme, National Creche Scheme, Rastriya Mahila Kosh (RMK), Swadhar Greh, UJJAWALA scheme, Schemes of One Stop Centre (OSC), Women Helpline (WH) and Gender Budgeting Scheme are implemented by the Ministry of Women and Child Development across the country. These schemes are now integrated into new umbrella scheme as "Mission Shakti" (Ministry of Women and Child Development, 2021).

Conclusions

Rural women are major stakeholders in growth of agricultural sector for the New India. Acknowledging and mainstreaming of rural women via ensured access to resources, technology, education, health facilities, ownership rights and skill development will improve agriculture productivity and help in building an empowered nation. Today women participation in the field of entrepreneurship is increasing at a considerable rate, efforts are being taken at the economy as well as global level to enhance woman's involvement in the enterprise sector. Value added products development from fruits, vegetables, spices, and plantation crops have immense potential for empowerment of women at rural level through establishment of small scale Industries with the financial support from Govt. At present women have broken the monopoly of men and proved that they are not inferior to men. The SHGs and micro enterprises had major impact on social and economic life of rural women. The economic status of the women is now accepted as an indicator of a society's stage of development and therefore it becomes imperative for the government to frame policies for development of entrepreneurship among women. Raised literacy level could be helpful for the SHG members to overcome cognitive constraints and to understand government policies, technical understanding and gaining required skills.

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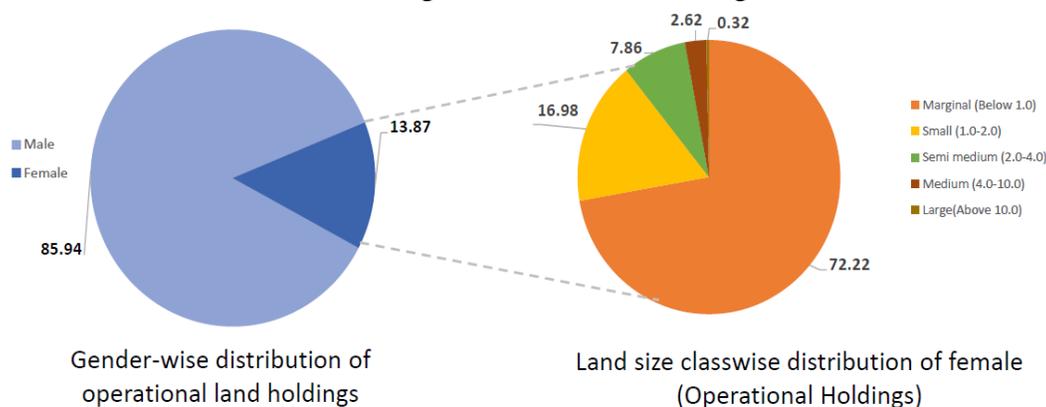
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Custom Hiring Centers: A Mechanization Opportunity for Women Farmers

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Introduction

It is observed in agricultural census, that women own 13.87 % operational land holdings and 11.57 % of area operated in 2015-16 as compared to 12.79 % and 10.36 % respectively in 2010-11. Thus, more females are participating in management and operation of land. But of this 13.87 % land owners 72.22 % are in marginal class with an average land size of 0.35 ha.



Meanwhile, there has been a decline of men's participation in the agriculture in recent years due to their migration in other sectors. But the Periodic Labour Force Survey 2017-18 also shows a sharp decline in the worker to population ratio for rural women. It has dropped from 24.8 per cent in 2011-12 to 17.5 per cent in 2017-18 (*all ages data*). This decline is observed more in group of lower income and lower literacy. Considerable proportion of this decline is accounted in the decreased participation of women in agricultural and allied activities. The report stated that, among the female workers engaged in agricultural activities the proportion decreased from 88.1 per cent in 1977-78 to 73.2 per cent in 2017-18. There is a need to counter this decline and retain the women in agriculture and allied sector by providing drudgery reducing tools and equipment for achieving sustainability.

As per Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization, 2018 report by Mechanization & Technology Division of Ministry of Agriculture & Farmers Welfare, the current national farm power availability in India is 2.03 kW/ha. For achieving desired intensity of cropping average and productivity, farm power requirement of 2.5 kW/ha by 2022 and 4.00 kW/ha by 2030 is considered essential.

Need for Farm mechanization:

Increased farm mechanization has positive impacts the crop productivity. It also ensures efficient use of energy and input, thus reducing the input cost. It also reduces the losses in storage,

processing, handling and transportation. This saving in the resources at an early stage and control of losses translates to increased profit in the end.

The changing climate is reducing the number of workable days in the agriculture. This creates a very small time window between the harvest of the first crop and sowing of the next. Possibility for higher cropping intensity is opened due to mechanized farm operations, as the machines ensure timeliness of the operations.

The rise in adoption of farm machines also raises employment, creates entrepreneurship opportunities in the manufacturing, service and repair sector.

Thus, it can be said that the mechanization in Indian agricultural system is inevitable to boost input use efficiency, reduce human drudgery, increase production and productivity of food grain, reduce cost of production and address issue of labour scarcity and timeliness of operations.

However it is pertinent to note that there is wide gap in technology absorption capacity across various farm categories and farming systems. In spite of providing subsidies, undertaking various schemes by government, the small and marginal farmers are not able to take advantage of improved mechanization systems.

Need of Custom Hiring Centers:

The women farmers, marginal and small farmers even though they could not afford to buy the machines themselves, could not avoid their usage for certain agricultural operations. A tractor is not a scale free technology, as its purchase is justified if it is put to use throughout the year, beyond the field operation. Hence, an individual farmer purchasing a tractor or machinery for only self utilization was not a viable venture. Some farmers did not have capital to purchase the machine, while others did not wish to invest time and skill to operate the machines themselves. Hence, there was needed a system for these farmers to hire machines from the machines owning farmers, whose machines were sitting idle after working one field only.

