Ensuring Food and Nutrition Security through the Promotion of Agrobiodiversity in the Semi-arid Region of Maharashtra:

An Action Research

WOTR-Working Paper

Authors

Anuradha Phadtare, Prithviraj Gaikwad, Sourya Das, Mayurkumar Deshmukh, Ajit Jadhav, Priya Sinha

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Abstract:

Hunger, malnutrition and food insecurity are among the most urgent challenges faced by India's people. This sad state of affairs is caused by several reasons including land degradation, water scarcity, climate variability, and a lack of awareness about nutrition. Considering the high rates of malnutrition in India, an action-research study was conducted in three locations in the semi-arid region of Maharashtra to address food and nutritional insecurities. Villages were selected for the study from among those where watershed development and improvements to soil health were implemented in the past with financial support from GIZ and BMZ. A set of interventions was initiated for this action research, including agrobiodiversity assessment, generation of awareness on food and nutrition, crop planning, multi-layer farming, hemoglobin assessment, monitoring growth of children, and food demonstration. A small fraction of households from two project villages per district were selected to benefit from the interventions. Another group of households was also selected as the control or comparison group, which did not receive these inputs. The main objective of the study was to determine the impact of agriculture, food, and nutritional security (Agri-FNS) on the diet and health of the targeted farmers. Moreover, the economic benefit of multi-layer farming interventions was also assessed. A quasi-experimental research design was adopted.

The study results suggest that the intervention group's dietary diversity score and hemoglobin level increased significantly over the control group, which speaks of the quality of interventions. Many villagers (residents of the villages where the interventions were carried out) were interested in activities like multi-layer farming and crop planning. Multi-layer farming was found to be economically viable. Most of the farmers in the intervention group expressed their satisfaction with Agri-FNS interventions, and were interested in participating in future FNS activities.

Keywords:

Food and Nutrition Security (FNS); Agrobiodiversity; Semi-arid; Anemia

Acknowledgment:

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Introduction

Hunger and food insecurity are among the most severe socio-economic crises in the developing world. Food security has four main dimensions—availability, access, utilisation, and stability. The nutritional dimension is one of the main aspects of food security (CSF, 2014). Unfortunately, thousands of people in the developing world suffer persistently due to food unavailability. There are several causes for this sad situation—poverty, vulnerability to shocks like climate and market, socio-economic disparity, degradation of land resources, and the loss of agrobiodiversity (Ashley, 2016).

India stood 102nd among 117 countries as per the Global Hunger Index in 2019 (GHI, 2019), faring worse than some of the most underdeveloped countries of Asia and sub-Saharan Africa like Tanzania, Rwanda, Mali, Ethiopia, and Namibia. According to the 2011 HUNGaMa report, 42.3 percent of children in India under five years of age are underweight, 58.8 percent are stunted, and 11.4 percent are "wasted" (Naandi Foundation, 2011). Some of the reasons leading to hunger, malnutrition and food insecurity in India are poverty, illiteracy, poor hygiene, unemployment, overcrowding, lack of women's empowerment, patriarchy, climate change, and decline in crop diversity (Upadhyay and Palanivel, 2011).

Despite being a major contributor to India's GDP, Maharashtra also has a high prevalence of under-nourishment. The National Family Health Survey-5 (NFHS-5) report suggests that the prevalence of anemia in the state has worsened since the NFHS-4 (Bramhankar and Gaikwad, 2020). Empirical evidence suggests that anemia is common in adolescent girls in different parts of Maharashtra (Deshmukh et al., 2008; Ahankari et al., 2017; Bharti et al., 2019). Anecdotal evidence from the work of WOTR during a women's empowerment project suggests that creating awareness, promoting multi-layer farming, and food demonstration helped reduce anemia in the target group. This experience provided a starting point for the current study and its design.

In this study, we attempt to make a comprehensive assessment of the effect of agriculture and FNS intervention on the diet of individuals in the semi-arid region of Maharashtra, India. WOTR implemented a project titled "Soil Protection and Rehabilitation of Degraded Soils for Food Security in India" in twenty-one villages located in three agro-ecological regions of Maharashtra to promote agricultural productivity by improving soil health. Six of these twenty-one villages were selected for this study to assess the efficacy of the agriculture, food, and nutritional security (Agri-FNS) intervention on the diet and health of the individuals, with the following specific objectives:

1. To assess the impact of the Agri-FNS intervention on:
    a. the individuals' dietary diversity
    b. the hemoglobin status of the individuals;
2. To assess the economics of the multi-layer farming carried out by the intervention group.
3. To assess and analyze the community's opinion on the efficacy of the Agri-FNS project and the scope for future continuation and promotion.

Methodology

1. Study Design

A non-equivalent group design type of quasi-experimental research was used in this study. Three different agro-climatic zones were selected, the details of which are provided in the next section. Two villages each were from the three agro-climatic zones where the Pro-Soil project is being implemented, which covers a total of 21 villages. In all 21 villages, watershed management was implemented earlier. For the FNS action research project, 25 farmer households were selected from the 2 villages in each cluster, with whom we interacted over two years (September 2019 to August 2021). In the same villages, another 25 households were selected as a control group. A combined total of 300 households of both the intervention and control groups from the 6 study villages were involved in the study. The difference-in-difference (DID) or double-difference method was used to assess the impact of the Agri-FNS intervention.

2. Description of Study Area:

The study was undertaken in six villages in three districts of Maharashtra—Ahmednagar, Jalna and Dhule. In these districts, WOTR was implementing the "Soil Protection and Rehabilitation of Degraded Soils for Food Security in India" project. The administrative jurisdiction and agro-climatic zones of the villages are given below:

Table 1. Number of households and locations of the study villages

Village	Number of households*	Taluka	District	Agro-climatic Zone
Kutewadi-Bhangadewadi	347	Parner	Ahmednagar	Western Maharashtra Scarcity Zone
Hivre Korda	407			
Deulgaon Tad	186	Bhokardan	Jalna	Central Maharashtra Plateau / Assured Rainfall Zone
Chandai Tepli	295			
Pimpalpada	220	Sakri	Dhule	Transition Zone 2
Mohgaon	281			

(Population Census of India, 2011)*

Demographics and soil type of study region:

Ahmednagar district

The area of Ahmednagar district is 17,410.91 sq. km., which is 5.66 percent of the total area of Maharashtra state. In terms of area, Ahmednagar is the largest district in the state. According to the 2011 census, Ahmednagar district has a total of 242,96,607 households adding up to a population of 45,43,159, out of which 22,00,334 are females and 23,42,825 are males. Ahmednagar district has 19 towns and 1584 villages spread over 14 talukas. The Parner taluka has 134 villages (Census 2011).

The soils in the district can generally be classified into three groups—black or *kali*, red or *tambat*, and laterite and grey of inferior quality locally known as *barad,* including white or *pandhari*. Of these, barad soils have very poor fertility.

Jalna district

The area of Jalna district is 7612 sq. km., which is 2.5% of the total area of Maharashtra state. The total population of Jalna district is 19,58,483, of which 15.81 lakh (80.73%) reside in rural areas, and 3.77 lakh (19.26%) in urban areas. There are 390,267 households in the district. Jalna district has eight talukas with 967 villages. The Bhokardan taluka has 158 villages. (Census 2011).

Jalna district has fertile black soil, which is mainly suitable for cotton cultivation. Bhokardan taluka has medium black to sandy-loam soils. Soil depth variation in the district indicates that 36.52% of the soils are shallow, 9.12% are moderately deep, 11.94% are slightly deep, and 14.42% are deep. Kharif is the main cropping season.

