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Integrated farming system for women empowerment in an island ecosystem

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ABSTRACT

A study was conducted to assess the impact of integrated farming system on a smaller scale in tribal areas of Nicobar Island, India. A small scale Homestead Integrated Farming System (HIFS) comprising home garden, goat/pig, backyard poultry was evaluated in farmer's field through participatory approach in three tribal villages of Car Nicobar during 2013–2020. To assess the impact of Integrated Farming System (IFS) on women empowerment, structured interview was carried out among 20 beneficiaries during October–November 2022. The women empowerment was assessed by quantitative and qualitative methods. Paired t test was conducted for different indicators of women economic and social empowerment comparing the baseline data collected before intervention in 2012. The study found an increase of average household income up to ₹15,000/- due to sale of surplus farm produce after home consumption from an area of 400 m^2 in 2020–21. The system provided an opportunity for the tribal women to earn money on their own providing financial independence. The statistical analysis indicated a significant improvement in all the indicators of economic and social empowerment of women. The women economic empowerment index increased from 0.088 (nil empowerment) before to 0.437(slight empowerment) after intervention on Likert scale. This economic empowerment led to social empowerment, the index of which has increased from 0.097– 0.278 during the same period. The study indicated that a small scale homestead farming system can be a promising path in improved livelihoods, enhanced income for achieving economic and social empowerment of women in tribal, remote and isolated areas as in Nicobar Islands.

Keywords: Integrated farming system, Nicobar Islands, Women empowerment

Women empowerment is the process of providing enabling conditions to gain control over their own lives, body and environment and to make strategic decisions. It is frequently emphasized on rights to decision-making, economic independence and legal protection against all sorts of discrimination (Astutik *et al*. 2020). It is reported that women empowerment is crucial for poverty reduction, economic progress and development of any nation (Sohail 2014, Gali`e 2019). Providing means to achieve financial independence is essential for women to have control over their lives and increase their social status. This includes providing education, training, creating awareness, skill development, entrepreneurship development, ensuring fair wages and eliminating workplace discrimination (EIGE 2016).

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Though land ownership in India is predominantly held by men, providing assistance to farm women in the farm of livestock, poultry, skill development in value addition, processing and integrating them with the existing farming systems not only enhance their fund flow but also provide economic independence. This will play a crucial role in empowering them in terms of money but also ensure food and nutritional security of farm family. Rural women have inherent potential for multiple roles to efficiently manage diverse natural resources to meet the daily household needs and also to increase the income from on-farm production and off farm activities.

The Nicobari tribes have homestead production system adjacent to the dwelling house producing diverse crops, small-scale livestock rearing mainly pig and backyard poultry. Majority of the tribal women in Nicobar Islands are homemakers and don't have direct means/ways for independent financial resources. These women are directly involved in production of vegetables, fruits, medicinal plants for home consumption.The modification of existing homestead production system through promotion of livestock farming and its integration with crop production within a limited piece of land will empower these women. Considering the remoteness, limited land and other resources

a small scale homestead integrated farming system (HIFS) was evaluated in a participatory mode to improve the livelihood opportunities of tribal households especially tribal women in Car Nicobar Islands.

MATERIALS AND METHODS

The study was carried out during 2013 to 2020 in Car Nicobar Island through Tribal Sub Plan of ICAR sponsored All India Coordinated Research Project (AICRP)-Integrated Farming Systems, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, Uttar Pradesh. A homestead Integrated Farming System (HIFS) was introduced in 25 tribal farmers field in Kinmai, Kinuka, Big Lapathy villages of Car Nicobar during 2013 and continued up to 2020. The components were homestead garden, goatery or piggery, back yard poultry and composting. Later lined pond was made in each unit for water harvesting.