Due to climate change, the weather has become erratic with frequent draughts, floods, and other extreme weather events. This has led to condense the workable days in agricultural operations. As the small and marginal farmers along with women farmers are also affected due to these events, they are forced to adopt the mechanized way. It can be easily done through Custom hiring centers.

History of Custom Hiring Centers:

The concept of giving agricultural machinery for hire surfaced during the early decades of 19th century. CHCs were common place occurrence by mid 1960s due to establishment of Agro-Industries Corporation (AIC). Government of India initiated a scheme to setup Agro-service centers all over the country by 1971. This scheme had various criteria to set up an agro service center. They were as follows:

- i. Provision of on farm maintenance and repair facility for all types of agricultural machinery;
- ii. Provision of machinery custom hire service particularly to the small and medium farmers;
- iii. Provision of sale of spare parts, fuel, oil, lubricants and agricultural machinery and equipment;
- iv. Supply of agricultural inputs such as seeds, fertilizers and pesticides etc
- v. Provision of facilities for soil testing.

Thus it can be seen that the idea of CHCs is not novel and has been in place for several decades. The benefits of which are profound, especially for small and marginal farmers. There is a need to extend these proven benefits to the emerging women farmers.

Benefits of Custom Hiring Centers:

The custom hiring centers make Farm machinery and equipments available to women, small and marginal farmers at affordable rent. It adheres to the timeliness of the operations through matching machinery. When the operations are done with machines even the small women farmers are able to reap the benefits of the innovative crop management practices with specific machinery. Thus it leads to increased productivity and cropping intensity by making ample power available at farm level. It solves the problem of labour shortage in uncertain weather conditions. Even the small women farmers get benefits of advanced technology. The custom hiring centers spread the ownership cost over larger area, thus making purchase viable for the farmers. Better matching equipments are made available to the farmers instead of the few that are owned.

Custom hiring centers for women:

As it has been mentioned before that owning costly farm machinery individually is not feasible for marginal, small and women farmers. Hence, formulation of an SHG by women to establish a Custom hiring center is successful way to ensure women farmers are equal beneficiaries of growing mechanization in agricultural sector of India. Steps to formulate CHC are described below.

A. Assessment of village

Village is needed to be done before setting up a CHC. Following aspects are needed to be assessed:

- **Crops:** The crops that are cultivated will dictate the type of tools to be stocked in the CHC. The cropping intensity of the area should also be taken into consideration while purchasing multiple sets of tools. If the area has mono-cropping then a single set of heavy machines should be sufficient. Higher number of small manual tools may be more economically feasible. While if the village has higher cropping intensity with less days available between harvest of first crop and sowing of the second, then capital may be invested in purchase of mechanical harvesters.
- **Geography:** The topography of the village is also an important factor while deciding the type of tools included in the CHC. For hilly areas, power tiller is a better option

that the tractor. Similarly, the weather will dictate the housing and maintenance regime of the machinery.

For the custom hiring center to be successful beyond the time of the schemes it needs to be ensured for following:

- **Availability of electricity supply:** If power operated stationary equipments like thresher, pumps, winnowers etc are to be included in the CHC, and then there has to be uninterrupted electric supply to the village, especially during the time of operation. If the case is not so, then based on the capacity of operation either manually operated equipments or diesel engine power equipments may be given.
- **Availability of Fuel:** If tractor, combine harvester is to be included then a fuel supply should be available in the vicinity. Smaller equipments like power weeder, power tillers, diesel engine etc are also dependent on fuel. Thus, for smooth functioning of these machines, the fuel should be easily available to women in the nearby area. Women's time should not be spent on long distance journeys just to purchase fuel to run these machines.
- **Availability of Spare parts:** It needs to be ensured that there is a shop available in the vicinity of the village which sells general spare parts like nuts, bolts, spanners, gaskets etc as these are required in day to day maintenance of the machines. Also there should be a market link available to purchase specific spare part of machines. These salers should also supply generic maintenance material like lubricating oil, grease, oil cans etc for purpose wear and tear
- **Availability of maintenance:** Proper maintenance of machinery is the key to prolong its life and durability. It also reduces the need for frequent repair. Thus the women should ne made familiar with basic maintenance practices. It must also ensured that there is a basic mechanic shop in the village for working out minor repair issues. Women should be properly linked with the supplier of machines for after purchase maintenance services.

B. **Training:**

The Skilling of the women is required along with the setting up of the CHCs. It can be done by:

- Creating awareness regarding the tools and imparting knowledge of operation
- Front line demonstrations of the machinery
- Training of master trainers

The training should be given in following aspects:

- **Assembly of the tools:** As the tools that will be delivered will be disassembled at the time of transportation, the women should be encouraged to assemble them at the time of delivery, especially for the small hand tools. This will familiarize them with the parts of machine, which will help them with the maintenance.
- **Operation:** Proper in field training should be imparted to women. Al the queries should be addressed regarding amount of force to be applied, direction of force applied during

operation etc. this will dissuade them from improper using practice and will avoid and hazard or drudgery.

- **Maintenance:** Women should be taught basic maintenance of machinery like cleaning of arts after use, tightening of frequently loosing bolts, lubricating the moving parts. This regular maintenance will help in avoiding heavy repair cost in long run.
- **Management Structure:** Proper management structure should be inculcated in the SHG of CHC. This will help in quick decision making regarding operation of CHS. Ultimately it will give a sense of belonging and make the CHC sustainable
- **Logbook keeping:** It is important to keep proper record of hiring, usage, income received. This record will hold the time of usage of machine thus will help for on time servicing. The record of income is important not only to share profits with the members, but also on making decision for repair, investment in buying more equipments etc. Reinvestment and purchase of higher machinery will lead to growth of the Custom hiring center.