Dhule district

The area of Dhule district is 7195 sq. km. which is 2.3% of the total area of Maharashtra state. According to the 2011 census, the taluka has a total of 4,06,329 households and a population of 20,50,862. Of these 9,96,831 are females, and 10,54,031 are males. Dhule district has eight towns and 678 villages spread over four talukas. The Sakri taluka has 225 villages. The percentage of the Scheduled Caste population is 6.2, while that of Scheduled Tribes is 31.6 in the district.

The soil in Dhule district is mainly classified into three types: shallow, medium, and deep fertile. Out of the total land area, 60 percent of soil is shallow, 25 percent is medium shallow, and the remaining 15 percent is deep. The shallow soil is mainly found in the western part of Dhule and in the Sakri taluka. This soil is suitable for the cultivation of pearl millet, sorghum, and groundnut.

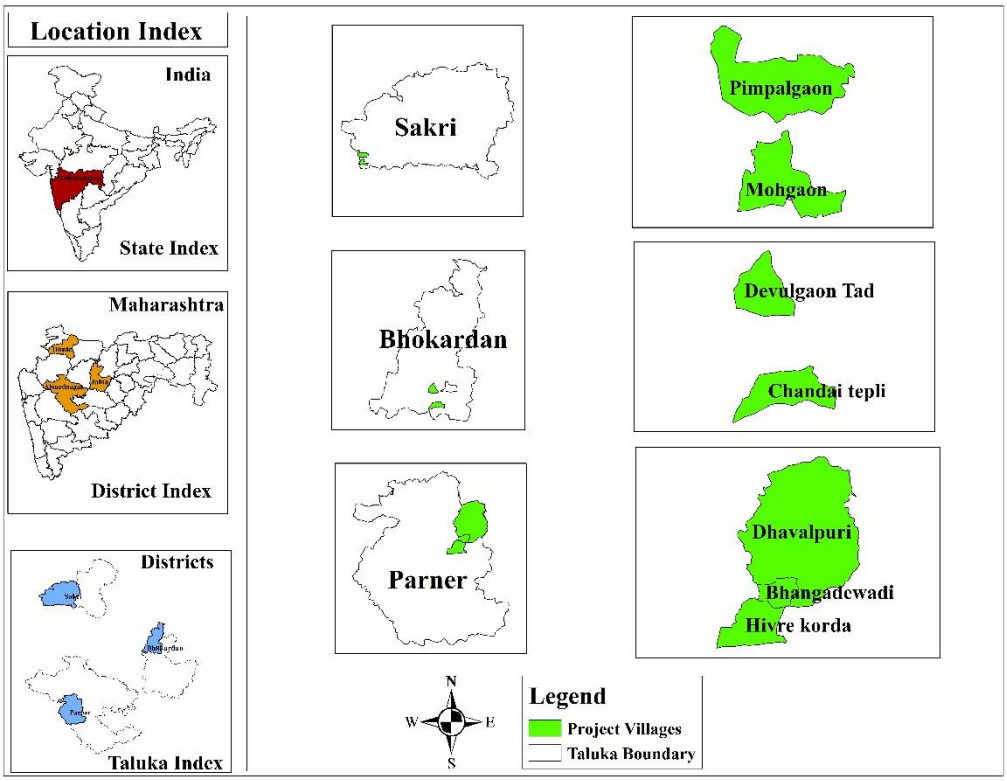


Fig. 1 Location map of the study area

3. Ethical Considerations

Written consent was taken from every household and individual participating in the study at every stage of the field investigation. After data collection, codes were used to replace the participants' names to maintain anonymity.

4. Interventions

The action-research project was designed with several activities to improve the health of the people in the project through the cultivation and consumption of nutritious food without hampering the economic condition of the households. The activities included: exploring community knowledge of the local agro-biodiversity, awareness generation, food demonstration, capacity building, and crop planning. Details of each activity and the logical framework are given in Table 1:

Table 2. Intervention plan for Food and Nutrition Security (FNS) action research with expected outputs

Key Issues/ Objectives	Project Activities Related to FNS
1. To identify the agro-biodiversity along with the package of practices performed by farmers 30 years earlier	- Key informant interviews to collect data on the indigenous crop varieties - Data to be used for crop planning and for preparation of the report - Agro-biodiversity data for protection of endangered varieties and search in other villages for the vanished varieties. - Promote awareness among farmers about agro-biodiversity through meetings, exposure visits, audio-video documentaries, and games
2. Promote knowledge on nutrition and health literacy in the community, particularly among small and marginal farmer households, to ensure food and nutrition security	- Empower and build the capacities of villagers about food and nutrition security, to grow indigenous varieties of crops along with the **PoP**[1] - Seasonal crop planning based on water availability and food crop requirements for the household: cereal, pulses, vegetables, oilseed, as well as fodder for livestock with a preference for local/indigenous varieties; - Building the capacities of farmers for application of good practices for the respective crops; which includes soil nutrient assessment and promotion of integrated nutrient and pest management. - Implementation of kitchen garden and multi-layer farming to ensure vegetable, tuber, and fruit consumption in the daily diet - Knowledge dissemination regarding a balanced diet through food demonstrations, trainings, meetings, and exposure visits; the preparation and consumption of nutritious foods to meet the needs
3. Improve the nutrition status of the community with indications of sustainability	- Monthly growth monitoring of children of 0-5 years of age - Hemoglobin assessments of all villagers - Build the capacities of Farmer Producer Organizations and local institutions to promote food and nutrition security models among their members to ensure continuity and replicability.

[1] PoP Package of practices for respective crops

Activities Implemented in the Study Villages

a) Crop Planning for Promotion of Indigenous Varieties:

In 2013, WOTR tested the willingness of 50 farmers in 2 villages in Maharashtra to promote the cultivation of indigenous crop varieties for food security on small farm plots, while allowing the cultivation of market-driven crops on the rest of the farmer's land. One was a tribal village and the second a caste-community village. It was found that approximately 50% of the experiment group continued with the practice years later. This was documented in an article titled, "Crop planning, a tool for climate-resilient food system", published in LEISA India (Phadtare, 2017). Based on this experience, WOTR applied the same methodology while implementing the current project. At first, data was collected on indigenous crop varieties, their behavior in different weather conditions, as well as their perceived nutritional benefits. This information was used in plot-wise crop planning and implementation of the package of practices (PoPs) with maps. The plots were geo-tagged to document the food grain as well as cash crops grown (Fig 2):