Car Nicobar Island is located in the south-east of the Bay of Bengal, 250 km from Port Blair, Sri Vijayapuram. Because of its proximity to equator, the island experiences hot, humid tropical climate with total annual rainfall of 300 cm received from both south-west and north-east monsoon. The livelihood of Nicobari tribes depends on agriculture and fishing. Only horticultural crops especially coconut is grown in 80% of agricultural area under rainfed, natural condition without any external input. Coconut is grown in *tuhet* gardens away from the settlement. In homestead gardens, banana, papaya, tapioca, pandanus, tuber crops, other native vegetables and medicinal plants are grown. Livestock production is limited to rearing of indigenous pigs in open range-semi feral-system and few of the tribal households practice backyard poultry with indigenous (native) birds. The productivity is very low and major food items including cereals, pulses, vegetable oil are supplied by the government through public distribution system.

Homestead integrated farming system (HIFS): The tribal agricultural system is characterized by community coconut plantations grown under natural condition with no or limited management. The Integrated Farming System (IFS) interventions were made in homestead gardens adjacent to their dwellings which was converted into a HIFS system by land allocation for different components, viz. home garden (400 m^2), backyard poultry (25 numbers), goats or piglets (2 numbers) and composting. In the home gardens, seasonal vegetables, viz. okra, brinjal, tomato, green amaranth, cucumber, bitter gourd, bottle gourd, sweet corn, fruit crops like banana, pine apple, papaya and tuber crops, viz. tapioca, sweet potato, greater yam and colacasia were grown during different seasons. The native fruit trees of *Pandanus* spp., *Morinda citrifolia,* and guava were grown in corners of the field. *Sesbania grandiflora* (agathi) and *Gliricidia sepium* were grown as biofence and also used as green fodder and green leaf manure. The livestock component in the present system includes goat or pig (2 numbers) and Vanaraja or local Nicobari fowl and reared under backyard condition. For effective recycling of crop residues compost tanks were made at a corner of the home garden. The droppings of goat and poultry along with crop residues were used for making compost which was applied for growing crops in the homestead garden as there is no scope for external input application.

Data recording: The baseline data was collected before initiation of the work during October–November 2012. After introduction of specific interventions, periodic observations were made on additional income obtained from each interventions, number of piglets, number of goat kids, number of eggs, meat produced, fruit and vegetable production, waste generated from the farm and used for composting, quantity of compost produced, surplus sale produce marketed and income earned. To assess the impact of HIFS, data on other economic as well as social indicators were collected from 20 beneficiaries through structured interview schedule conducted during October–November 2022. The primary data was collected from women of the beneficiary households by interview and discussions with the help of pre-designed structured questionnaire and secondary data from published works, state level statistic publications and also from line departments.

Data analysis: Data was analysed by both quantitative and qualitative approaches. In quantitative method, index of empowerment was divided in to Likert scale. The different categories with respective scale are, 1, No empowerment (0–0.20); 2, Less empowerment (0.21–0.40); 3, Slight empowerment (0.41–0.60); 4, Moderate empowerment (0.61–0.80); 5, High empowerment (0.81–1.0) (Israr *et al*. 2020). The indicators used to measure different dimensions of women empowerment was adopted from Tariq Khan *et al*. (2020) (Supplementary Table 1). Though the women empowerment is measured in four dimensions, in this study only two i.e. economic and social empowerment indices were calculated as they are more pertinent and visible. The specific methodology for calculating the different empowerment measures are as follows

Women economic empowerment index (WEEI): Economic empowerment pertains to access to economic resources, such as income, assets, savings and exercising control over these resources. This study used indicators such as income, asset generation, consumption expenditure and savings for measuring economic empowerment as below:

$$\text{WEEI} = [\sum_{i=1}^{6} \text{Xi}]/6$$

where WEEI, Women economic empowerment index; X_1, Independent income; X_2, Independent savings; X_3, Asset generation; X_4, Control over household income; X_5, Control over household savings; X_6, Control over household purchases.

Women social empowerment index (WSEI): The social empowerment of the women of beneficiary households was calculated as:

$$\text{WSEI} = [\sum_{i=1}^{4} \text{Xi}]/4$$

where WSEI, Women social empowerment index; X_1, Visit to friends or relatives; X_2, Visit to market, bank or

hospital; X_3, Respect or status within and outside family; X_4, Interaction with outsiders or officials.