C. Tangent businesses to the Custom Hiring centers:

There is also a possibility to start a tangent business for women to support not only their custom hiring centers but also other farm machinery owners like:

- Spare parts supply
- Repair and maintenance
- Training center
- Skill on hire

During study Agro Machinery Service Centers of Punjab state, it was observed that the operations of AMSCs were economically viable as they generated profits to the extent of 2 to 30 per cent of the annualized costs. Thus it can be stated that if properly managed a custom hiring center is a profitable venture for women entrepreneurs

D. Success Stories:

Custom Hiring Centers(CHC) were established in 5 villages of Puri district through women SHGs after careful assesment of cropping pattern and farming activities of the district studied under the project “Involvement of Women in Agriculture in the State of Odisha” (AICRP on ESA) by utilizing SCSP fund.

1. Kunjar Village: Pipili Block, Puri district (NAGESWARI Women Self Help Group)
2. Siula Village: Pipili Block, Puri district (SATYASAI Women Self Help Group)
3. Algum Village: Satyabadi Block, Puri district (JOGAMAYA ATMA SAHAYIKA SANGHA Women Self Help Group)
4. Chitra Village: Nimapada Block, Puri district (MAA TARINI Women Self Help Group)

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Digital Technologies: A Way Forward for Developing Gender Sensitive Agripreneurship

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Digital Technology has potential to change the current agriculture scenario into data driven precision agriculture. The term digital agriculture is an extension of smart farming incorporating with digital technology like artificial intelligence, Internet of Things, Block chain technology etc. Traditional agriculture is not efficient in terms of cost and resource utilization. When the current agriculture is seen with gender lens, the farm women are still marginalised and involved in drudgery prone activities. Digital technology can help in reducing gender inequality which is one of the SDG. Cloud computing, blockchain technology, Internet of Things (IoT), and other contemporary technologies are reshaping agriculture to feed the world's population and lessen the impact of daily land loss. More farm women can be connected by digital technology by utilising data mining, artificial intelligence, and mobile. Due to the reduced need for physical intervention, this could aid in the elimination of drudgery. This paper mainly focuses on gender inclusive digital technology in agriculture.

Digital divide in India

India's rural and urban digital environments differ greatly from one another. Data about the digital divide which wasn't yet reported became visible by the COVID epidemic. The table clearly shows the shows the digital divide in India. The internet penetration for women in India is only 24.6 whereas many states are still below from the national average.

Table 1: Internet and Mobile usage in India (Source: NFHS)

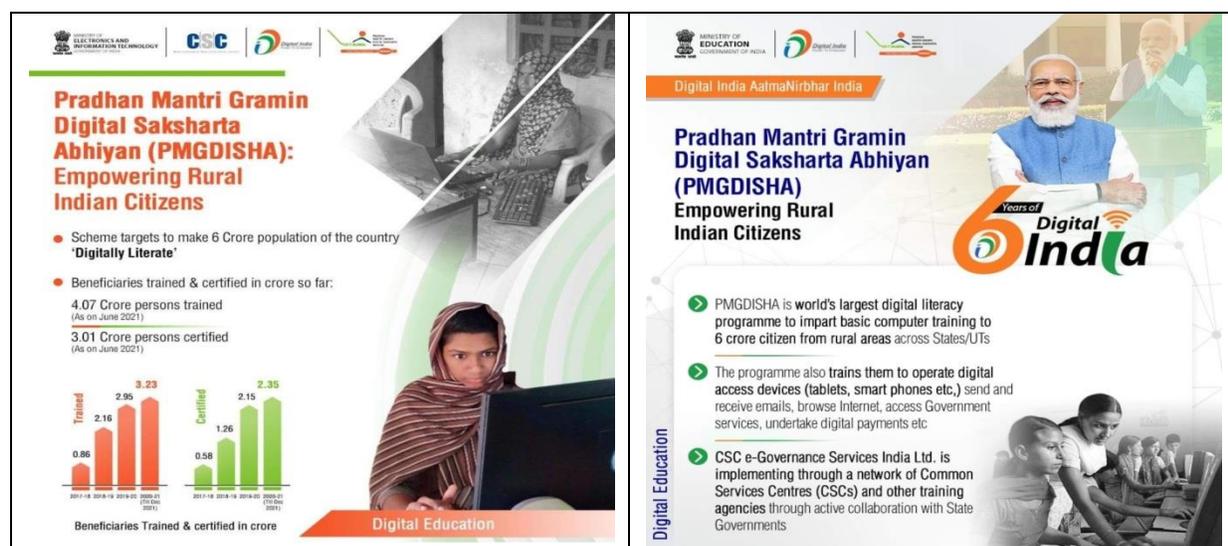
State	Women who have ever used the internet (%)		Women having a mobile phone that they themselves use (%)		
	NFHS-5 (2019-21)		NFHS-5 (2019-21)		NFHS-4 (2015-16)
	Women (Rural)	Men (Rural)	Rural	Total	Total
Bihar	17.0	39.4	49.3	51.4	40.9
Odisha	21.3	47.2	48.0	50.1	39.2
Jharkhand	22.7	53.2	43.7	49.0	35.2

Andhra Pradesh	15.4	41.5	40.9	48.9	36.2
West Bengal	14.0	38.3	39.1	50.1	41.8
Chhattisgarh	20.8	50.4	34.0	40.7	31.0
Madhya Pradesh	20.1	49.3	31.4	38.5	28.7
India	24.6	48.7	46.6	54.0	45.9

Policies and programmes for enabling digital agriculture

Digital India: The vision of Digital India programme is to transform India into a digitally empowered society and knowledge economy. The programme was started in 2015 and impacted almost every sector. Digital India has brought major changes in agriculture sector too. Today almost every agriculture related website has a dashboard and mobile application to help the stakeholders.

PMGDISHA: It is the scheme to make six crore persons in rural areas, across States/UTs, digitally literate. It is basically for empowering the rural citizens of India specially targeting marginal section of society.