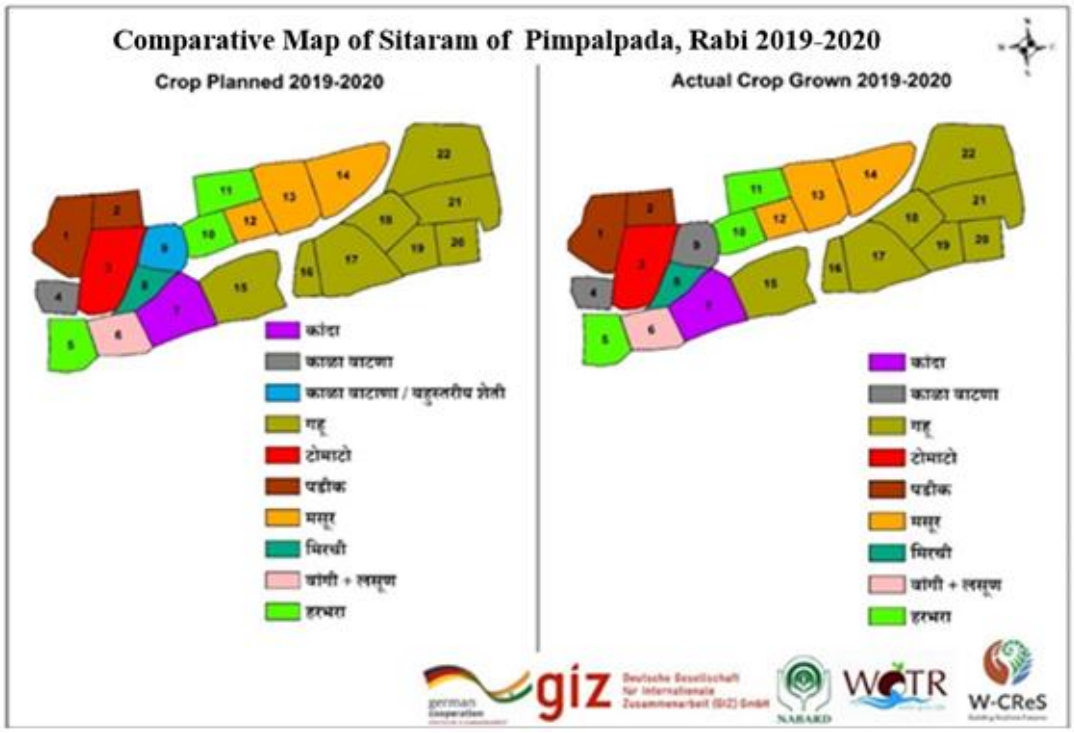


Fig. 2 Comparative crop map of Sitaram (name changed) showing crops planned and actually grown in the 2019-20 rabi season

Crop planning was done based on food and nutrition requirements for the household. Based on the economic, food, and nutritional needs, we promoted a variety of crops like cereal, pulses, vegetables, oilseeds, millets, and fodder crops, giving preference to indigenous and climate-resilient varieties. In addition, farmers were enabled to apply the PoPs for the respective crops, including soil nutrient assessment and the promotion of integrated nutrient and pest management. A booklet on the package of

practices was prepared in the local language, and several copies were disseminated among the farmers.

b) Kitchen Garden and Multi-layer Farms:

To meet the need for vegetables, seasonal fruits, and tubers, kitchen gardens and multi-layer farming plots were prepared. Backyard kitchen gardens were prepared and maintained with minimum technical and financial inputs.

Fig. 3 Multi-layer farming

Various types of vegetables, pulses, and fruits are grown in multi-layer farm plots. The design is such that it also meets complementary needs: it provides shade canopy and litter as well as increases the moisture-holding capacity of the soil while nurturing microflora. The crops have different lifecycles—some die off and need to be replaced, while others are of longer duration. Some act as trap crops and prevent pest attacks. Vegetables and fruit crops grown in multi-layer farms using the organic and integrated method are rich in vitamins, minerals, protein, and carbohydrates. The plan ensures the year-round availability of leafy vegetables, roots, tubers, and fruits through the multi-layer farming method. The exact process and the layout are provided in the Annexure.

c) Capacity Building and Interventions for Improving the Nutrition Status:

Different methods like meetings, exposure visits, and audio-visual tools were used to create awareness regarding the importance of nutrition and build the capacities of the people, particularly women, on how to meet their food and nutrition security needs. Women, adolescents, and children were important participants. Campaigns were

conducted to disseminate the importance of food and nutrition security through rangoli[2], drawing, rallies, and discussions.

Fig. 4 Capacity-building exercises with the community

d) Food Preparation Demonstration:

Women participants were given demonstrations on preparing nutritious recipes using locally available and affordable ingredients. They were taught step-by-step recipes and were given information on the nutritional benefits of the ingredients. Some recipes were traditional though with modifications, while others were new. Learning different recipes through food demonstrations helped the mothers to be creative in maintaining a balance between taste and nutrition.

Fig. 5 Food demonstration

e) Nutrition and Health-related Interventions:

The *Mahila Pravartak* (women promoter) was responsible for monitoring the height and weight of children of 0-5 years, together with the Anganwadi workers. They categorized the children according to nutritional standards (WHO criteria). The *mahila pravartak* also guided the parents of malnourished children to improve their nutrition intake. Blood hemoglobin (Hb) assessments for all the villagers were done annually. Anemia detection camps were organized, and the improvement was tracked. Those who suffer from anemia were given iron supplements and advice on food intake. The standard Hb range norms were followed.

Finally, WOTR promoted child growth monitoring as an activity to build awareness. In this activity, the *mahila pravartak* recorded the height and weight of every child of

[2] "Rangoli is an art form originating in the Indian subcontinent, in which patterns are created on the floor or a tabletop using materials such as powdered lime stone, red ochre, dry rice flour, coloured sand, quartz powder, flower petals, and coloured rocks." https://en.wikipedia.org/wiki/Rangoli

ages 0-5 years once a month. This was conducted together with the Anganwadi worker. During the activity, parents of malnourished children were provided guidance to overcome malnutrition. Results of child growth monitoring are given in the Annexure.

f) Assessment of Sustainability:

In July 2021, discussions were held with the FPOs to take this initiative to a wider level in order to replicate and sustain the model in other villages.

Data Collection and Methods of Analysis:

This study involved a combined total of 300 households, of which 150 belonged to the intervention group, while 150 were in the control group that participated in the structured interviews. The DDS score was recorded for all individuals in each household. The Dietary Diversity Score (DDS) was recorded for 679 individuals in the control group and 739 in the intervention group of households. Both men and women participated in the interviews with most households. However, for the dietary recall, it is the women who responded.

The impact of these activities is expected to improve the nutritional intake of the target group. Therefore, data on the types of food consumed was collected in both the baseline and end-line by a household questionnaire. A Dietary Diversity Score (DDS) was used to assess nutritional intake. The DDS was calculated for the control and intervention groups of individuals in the baseline and end-line assessments. The difference-in-difference (DID)-regression and descriptive statistics analysis were performed to assess the impact of the Agri-FNS intervention. The average values and counts of different categories have been presented in the form of pie-charts and bar-diagrams.

The difference-in-difference (DID) regression model is used to assess the impact of any intervention in a quasi-experimental study, i.e., in a study where randomization has not been possible. The DID regression model uses the intervention variable as one of the independent variables to assess if the change in the intervention group is greater than that of the control group; and if the change in the intervention group is significantly different. Therefore, it is used to estimate the impact of the intervention (Fredriksson and Oliveira, 2019).

Dietary Diversity Score: One of the major objectives of the Agri-FNS intervention was to increase the diversity of the diet of the individuals in the intervention group so that people start eating food items of varying nutritional value. One of the ways to assess and measure the dietary diversity of individuals is by calculating their dietary diversity score (DDS) (Krebs-Smith et al., 1987; Rathnayake et al., 2012). Based on the household survey of every individual's diet in the baseline and endline (24-hour diet recall for a normal day), data on the diet was analyzed to extract information on the number of food categories the diet covered. We divided the food categories into cereals; pulses; milk and milk products, eggs, fish, and meat; oil and fat; fruits and vegetables containing Vitamin A; fruits and vegetables containing Vitamin C, and other vegetables. When calculating the DDS of any individual, we have assigned a score of 1 for each of these food groups.