Statistical analysis: In order to analyse the impact of IFS interventions on two major dimensions of empowerment, paired t-test analysis was done for each indicator and also for indices to compare the status of women before and after interventions. The analysis of the primary data has been performed in MS-Excel software.

Qualitative evidence: In addition to calculating indices, qualitative approach has also been employed in the present study with a view to get more clear insights and understanding on the impact of integrated farming system interventions on women empowerment. In the present study, case study approach has been mainly employed by conducting unstructured interviews and periodic field data recording of IFS interventions with successful women farmers to get better understanding of women empowerment.

RESULTS AND DISCUSSION

Productivity and increased household income: The results indicated that small scale HIFS system could produce different types of vegetables, fruits, tuber crops, eggs and poultry throughout the year which is more than sufficient to meet the household consumption. The average production of different farm produce from 20 units in 2020–21 is given in Table 1. There was a significant increase in production of various components because of interventions and scientific management of the existing native crops like greater yam, banana etc. The goat was introduced for the first time and found successful in tribal areas because of ease of maintenance. Each household could able to produce a mean of 3 ± 1 kid in a year which is found to be remunerative and highly economical. The provision of night shelter for poultry birds along with introduction of dual purpose Vanaraja breed significantly increased the poultry production from 120–735 eggs/year providing valuable animal protein through meat and eggs to the tribal families. The demand for poultry chicks was quite high throughout the project duration as it significantly improved the cash flow and also played an important role in improving family food and nutritional security especially children and women as reported in several studies (Lowe *et al*. 2021, Singh *et al*. 2022). As the island is known for natural production without any additional external chemical inputs, composting was integrated into the system for residue recycling and sustaining the production of vegetables and fruits within the system. The farmers could produce about 800 ± 160 kg of compost in a year which was used for manuring the crops within the production system.

The HIFS interventions increased the mean tribal household income up to ₹15,000/- per year by sale of surplus farm produce, viz. seasonal vegetables, fruits, egg, poultry, goat kids and piglets from an area of 400 m^2. From the system about 325 kg of seasonal vegetables, 120 kg of greens, 310 kg of tubers, and 290 kg of fruits were produced from an area of 400 m^2, besides around 735 eggs, 3 goat kids and 10–12 piglets from the system in a year. After consumption, the sale of surplus farm produce resulted in additional household income of about ₹15,000/- from the system. The livestock component contributed the major share followed by poultry and crops (Fig. 1). The introduction of goat as a livestock component in addition to pigs played significant role in improving the productivity of the system. Though the tribal households traditionally maintain pigs as a major livestock, the improved production was achieved by introduction of goat rearing along with scientific management including feeding, deworming etc. The importance of goat rearing in enhanced production and empowerment of poor in tribal areas was well documented (Das *et al*. 2022, Sahu *et al*. 2022). The crop and enterprise diversification has provided opportunity for efficient utilization of available farm and family resources resulting in increased household income in tribal areas (Damodaran *et al*. 2017, Singh and Meena 2021).

Table 1 Mean production of different components from small scale HIFS in 2021 (n=20)

Item	Production (kg)/Number per year/ Household	
	Before intervention (2013)	After intervention (2020–21)
Vegetables	35 ± 5	325 ± 50
Green leafy vegetables	50 ± 2	120 ± 25
Tubers	150 ± 25	310 ± 46
Fruits	100 ±12	290 ± 63
Goat kids	0	3 ± 1
Piglets	8 ± 2	12 ± 4
Egg	120 ± 30	735 ± 50
Poultry meat	25 ± 7	63 ± 15
Compost	0	800 ± 160

HIFS, Homestead integrated farming system;.