Digital technology supporting modern agriculture

Drone Technology: Drone technology has changed the scenario of modern agriculture. The manual intervention has reduced drastically. The technology is able to perform various task like Soil Analysis for field planning, Seed Pod Planting, Crop Monitoring, Crop Spraying, Irrigation,

Crop health assessment, Crop surveillance, Controlling weed, insect, pest and diseases, Scaring birds etc.

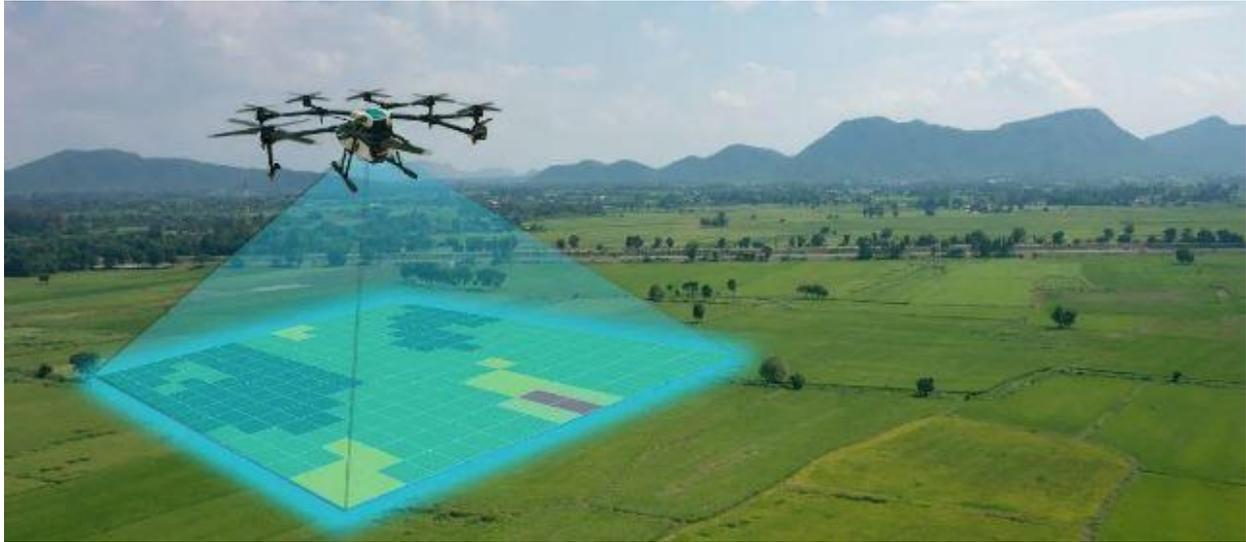


Figure 1: Drone Technology in Agriculture

Artificial intelligence: Artificial Intelligence has already proven its efficiency in other fields so it must be used in Agriculture sector. There are various AI-enabled apps available in market for different sectors. It is well suitable in monitoring health of the cattle, vaccination of the cattle, etc. Due to its efficacy it is widely adopted by different sectors.

The use of artificial intelligence in agriculture helps farmers understand information from data such as temperature, precipitation, wind speed, and solar energy. Analysis of historical stock data provides a better comparison of ideal results. The best aspects of artificial intelligence implemented in agriculture will not eliminate the work of human farmers; on the contrary, it will drive the procedures. The implementation of AI emphasizes defective crops and strengthens the prospects for the production of healthy crops. The development of artificial intelligence technology is better managed by agrobased companies. AI is used for use in applications such as weather forecast and pests or pest identification. Artificial intelligence can improve crop management practices, resulting in investing in algorithms that many technical companies are useful for agriculture.

IoT: The Internet of Things is also the latest technology adopted by the agricultural sector. The IoT devices communicate with each other, and the artificial intelligence enabling mechanism can make decisions. Intelligent agriculture based on the Internet of Things is a system designed to monitor farmland and realize irrigation automation with the help of sensors (soil moisture, humidity, light, temperature, etc.). Farmers can observe field conditions from anywhere. Irrigation systems equipped with IoTe not only save water, but also ensure that crops receive the right amount of water for optimal growth. This irrigation method is based on soil moisture levels rather than watering at predetermined intervals. Real-time data can be used as input for crop monitoring and

yield modeling. However, using existing platforms to record information in real time to model and monitor crops is puzzling.



Figure 2: IoT usage in agriculture

Portals Helping Farm Women:

Integrated Scheme for Agricultural Marketing (ISAM) : The one of main objectives of this scheme is " to use ICT as a vehicle of extension to sensitize and orient farmers to respond to new challenges in agricultural marketing ". So due to the issue of digital literacy the stakeholders are not taking benefits as up to the mark.

FARMER PORTAL

The portal is intended to provide relevant information and services to the farming community and the private sector through the use of information and communication technologies, to complement the existing distribution channels provided by all 'supply. The Farmers Portal is an attempt in this direction to create a one-stop-shop for all information needs related to the field of agriculture, animal husbandry and fish production, sale / store of an Indian farmer. With this Indian farmer, there will be no need to sift through the maze of sites created for specific purposes

E-NAM: The NAM portal provides one aggregator for all APMC related information and services. This includes incoming goods and prices, commercial offers for buying and selling, providing responses to trade offers, among other services. While the flow of raw materials (agricultural products) continues through the mandis, the online marketplace helps to reduce transaction costs and information asymmetries.

MKISAN

mKisan SMS Portal is designed to provide a leap in farmer coverage and geographic area by disseminating timely, specific, comprehensive and essential knowledge to farmers. farmers, but also to respond to their concerns and questions.

Different mobile applications: Hundred of user friendly mobile applications have been developed for Farmers. The different mobile apps covers all sectors of agriculture's. e.g Horticulture, fisheries, animal science, crop science etc. A brief list of apps are also given at ICAR website for their help.