Hemoglobin testing camps were organized in each of the project villages to assess the Hb level of the individuals. Using Sahli's method, the Hb test was conducted twice during the project period—during the baseline (September 2019), and the end-line periods (December 2021). The change in the Hb level for both the control and intervention groups has been analyzed by descriptive statistics. A total of 486 participants were present for both the baseline and end-line Hb test, whose data has been used for the analysis. Of these, 216 are from the control households and 270 from the intervention households.

The respondents' opinions were gathered through household interviews on the perceived and actual efficacy of the Agri-FNS activities and their willingness to continue these. Descriptive statistics were used to analyze the data. Cost-Benefit Analysis was done for each of the multi-layer farms (MLFs) to assess their economic viability.

Results and Discussion

The objective-wise results and discussions are given below.

Objective 1a: To check the impact of Agri-FNS activities on the dietary diversity score (DDS) of the intervention group

The dietary recall was collected for 739 individuals in the intervention groups, and 679 individuals in the control groups. At the time of the baseline study, the average DDS of the control and intervention groups were found to be almost the same. However, in the end-line study, the DDS value for the control group decreased slightly, whereas in the intervention group, it increased (Fig. 6). This indicates that while the control group has very slightly lost its dietary diversity, the diet of the intervention group of individuals has become more diverse. During the COVID-19 lockdown and the subsequent turmoil, livelihood and daily transactions were greatly affected, which had an impact on the food and nutrition security of the people as a whole. Families within the villages were cautious about interacting with each other. However, it appears that the intervention group, due to their enhanced awareness and multi-layer farming practices, had the resources and managed to increase or maintain the DDS.

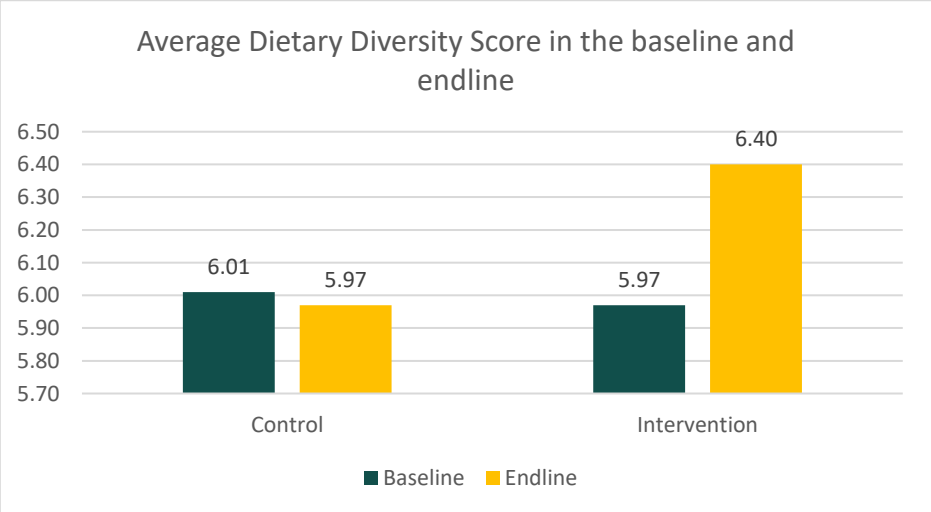


Fig. 6 Average DDS of households in the control and intervention groups

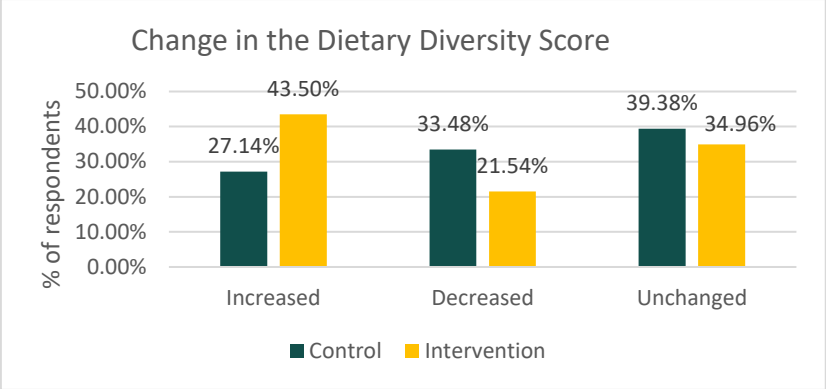


Fig. 7 Percentage of responses on the change in the DDS

Fig. 7 shows an increase in the DDS of 27.1 percent in the control group and 43 percent in the intervention group. The DDS of 33.5 percent of individuals in the control group has decreased from the baseline period, while the corresponding value for the intervention group is 22 percent. Those who have maintained the same DDS are 39.4 percent of the control and 35 percent of the intervention group. The result indicates an improvement in the intervention group as compared to the control group.

The DID regression has also been used to understand the statistical significance of the change in the two groups. We have found (Table 3) that the model is significant with Probability>F at 1 percent or less, with the interaction effect positively significant at the level of 1 percent. These results indicate that the DDS of the intervention group increased significantly over the change in the control group.

Table 3. DID regression model of the determinants of the DDS

Source	SS	df	MS	Number of obs	=	2,838
				F(3, 2834)	=	26.45
Model	95.9696325	3	31.9898775	Prob > F	=	0.0000
Residual	3427.18364	2,834	1.20930968	R-squared	=	0.0272
				Adj R-squared	=	0.0262
Total	3523.15328	2,837	1.24185875	Root MSE	=	1.0997

DDS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
T	-.0397119	.0584364	-0.68	0.497	-.154294	.0748703
EL	-.0397059	.0596389	-0.67	0.506	-.1566458	.0772341
Int	.4700171	.0826415	5.69	0.000	.3079735	.6320607
_cons	6.005882	.042171	142.42	0.000	5.923193	6.088571

The change in the Dietary Diversity Score

The highest DDS value for an individual is 9, whereas the lowest theoretically possible DDS is 1. Therefore, we have grouped the DDS into four categories: category 1—DDS 1 to 4; category 2—DDS 5 to 6; category 3—DDS 7 to 8, and category 4—DDS 9 and above.

Figs. 8 and 9 show the percentage of individuals in the control and intervention groups under different DDS categories for the baseline and end-line periods. In the control group (Fig. 8) there is an improvement in the DDS by 1.2 percent in both category 3 (DDS 7 to 8) and category 4 (DDS of 9 and above), while the DDS has reduced, as is noted in the 6.8 percent increase in individuals consuming fewer food types as compared to the baseline in category 1 (DDS up to 4). In the intervention group (Fig. 9) there is an increase of 18.3 percent and 2.7 percent in categories 3 and 4 respectively which indicates a positive shift, while 2.3 percent have reduced DDS as is observed in category 1. The findings of the DID regression model indicate that more individuals in the intervention group achieved higher DDS scores in the endline.