Impact of HIFS interventions on economic empowerment of women: The economic empowerment was assessed before and after the HIFS interventions. The HIFS interventions significantly enhanced all economic

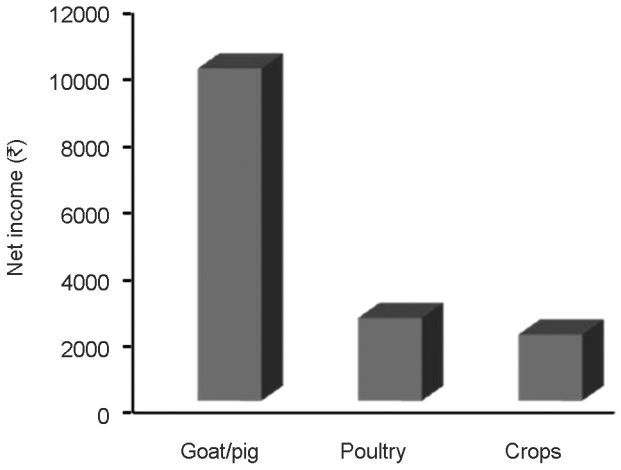

Fig. 1 Mean annual income from different components of HIFS after household consumption (n=20).

Table 2 Impact of homestead IFS on economic and social empowerment in tribal areas of Nicobar Islands

Variables	Index values on Likert scale (0–1)[#]	
	Before (2012)	After (2022)
Economic empowerment		
Independent income	0.035	0.407**
Independent savings	0.025	0.618**
Asset generation	0.019	0.502**
Control over household income	0.013	0.5**
Control over household savings	0.289	0.371**
Control over household purchases	0.149	0.222**
Women economic empowerment index	0.088	0.437**
Social Empowerment		
Visit to relatives or friends	0.085	0.133**
Visit to market, banks or hospital	0.226	0.268ns
Respect or status	0.061	0.313**
Interaction with outsiders or officials	0.02	0.399**
Women social empowerment index	0.097	0.278**

[#]paired t test was carried out on individual index comparing the respective values before and after intervention, then cumulative index of WEEI and WSEI was calculated.

indicators resulting in overall economic empowerment of tribal women (Table 2).

The women economic empowerment index has increased significantly from 0.088 (no empowerment)–0.437(slight empowerment) by the interventions indicating that the interventions have provided means for financial independence for the tribal women. The tribal women were mostly homemakers and had no or limited opportunity for earning their own income. The interventions carried out in HIFS provided means for the tribal women to actively engage in their own backyard by raising seasonal vegetables, tuber crops, fruits, poultry, goatery etc. As these activities are carried out mostly by women, major share of the proceeds from sale is taken by themselves which is used for savings, purchase of household assets etc. The surplus production beyond the home consumption helped these women in gaining higher bargaining power in their household (Dupuis *et al*. 2022). This independent income generation had provided opportunity for them to have improved control over family income, savings and household purchases. Similar reports of enhanced women empowerment through interventions like livestock farming, integrated farming system were reported (Verma *et al*. 2022, Nath *et al*. 2024).

Impact of HIFS interventions on social empowerment of women: All the social empowerment indices except visit to market, banks or hospital showed significant improvement indicating women empowerment in social dimension as well. The financial independence attained through HIFS increased their mobility comparatively. This was possible because of enhanced bargaining power, negotiation skills with other family members. Moreover, the confidence gained through various capacity building programmes and their frequent interaction with scientists and officials from line departments helped them to come out of their confinement. This increasing mobility will further enhance their autonomy and improve their communication skills (Nath *et al*. 2024). The success of these women enhanced their status in the tribal community as a role model and they act as a link between the tribal society and government officials or outsiders. It is also observed that these women influence their peer group in adopting scientific interventions and success of many extension activities. The on farm production of seasonal vegetables, fruits, egg and poultry in HIFS not only provided the tribal women much needed financial independence leading to economic and social empowerment but also significantly improved the household nutritional security.

Qualitative evidence-report from case studies: The women participation and their empowerment was observed during the study period. One such success story is presented here along with brief narratives.