Fig 3: Smart agriculture using the mobile application

Benefits related to the Movement towards digital agriculture:

Global reach: The digital technology has a global reach or world wise access of farming techniques. farmers may be benefitted from many sources digitally.

Enhanced Data collection: data is an asset in modern world. Based on the data, the automated systems are able to take decision accurately about the showing time, soil test, pest management etc.

Low time: As we have fast computers today the collection, analysis and decision making process takes less time.

Provides better suggestion: Based on the data accuracy the modern systems are able to take decision wisely. The invasion of AI plays a pivotal role for this purpose.

Efficient in terms of cost: In today's digital era the digital devices are not too much costly, so it can be used as one time investment for taking benefits for years.

Increased productivity: The productivity must be increased if the digital technology will be used in agriculture sector.

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- 7 Ministry of education

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Institutional Support for Agripreneurship Development in Women in India

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Over time, there has been an increasing acknowledgment of the pivotal role that women play in the agricultural sector, making significant contributions to the food and nutritional security and related domains. Women are integral to agriculture, not only in food production but also in key phases like processing, preservation, and packaging. It is hence crucial to prioritize the development of women's entrepreneurship in these sectors as well, as it holds the potential to enhance the value of agricultural products and dairy. This, in turn, can boost the income-generating capacity of small-scale women producers and entrepreneurs, leading to better resource management, the creation of employment opportunities for rural women, and socio-economic empowerment.

Entrepreneurship, a comprehensive concept, entails creating, organizing, and managing business ventures across diverse economic sectors, including technology and retail. It empowers individuals to identify opportunities for innovation and business development. In contrast, agripreneurship, often termed agricultural entrepreneurship, represents a specialized subset with a specific focus on entrepreneurial activities within the agricultural sector. Agripreneurs are involved in producing, marketing, and managing agricultural products and services, encompassing farming, agribusiness, and value-added agricultural products. Unlike general entrepreneurship, agripreneurship revolves around agricultural innovations and business initiatives, contributing to the development and commercialization of agricultural goods and services. While entrepreneurship is versatile, spanning numerous industries, agripreneurship is a niche form of entrepreneurship uniquely dedicated to the agricultural domain. Agripreneurship, can be hence considered as a fusion of "agriculture" and "entrepreneurship,". It encompasses entrepreneurial endeavors within the agricultural sector.

In India, agriculture has been a cornerstone of the economy, with women playing a vital role for generations. Agripreneurship is generally considered as a sustainable approach focusing on agricultural community. It emphasizes sustainability and takes a broader approach to farming, considering the interconnections of socio-economic and environmental factors. In simpler terms, agripreneurship refers to entrepreneurship within the broad field of agriculture. Within agriculture, there are numerous areas and sub-areas, each offering a wide range of commodities. Agripreneurs can select specific commodities based on factors like local needs, agro-climatic conditions, and available resources. This approach allows them to thrive and better production and yields through improved practices in agriculture.

Government of India defined (1984) woman entrepreneur as someone who owns and controls an enterprise, contributing a minimum of 51% of the capital and ensuring that at least 51% of the employment within the enterprise is provided to women. Women's entrepreneurship in agriculture

commonly takes the form of individual agripreneurs, small businesses, startups, as well as collective initiatives such as Self-Help Groups and Farmers Producers Organizations. Furthermore, it is crucial to provide training in agri-business management, with a particular focus on women in rural areas who may be unemployed. Additionally, offering financial support and necessary equipment to rural women is essential to enable them to initiate their enterprises in agriculture. This approach promotes economic empowerment and contributes to the development of the agricultural sector.

The advantages of nurturing agripreneurship among women are manifold. It grants women economic independence by enabling them to generate income from agricultural activities. This financial self-sufficiency contributes to their overall empowerment, enhancing their decision-making influence in their households and communities. Women's involvement in agripreneurship directly bolsters food security, raising agricultural productivity and ensuring improved nutrition for their families and communities. Moreover, the success of women in agripreneurship encourages them to stay in rural areas, curbing urban migration. This, in turn, promotes rural development and sustains agriculture in India. However, women often encounter obstacles like limited access to resources, technology, and markets, impeding their progress in agripreneurship. Institutional support is essential in addressing these challenges and empowering women to excel as agripreneurs.

Rural women and agripreneurship

Agriculture is the backbone of many developing economies, and food processing plays a vital role in boosting agricultural production and advancing sustainable agricultural practices. Consequently, it is imperative to focus on fostering the development of agripreneurship among rural women, particularly in the domains of food processing, preservation, and packaging. Often, food is produced in significant quantities, surpassing immediate consumption needs. Processing is essential to extend the shelf life, ensuring food availability throughout the year and diversifying product offerings. The women's involvement in manufacturing and food processing tends to be underestimated, primarily because their activities are frequently secondary to subsistence agriculture. By engaging in food processing and preservation, women entrepreneurs can enhance their income-generating capabilities, ultimately improving the economic potential of women. Food processing brings a multitude of advantages to enterprising women in developing nations, including the capacity to add value to basic agricultural and dairy products. This, in turn, enhances the income-earning potential of small-scale women producers and entrepreneurs, facilitates better management of local resources, and contributes to the creation of employment opportunities for rural women.

The development of entrepreneurship within the food sector of agriculture yields various benefits that contribute to rural development and empowerment. It plays a pivotal role in curbing rural-to-urban migration, leading to a redistribution of economic power to rural areas, ultimately elevating the economic status of both rural women and the entire community. This economic boost, facilitated by agripreneurship, fosters real development in rural regions, promoting balanced and eco-friendly growth. Additionally, it reduces transportation costs and post-harvest losses of

perishable goods. Agripreneurship initiatives in rural areas improve infrastructure, with cascading effects on transportation, roads, product availability, and the overall economy. This approach also creates employment opportunities, particularly for women who may be constrained to their homes. By harnessing the energy of rural youth, agripreneurship mitigates social issues and contributes to increased livelihoods for women. Ultimately, it enhances women's economic status, empowering them and elevating their societal standing. Moreover, untapped local natural resources find productive utilization, generating revenue. By identifying suitable business ventures, both organized and unorganized women resources can be channeled to empower them.