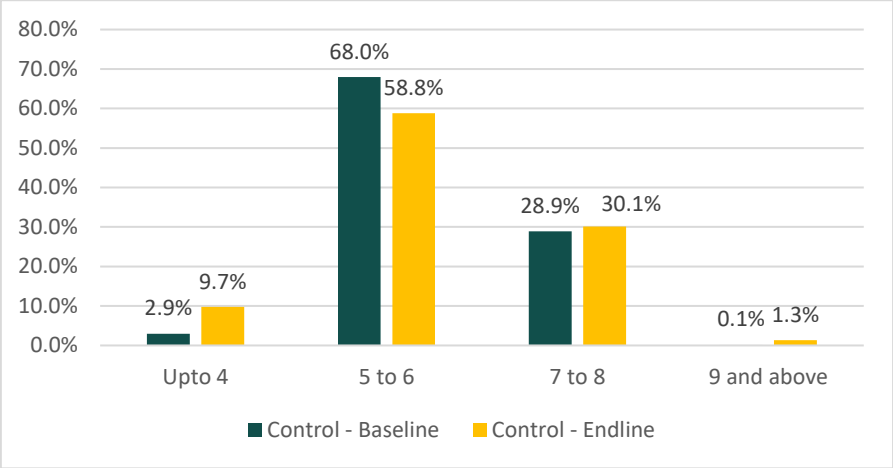


Fig. 8 Percentage of control group individuals in the different DDS categories in the baseline and endline periods

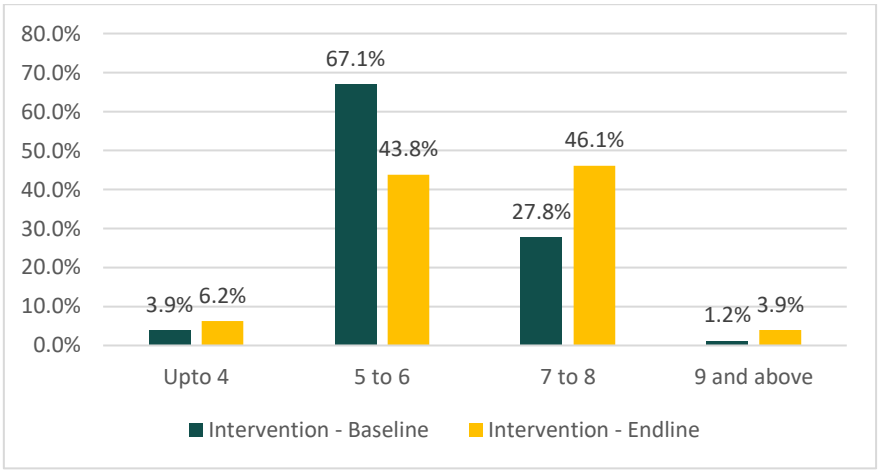


Fig. 9 Percentage of the intervention group individuals in different DDS categories in the baseline and endline

At the start of the project (baseline), the dietary consumption is somewhat similar, with most individuals falling into categories 2 and 3. In the combined total for categories 2 and 3, in the control group, 97 percent fall in these categories, while in the intervention group, 95 percent fall in the same categories (Fig. 8 & 9). In the interim period of 23 months, the control group dropped by 9.1 percent in category 2, with a marginal improvement of 1.2 percent each in categories 3 and 4. However, following the implementation of Agri-FNS activities, the intervention group improved by an overall 23.3 percent. The comparative change between both groups is observed in Fig. 10.

While the project period for the Agri-FNS interventions was from September 2019 to August 2021, the activities for the intervention group could only be implemented between September 2019 and mid-March 2020 due to the lockdown restrictions of the pandemic. Visits of the field staff were reduced to a minimum, and meetings within the village and between households as well as interactions with the market were greatly restricted. All households, villages, and in fact the entire country faced this situation. Yet, it is interesting to note that despite these limitations, the activities implemented appear to have benefited the people of the intervention group.

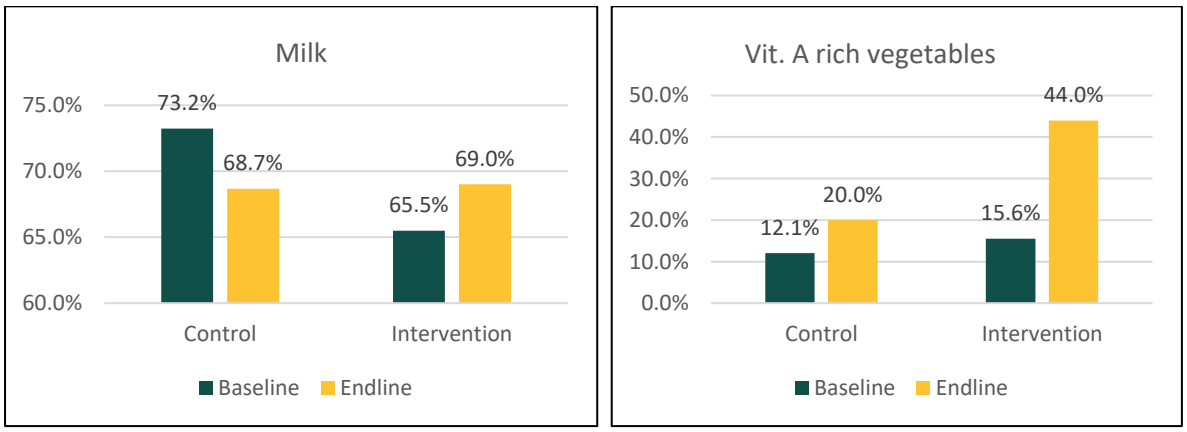


Fig. 10 Percentage of individuals consuming (a) milk and (b) Vitamin A-rich vegetables in the baseline and endline

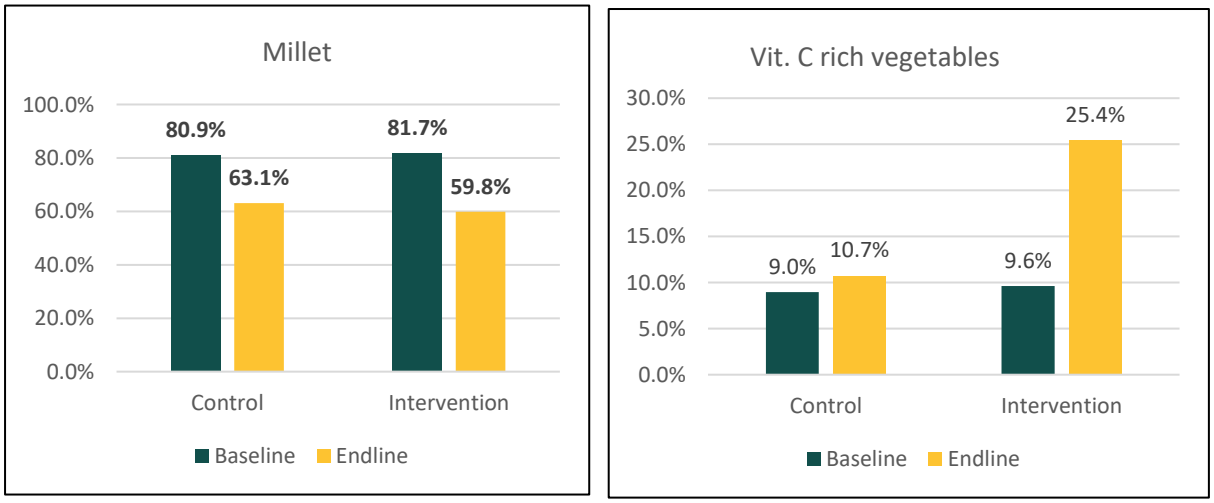


Fig. 11 Dietary consumption of (a) Vitamin C-rich vegetables and (b) millets in the baseline and endline

Considering the change from baseline to end-line in terms of the percentage of individuals reporting the intake of food items under the category of milk, vitamin A, vitamin C, and millets, the control group does not perform as well as the intervention group (Fig. 10 and Fig. 11). A greater percentage of the latter consume milk in the end-line, whereas the percentage is reduced in the control group. There is a sharp increase in the percentage of people consuming foods rich in Vitamin A and Vitamin C in both groups, however, the increase is higher for the intervention group. It is probably the information through the awareness sessions, food demonstrations, as well as the availability of a wider variety of vegetables and food produce cultivated in multi-layer farms that may have helped. The millet and pulse consumption are reduced in both groups, with a slightly greater reduction in the intervention group. Though millet is one of the more important crops, the intervention did not make any effort to popularize millet in place of other cereals.