Miss Margret is one such beneficiary who is a resident of Kinmai village, Car Nicobar. She has a family of five members including her husband and three children. The family owns a *tuhet* garden of 1500 m^2 where coconut plantation is found and 500 m^2 of home garden in her backyard. Her husband was a wage labour. Her family dependent on his labour income, harvests from coconut plantation which was more erratic and low. The annual income from the above sources was only ₹1,25,000/-. The essential food items, viz. rice, wheat, pulses and oil are provided through monthly ration by the government. She is a home maker and had no opportunity for income generation on her own. She grows some seasonal vegetables for home consumption in her backyard. The family diet and nutrition mainly depends on native vegetables like tapioca, greater yam, fish collected from coastal areas. The family dietary pattern was poor with major consumption of tubers while protein, fat and other nutrition requirement is limited due to non-availability and higher costs.

After much convincing she adopted the farming system model in her home garden. Initially, she was guided to prepare compost by collecting all the farm and kitchen waste. During the project period, training programmes were conducted for composting, scientific cultivation of different vegetables, fruits, nutritious kitchen garden, backyard poultry farming, goat, pig farming and post-harvest processing and value addition of tuber crops, coconut etc. She actively participated in all the training programmes and carried out the farm activities with guidance and supervision of scientists from ICAR-Krishi Vigyan Kendra (KVK), Nicobar. The interventions carried out significantly increased the production of vegetables, fruits, tubers, meat and egg.

Table 3 Mean production of different components in HIFS (2019–21)

Item	Mean yield and/or sold (kg)/ year/400 m^2		
	Production	Quantity sold	Additional income (₹)
Vegetables[1]	350	220	4400
Green leafy vegetables[2]	170	85	850
Tubers[3]	350	200	4000
Banana	220	50	1000
Pineapple	30	0	0
Kids[4]	4	4	10000
Egg (number)	670	175	1750
Chicken meat	150	-	-
Total income	-	-	22000

[1]Bhendi, Brinjal, Lobia, Bitter Gourd, Sem, Pumpkin, Radish; [2]Amaranthus and Sesbania (Agathi), [3] Tapioca, Greater yam and Sweet potato; [4]Goat kids.

From this intervention, she has earned around ₹22,000/yr from an area of 400 m^2 in 2021 as additional income by sale of goat kids, poultry birds, eggs and surplus vegetables after meeting her family needs (Table 3). She was able to produce about 750–800 kg of compost which was used for production of vegetables with the system.

After self-consumption, the surplus was sold out or shared with neighbours. This intervention helped her to earn her own income and provided much needed financial independence though to a smaller extent. She used this income for purchasing dress and other household items for important festivals like Christmas and New Year without any financial support from her husband. She helped her family in getting nutritional requirement by on farm production of vegetables, egg and poultry, which is otherwise a costly proposition for their family. The interaction with outsiders during the period helped her gaining confidence and she actively participated in training programmes organised by KVK, ICAR-Central Island Agricultural Research Institute and line departments on various aspects. For the first time she travelled to Port Blair, the capital city of Andaman and Nicobar Islands for participation in Kisan Mela and it was followed by several visits for training and capacity building programs. The financial independence provided her enhanced mobility and helped her in increasing the frequency of visits to friends, relatives even in other islands. By her success, she is able to convince her fellow women in her *tuhet* to adopt new initiatives.

A small scale Homestead Integrated Farming System (HIFS) encompassing home garden, livestock and poultry can be a promising path in improved livelihoods, enhanced income for achieving economic and social empowerment of women in tribal, remote and isolated areas as in Nicobar Islands. These interventions helped the women in having their own income, helped them in gaining control over family income, savings, purchases and asset generation to some extent. The overall women economic empowerment has enhanced from nil to slight degree on Likert scale. Boosted by this economic empowerment, the interventions also helped the women in improving social empowerment indicators. Multiple factors such as increased awareness, knowledge, extension contact, and training, positively influenced the tribal women and played a significant role in their economic and social empowerment.

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