Challenges Faced by Women in Agripreneurship

Women in agripreneurship face a multitude of challenges that impact their ability to thrive in this field. One of the primary challenges is the dual role they must play, juggling responsibilities at home and in their profession. This dual burden often results in time constraints and overburdened personal obligations, exacerbated by the lack of infrastructure such as childcare and support from spouses. Women often encounter challenges in accessing essential resources such as land and modern agricultural technologies. This limited access inhibits their ability to innovate and expand their agricultural ventures. Access to finance is another significant obstacle, particularly for women who lack property in their name and require their husband's signature on various documents. The prevalent practice of passing parental property to male children in India further hinders women's capital-raising efforts. Family dynamics can pose challenges, as some families may make women feel guilty for neglecting household duties in pursuit of their entrepreneurial ambitions, influenced by cultural traditions. The unavailability of necessary equipment, lack of knowledge about alternative sources of raw materials, and low-level negotiation skills affect women's business ventures. Additionally, women entrepreneurs often struggle with management skills, relying on office staff and intermediaries, particularly in areas like marketing and sales. Storage and warehousing facilities are often lacking, leading to product spoilage. Moreover, a risk-averse attitude, stemming from low education and self-confidence levels, can hinder women's entry into entrepreneurship. A lack of training and education specific to agripreneurship restricts women from adopting modern farming practices, marketing strategies, and value addition techniques. Marketing locally produced products can be challenging due to consumer trust issues and a preference for readily available items. Women in agripreneurship frequently face difficulties in accessing markets and negotiating fair prices for their agricultural produce. This hampers their income and profitability. Obtaining loans from banks is complicated, as financial institutions may doubt women's entrepreneurial abilities and impose unrealistic securities. Finally, weak linkages between women entrepreneurs and government agencies result from low awareness about policies, often exacerbated by low education levels, leading to dissatisfaction with support systems due to harassment and corruption. Therefore, there is a need to establish stronger connections between women entrepreneurs and government agencies to address these challenges effectively.

Institutional Support for Agripreneurship Development

Women entrepreneurs play a crucial role in a country's economic growth, and achieving gender equality and enhancing opportunities for women is vital to unlock their potential. Research from

around the world has shown that enterprises founded or co-founded by women tend to perform better than those managed solely by men. Women often excel in key skills necessary for business, such as teamwork, problem-solving, and orientation. The Government of India (GOI) has recognized the untapped potential of women and taken numerous policy initiatives to mainstream women entrepreneurs and provide them with a level playing field. In India, there are approximately 8 million women-led enterprises, comprising about 14% of all entrepreneurs. While this figure may not be as encouraging, it's promising to note that 35.5% of startups have women serving as directors, and 58% of entrepreneurs initiated their businesses between the ages of 20 and 30. Therefore, any efforts to increase the number of women-led enterprises and enhance their productivity directly contribute to the country's economic growth. Promoting gender equality and supporting women entrepreneurs are essential steps in advancing India's economic development.

The Ministry of Women and Child Development (MWCD) introduced the Draft National Policy for Women in 2016 with the aim of promoting gender equality and empowering women to become equal partners in the country's development. This policy emphasized the need to incorporate gender-sensitive policies at the micro-level to address women's concerns effectively. It encompassed various aspects of women's participation in the economy, including entrepreneurship development, training, skill enhancement, and support for women farmers. MWCD has been actively working to eliminate barriers that hinder women from becoming successful entrepreneurs. They are focused on creating an enabling environment by addressing issues such as access to finance, acquiring the latest skills and technology, and gaining access to markets and business skills. To promote entrepreneurship, several government ministries in India have implemented numerous programs. These programs include special provisions and incentives to ensure women's active participation and their fair share in economic activities. These efforts collectively aim to uplift women and enhance their role as key contributors to the country's development.

The Indian government has introduced various schemes and policies aimed at supporting women in agriculture and agripreneurship. Programs like the Kisan Credit Card, Pradhan Mantri Kisan Samman Nidhi (PM-KISAN), and National Bank for Agriculture and Rural Development (NABARD) schemes provide financial support to women in agriculture. Agricultural universities and research institutions offer training programs, workshops, and extension services tailored to women in agriculture. These educational resources empower women with knowledge and skills to succeed in agripreneurship. Women SHGs provide a platform for rural women to access credit, share knowledge and experiences, and engage in collective agricultural activities. They promote financial inclusion and empower women to take control of their agricultural ventures.

Women Entrepreneurship Platform

Launched in 2017 through a collaboration between the Government of India and NITI Aayog, the Women Entrepreneurship Platform (WEP) is dedicated to creating a conducive environment for women's entrepreneurship across the nation. Functioning as a comprehensive hub for essential information and services, WEP strives to strengthen industry ties and increase awareness of available programs for women entrepreneurs (WEs). The platform facilitates access to a spectrum of initiatives, encompassing incubation and acceleration programs, entrepreneurship skilling,

mentorship, marketing assistance, funding and financial support, compliance and tax guidance, as well as community and networking opportunities. Since its establishment in 2018, WEP has seen the registration and benefit of over 26,500 women, attesting to its role in providing a diverse range of resources and supportive mechanisms.