Objective 1b: To check the impact of Agri-FNS activities on the health status of the individuals

Hemoglobin (Hb) levels of individuals in the control and intervention groups were tested during the baseline (September 2019) and endline (December 2021) periods of the project to assess the effectiveness of the Agri-FNS project on the health status of the individuals. Hb assessment was done for 2561 individuals in the baseline and 1057 individuals in the endline. However, based on the data available for both baseline and endline, we have only considered data from 270 individuals from the intervention and 216 individuals from the control groups, of all ages combined, for both the baseline and the endline.

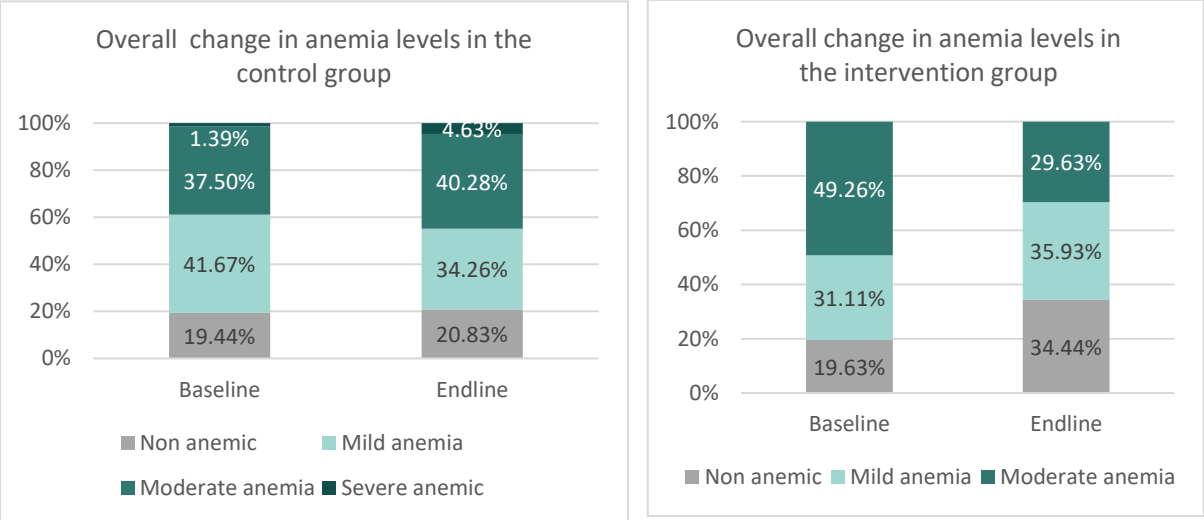


Fig. 12 Overall change in the anemia levels: control (left) and intervention group (right)

It is observed that in the baseline levels, moderately anemic participants in the control group were 37.50 percent of total participants, as compared to 49.26 percent in the intervention group. However, after the implementation of the set of activities, there is a marked improvement in the intervention group: there is a 14.81 percent and 4.82 percent increase in normal and mild anemia, respectively, with a 19.63 percent reduction in moderate anemia, and crucially, no individuals are severely anemic. While in the control group, there is an increase of 1.39 percent of participants in the non-anemic group; however, as compared to the baseline status, there is also an increase of 7.41 percent, 2.78 percent, and 3.24 percent

in mild, moderate, and severe anemia respectively. Overall, the intervention group seems to perform slightly better than the control group.

The data for female individuals are similar to the overall Hb findings at the start (baseline) of the activities, with the Hb levels of the control group being better than those of the intervention group. The control group had 39.81 percent suffering from moderate anemia, with none suffering from severe anemia, while in the intervention group, 67.11 percent of females suffered from moderate anemia. Following the interventions, the percentage of moderate anemia is almost 1 percent lower in the intervention group than that of the control group, with 2.80 percent of individuals in the control group suffering from severe anemia in the endline assessment. The percentage of non-anemic individuals in the intervention group increased by more than 12, while that in the control group was reduced by more than 4.63 percent (Fig. 13). The Hb levels of males in the treatment group at the baseline level were better than those in the control group. At the endline stage, the gap widens as the condition in the control group deteriorates (Fig 14), with 72.22 percent falling in the mild, moderate, and severe categories in the control group, while in the intervention group it is 47.94 percent, with no one suffering from severe anemia.

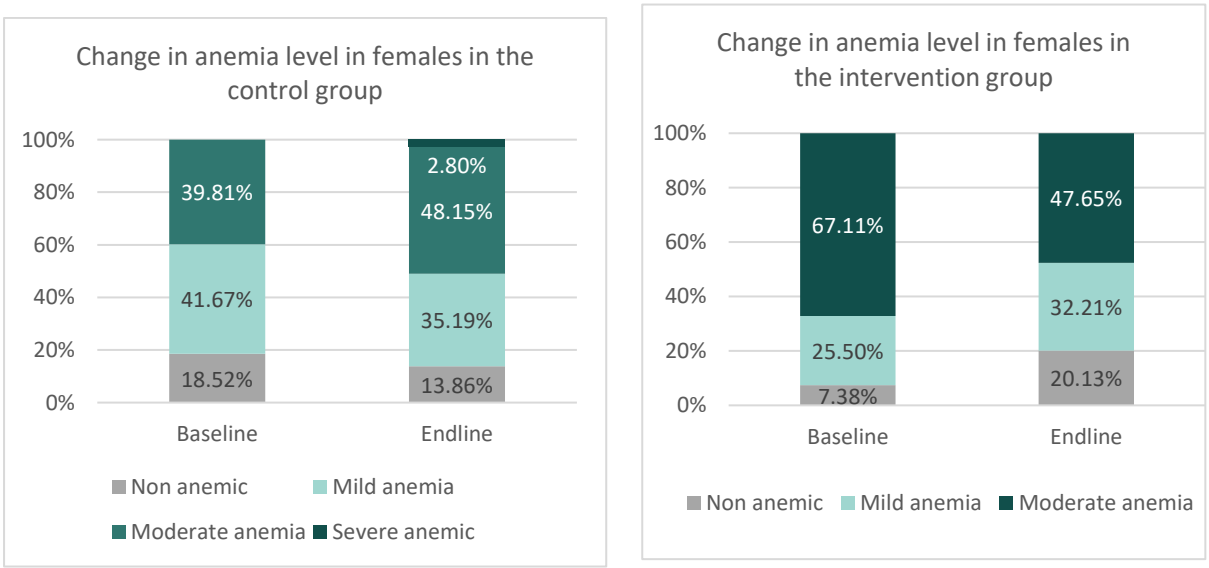
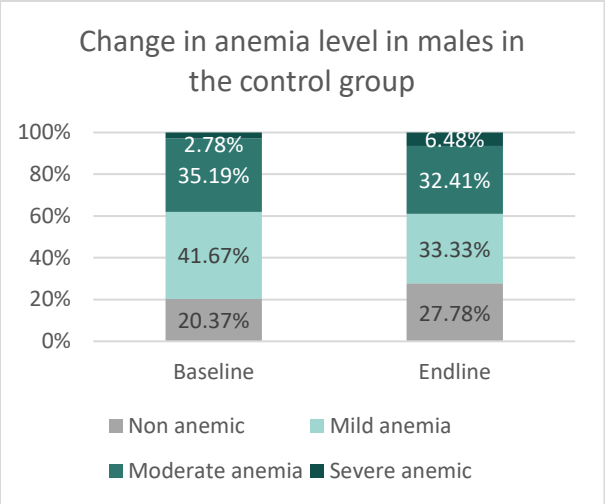