Support ecosystem for women's agriprenuership in India

- A total of 70 central government schemes, spanning 15 ministries, are dedicated to offering direct or indirect support to entrepreneurs or enterprises across the six key ecosystem needs. Additionally, across 28 states, there are 433 state government schemes designed to provide state-level support for entrepreneurship.
- The primary contributors to central government schemes, constituting 60% of the total with 42 schemes, are the Ministry of Micro, Small, and Medium Enterprises (24 schemes), the Ministry of Agriculture and Farmers Welfare (10 schemes), and the Ministry of Skill Development and Entrepreneurship (8 schemes).
- On the state level, seven states, namely Odisha (41 schemes), Kerala (36 schemes), West Bengal (32 schemes), Assam (27 schemes), Rajasthan (26 schemes), Tamil Nadu (22 schemes), and Telangana (21 schemes), collectively account for 47.3% of all entrepreneurship support schemes implemented by state governments, totaling 205 schemes.
- Approximately 45% of central schemes primarily focus on providing support for access to finance, while 27% concentrate on addressing training and skilling ecosystem needs. The predominant focus of state schemes lies in providing support for access to finance and access to business support services. Notably, only 3% of state schemes and 4% of central schemes prioritize mentoring or networking as their primary support domain.
- Most central schemes are designed to benefit both male and female beneficiaries, but some programs have distinct provisions aimed at supporting women. Schemes like StandUp India, the Central Sector Integrated Scheme on Agricultural Cooperation (CSISAC), the Prime Minister's Employment Generation Programme (PMEGP), and the Jan Shikshan Sansthan scheme have specific measures for women, such as additional subsidies, quotas in the number of beneficiaries, and allocations in fund utilization.
- Out of all state schemes, only 31 (constituting 7% of the total) exclusively focus on women, limiting eligibility to female beneficiaries. Additionally, within the broader category of schemes targeting both male and female beneficiaries, only 7.6% incorporate special provisions specifically for women. These provisions encompass aspects such as age relaxation, increased subsidy rates, low-interest rates, additional subsidies, special incentives, a designated quota for female beneficiaries, and an allocation quota in fund utilization aimed at fostering the development or promotion of entrepreneurship among women.
- While the majority of central and state schemes aim to benefit entrepreneurs and enterprises across diverse industries, there is a notable emphasis on certain sectors like agriculture, allied activities, and manufacturing. The Ministry of Agriculture and Farmer's Welfare

oversees 10 out of the 14 central schemes in the agri and allied activities sector, with Odisha leading in the number of state schemes in this domain. It's worth mentioning that a limited number of both central and state schemes include incentives for sustainability or green initiatives. State-level schemes primarily focus on the manufacturing and agri and allied sectors, with over half of them supporting beneficiaries from any sector. Kerala and Odisha stand out as leaders with the highest number of schemes in the manufacturing sector. Among the top three states with the highest number of sector-agnostic schemes are Tamil Nadu, West Bengal, and Rajasthan. Around 20 percent of the schemes specifically target agriculture and allied sectors.

Important schemes supporting agripreneurship in women

Start up scheme for women

The Indian Government launched the 'Startup India initiative' on January 16, 2016, to foster a robust ecosystem for nurturing startups, thereby driving economic growth and supporting entrepreneurship. This initiative also prioritizes strengthening women's entrepreneurship through various policies and initiatives. Under the Startup India initiative, entities are recognized as startups by the Department for Promotion of Industry and Internal Trade (DPIIT) based on specific eligibility conditions. As of December 31, 2022, a total of 86,713 startups have been officially recognized by DPIIT across more than 660 districts, ensuring representation from every state and union territory. Notably, over 46% of these recognized startups have at least one woman serving as a director. In addition to startup recognition, the Government has implemented several measures to promote women's entrepreneurship. These measures include reserving 10% of the Fund of Funds for Startups Scheme for women-led startups, conducting Virtual Incubation Programs for Women Entrepreneurs to support tech startups, creating a dedicated webpage for women entrepreneurs on the Startup India portal, organizing awareness and capacity-building workshops specifically tailored to women entrepreneurs, and launching the WING program, a capacity development initiative for women entrepreneurs that saw participation from 114 attendees in Guwahati, Assam, and Kohima, Nagaland, in January 2020. These comprehensive efforts aim to empower and encourage women's participation in India's dynamic startup ecosystem.

Role of ICAR in Women-led Startup Incubation

The Ministry of Agriculture and Farmers Welfare launched the "Innovation and Agri-Entrepreneurship Development" component in the fiscal year 2018-19 as part of the Rashtriya Krishi Vikas Yojana (RKVY-RAFTAAR) to promote innovation and agri-entrepreneurship. It provides financial support and nurtures incubation ecosystems. The Ministry has designated five Knowledge Partners (KPs) as Centres of Excellence, namely MANAGE-Centre for Innovation and Agripreneurship in Hyderabad, AAU-North East Agriculture Technology Entrepreneurs Hub in Jorhat, ICAR-IARI Pusa Krishi in Delhi, CCSNIAM ABI in Jaipur, and UAS-Krishik ABI in Dharwad. Additionally, twenty-four RKVY-RAFTAAR Agribusiness Incubators (R-ABIs) and 13 ICAR Incubation Centres have been designated across the country for program implementation. Thus far, 173 women-led startups and entrepreneurs have received support through the "Innovation and Agri-Entrepreneurship Development" initiative.

In parallel, the ICAR also actively supports agri-based startups via the National Agriculture Innovation Fund (NAIF) initiated in the fiscal year 2016-2017. Under the NAIF scheme, 50 Agri-Business Incubation Centers (ABICs) have been established and are currently operational within the ICAR network. These initiatives offer opportunities for potential women entrepreneurs to benefit from the support and resources provided by these programs.

Table 1. Schemes supporting women agripreneurship

Scheme	Support
Skill Upgradation and Mahila Coir Yojana	Skill development of women artisans engaged in the coir industry.
Mahila Samridhi Yojana	This is a women-centric microfinance initiative offering a reduced interest rate. Eligible individuals can receive financial support up to a maximum of Rs. 1,40,000.
Trade Related Entrepreneurship Assistance and Development (TREAD)	Non-Governmental Organizations (NGOs) supporting entrepreneurship among specific women's target groups receive assistance from the Government of India (GoI) in the form of a grant, amounting to up to 30 percent of the total project cost as evaluated by the lending agency.
Support to Training and Employment Programme (STEP) for Women	The scheme has dual objectives: firstly, to impart skills that enhance employability for women, and secondly, to equip women with the competencies and skills necessary for self-employment and entrepreneurship.
Mudra Yojana for Women/ Mahila Udhyaami Yojana	Women entrepreneurs can access loans up to Rs 10 lakh without requiring collateral. These loans come with low-interest rates and offer a flexible repayment tenure.
Stand Up India	The Stand-Up India (SUI) scheme, aimed at financing entrepreneurs from the SC/ST and/or Women categories, was inaugurated by the Honorable Prime Minister (PM) on April 5, 2016.
Nai Roshni- Scheme for Leadership Development of Minority Women	It empowers and boosts the confidence of minority women, as well as their neighbors from different communities residing in the same village or locality. This is achieved by offering them knowledge, tools, and techniques to effectively engage with government systems, banks, and various institutions at all levels.
Mahila Shakti Kendra	The scheme is designed to create a platform for rural women to access government entitlements and to empower them through training and capacity building initiatives.
Nari Shakti Puraskars	The Nari Shakti Puraskars are bestowed upon distinguished women and institutions in acknowledgment of their significant contributions to the advancement of women's empowerment.
National Startup Awards	Entities derive benefits across multiple facets of their business, encompassing areas such as business operations, financing,

	partnerships, talent acquisition, serving as role models for other entities and aspiring entrepreneurs. This, in turn, inspires them to pursue purposeful and responsible initiatives, aiming to create a meaningful socio-economic impact.
BIRAC-TiE WInER Awards	Fifteen chosen women entrepreneurs will be granted seed funding amounting to INR 5 lakhs each. They will also gain access to the expert mentor network of TiE and BIRAC, receive a one-year membership with TiE Delhi NCR, have opportunities for showcasing at TiE events, access the TiE Startup Accelerator program, and the chance to undergo an intensive accelerator program.
Credit Guarantee Scheme for Micro and Small Enterprises	Women, micro-enterprises, and units in the Northeast region can avail a credit facility of up to INR 5 lakhs at a 1% interest rate. For amounts exceeding INR 5 lakhs and up to INR 50 lakhs, the interest rate for women, micro-enterprises, and covered units in the Northeast region is set at 1.35%.

Bank-Facilitated Funding Initiatives

Numerous banks offer programs to encourage women's entrepreneurship, providing specific benefits such as reduced interest rates and relaxed requirements for collateral security.

- **Shri Shakti Package for Women Entrepreneurs:** a State Bank of India initiative aimed at providing concessions to businesses with majority ownership (over 50%) by women. Under this scheme, there is an interest concession of 0.05% on loans exceeding Rs 2 lakhs, and loans up to Rs 5 lakhs do not require collateral security
- **Cent Kalyan Scheme:** Central Bank of India designed this scheme for new entrepreneurs and self-employed women engaged in macro/small enterprises. This scheme offers loans up to Rs 1 crore without the need for any collateral security
- **Mahila Udyam Nidhi Scheme:** provided by Punjab National Bank and SIDBI, is designed to assist women in establishing new small-scale ventures. The scheme extends loans up to Rs 10 lakhs, repayable over 10 years. Additionally, women entrepreneurs can receive support with loans going up to Rs. One Crore, and notably, no collateral security is required for these loans.

Some other example include Oriental Mahila Vikas Yojana Scheme offered by Oriental Bank of Commerce, business loan tailored for women entrepreneurs by Bhartiya Mahila Bank, Dena Shakti Scheme by Dena Bank , Udyogini Scheme by Punjab and Sindh Bank etc.

Conclusion

The pivotal role of women in agripreneurship is indispensable for the holistic advancement of India's agricultural sector. Women make substantial contributions across various facets of agriculture, ranging from food production to processing, preservation, and packaging. Recognizing and harnessing the potential of women in agripreneurship is not only vital for economic growth

but also imperative for bolstering food security and championing sustainable agricultural practices. Agripreneurship, being a distinct form of entrepreneurship within the agricultural sector, serves as a key driver for women's economic independence. By nurturing agripreneurship among women, both the government and various institutions can empower them to generate income, make significant contributions to food security, and actively participate in the advancement of rural development. Furthermore, the promotion of agripreneurship helps address challenges like rural-to-urban migration, encourages balanced growth, and creates valuable employment opportunities, particularly for women residing in rural areas. Despite the myriad benefits, women engaged in agripreneurship confront a host of challenges, encompassing limited access to resources, technology, and markets. The provision of robust institutional support becomes imperative in surmounting these challenges and facilitating an environment where women can thrive as successful agripreneurs. The commendable initiative of the Women Entrepreneurship Platform (WEP), launched by the Government of India and NITI Aayog, stands as a testament to such institutional support, offering a comprehensive hub of information, services, and mechanisms to uplift women entrepreneurs. Furthermore, various central and state government schemes are tailored to bolster agripreneurship, featuring special provisions designed to benefit women. While the emphasis on sectors like agriculture, allied activities, and manufacturing aligns with the concentration of MSMEs in these domains, there remains an opportunity for enhancing efforts in addressing sustainability and promoting green initiatives within the agripreneurship landscape. Looking ahead, it is imperative to sustain efforts in strengthening institutional support, addressing the challenges faced by women in agripreneurship, and fostering awareness about the array of available schemes and initiatives. Through these ongoing efforts, India can fully unlock the potential of women in agripreneurship, contributing to inclusive economic growth, fortified food security, and the sustainable development of rural communities.

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