Fig. 13 Change in the anemia levels in females in the control (left) and intervention group (right)



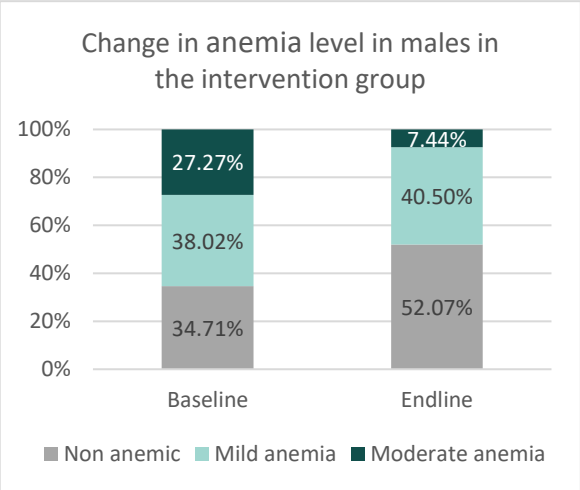


Fig. 14 Change in the anemia level of males in the control (left) and intervention group (right)

These findings clearly show that the activities and interventions such as awareness programs on nutrition, food demonstrations, and access to the various food types through the kitchen garden, multi-layer farming, and crop planning could make a difference in the hemoglobin level. As mentioned above, in the DDS, the intake of vitamin A and C vegetables, milk, and nutritive products were increased in the intervention group. The result is seen in the Hb levels.

It is observed that overall, during the study period, the Hb level of the control group deteriorated from the baseline value, whereas that of the intervention group improved. During the period from March 2020 to the middle of 2021, due to the pandemic and lockdown, both the control and the intervention groups faced hurdles in agricultural production, in terms of access to inputs, purchase, and sale of produce due to market inaccessibility, which had deleterious impacts on income as well as food and nutrition security. However, it appears that Agri-FNS activities, like awareness generation, food demonstrations, multi-layer farming, and crop planning, had a positive impact on the intervention group whose members managed to improve their food and nutrition security, whereas the control group could not.

Reasons for the effectiveness of Hb testing

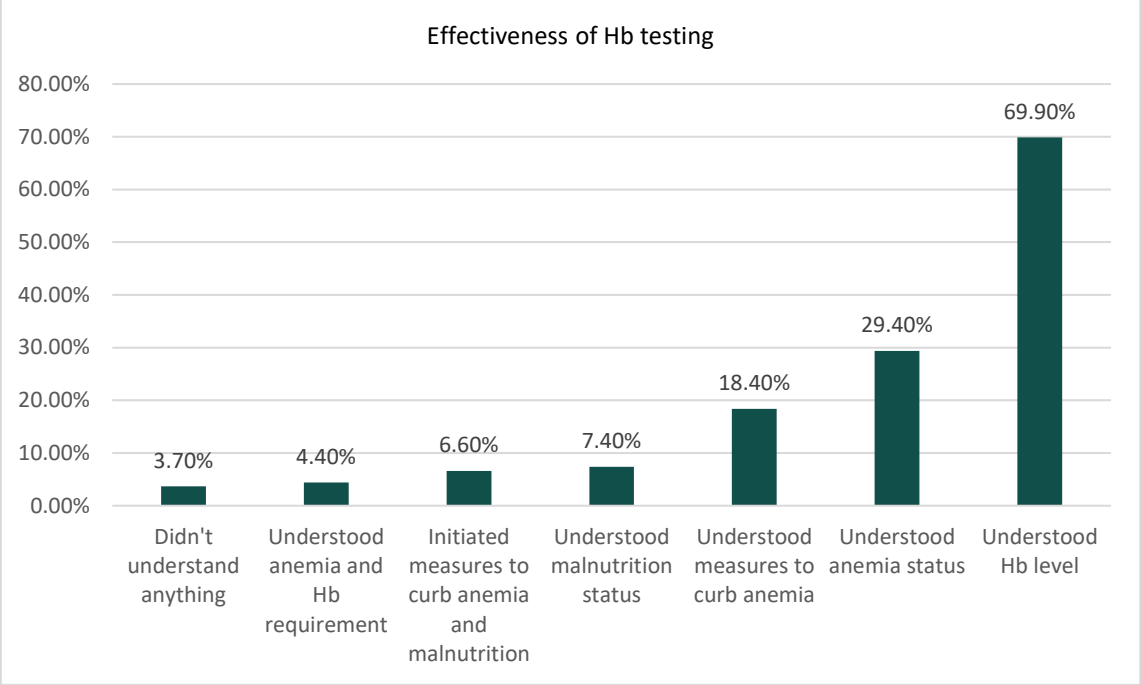


Fig. 15 Opinion of participants of the intervention group about the effectiveness of Hb testing

A total of 150 intervention households participated in the Hb testing. The intervention group participants were asked their opinion regarding the different activities implemented and how they benefited with respect to anemia levels. The above graph (Fig. 15) shows the perception of the participants with regard to the various aspects related to anemia and the Hb testing. While 69.9 percent of households responded that they understood the meaning of their Hb levels, they also expressed the opinion that Hb testing helped to make them aware of their blood Hb level and the standard ranges. Others respondents informed the team that they were guided on how to reduce anemia and malnourishment during the Hb-camp (18.4 percent).

Objective 2: To assess the economics of the multi-layer farm activity in the intervention group

Economic Analysis of the Multi-layer Farms

Considering the life of a multi-layer farm (MLF) as seven years, we have carried out a cost-benefit analysis of each of the 103 households that have installed MLF. Of these 103 households, 70 have been practicing MLF for more than one year, which has been included in the cost-benefit analysis. The other households started multi-layer farming later, and the delay was due to the COVID-19 lockdown, which restricted demonstrations and training. Therefore, in the cost-benefit analysis, the cost includes the installation of the MLF and the economic value of the time invested for its regular maintenance. On the benefit side, the market value of the fruits and vegetables has been used as the benefit. The result of the cost-benefit analysis is as follows:

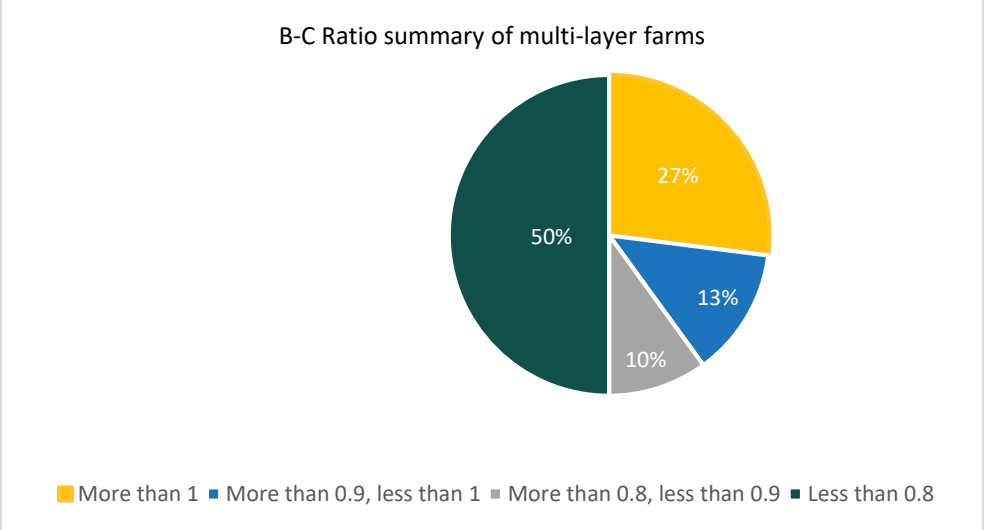


Fig. 16 Pie-chart showing the summary of the B-C Ratio of multi-layer farms

Fig. 16 summarizes the cost-benefit analysis of the 70 households implementing MLFs. The figure indicates that 27 percent of farmers have a Benefit-Cost Ratio (B-C Ratio) of more than 1; while this ratio for 40 percent of farmers is more than 0.9, and for 50 percent of farmers is more than 0.8. A benefit-cost ratio of more than 1 indicates that the benefit from MLF is more than the cost incurred. Despite the fact that only 27 percent of households have a B-C Ratio of more than 1, the results are still encouraging, considering the following facts:

1. During the pandemic, monitoring and handholding support was difficult and very limited. Most of the meetings, training, and agricultural extension activities were conducted in virtual mode or through phone calls. This affected the quality of activities as on-field direct interactions are better.
2. The benefit has been calculated based on the farmers' self-reported value, not the actual market price of the good quality fruits and vegetables. The real market price of good quality fruits and vegetables was unknown to them due to the lockdown, which is generally much higher than the self-reported value. The fruits and vegetables on the MLF are grown with the minimum amount of chemical fertilizers and pesticides.

3. Most of the fruit crops in the multi-layer farm take time to produce fruit; some fruit within a few months, while others may require 2 to 3 years.
4. Due to the lockdown and fear of COVID-19, communication between the project team and the intervention group was severely restricted, which affected the quality of data obtained. Therefore, we assume that other benefits of the MLF were under-reported, as we took a conservative estimate. However, in-depth physical interviews with some of the respondents may have helped to obtain a more accurate estimation of the benefits, which may likely increase the B-C ratio.
5. The value of the discount rate is taken at 8 percent. However, the MLFs have several environmental benefits; therefore, a lower B-C ratio may be accepted.

Overall, the economic analysis is encouraging. Furthermore, most of the multi-layer farmers informed the team that multi-layer farming was beneficial to them (discussed in the next section).

Objective 3: To assess and analyze the community's opinion on the efficacy of the Agri-FNS project and the scope for future continuation and promotion

Participation in the Agri-FNS activities, and response of the participants in the intervention group on the efficacy of the Agri-FNS component

The overall response of the farmers in the intervention group about the Agri-FNS component is positive. A high percentage of participants said that they participated in various activities (Fig. 17). Of the intervention group, only 57 percent of individuals have reported their participation in indigenous crop cultivation and multi-layer farming. We have found two reasons for the low implementation of indigenous crop cultivation. First, most farmers have lost their traditional knowledge of the indigenous crop varieties, and were skeptical about cultivating them, because they believe the productivity is low. In many villages, the indigenous varieties have disappeared. Moreover, the project activities, especially the crop planning and day-to-day support, were also hampered due to the COVID-19 pandemic and lockdowns.

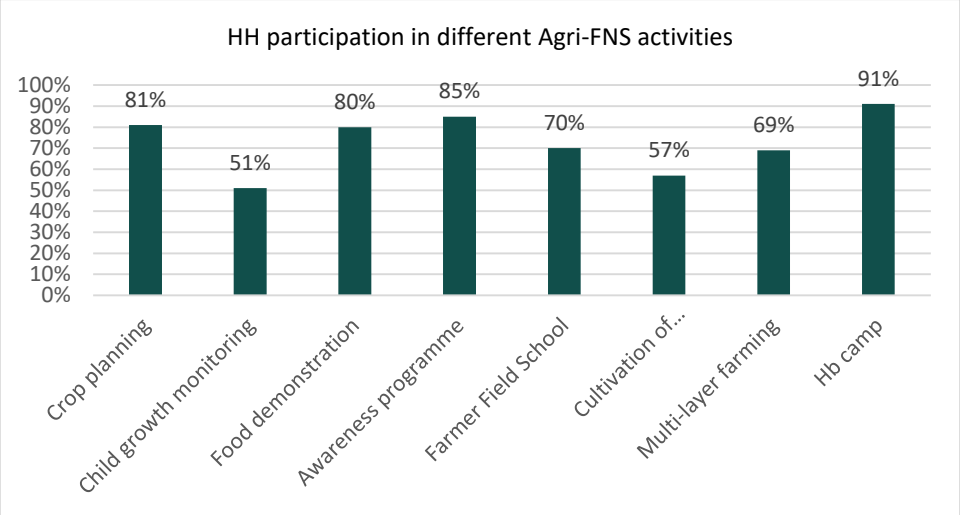


Fig. 17 Percentage of farmers in the intervention group who participated in the different Agri-FNS activities

Most of the households in the intervention group or the project target group replied that they want to continue the activities in the future (Fig. 18), and wish to be part of future promotion in their villages and nearby villages (Fig. 19).

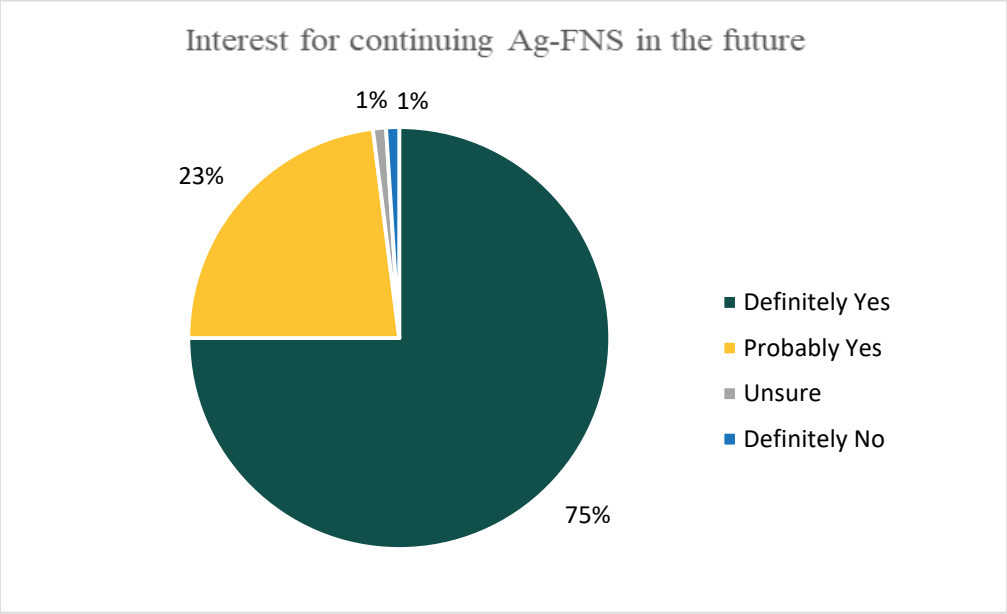


Fig. 18 Households interested in continuing the Agri-FNS activities in the future

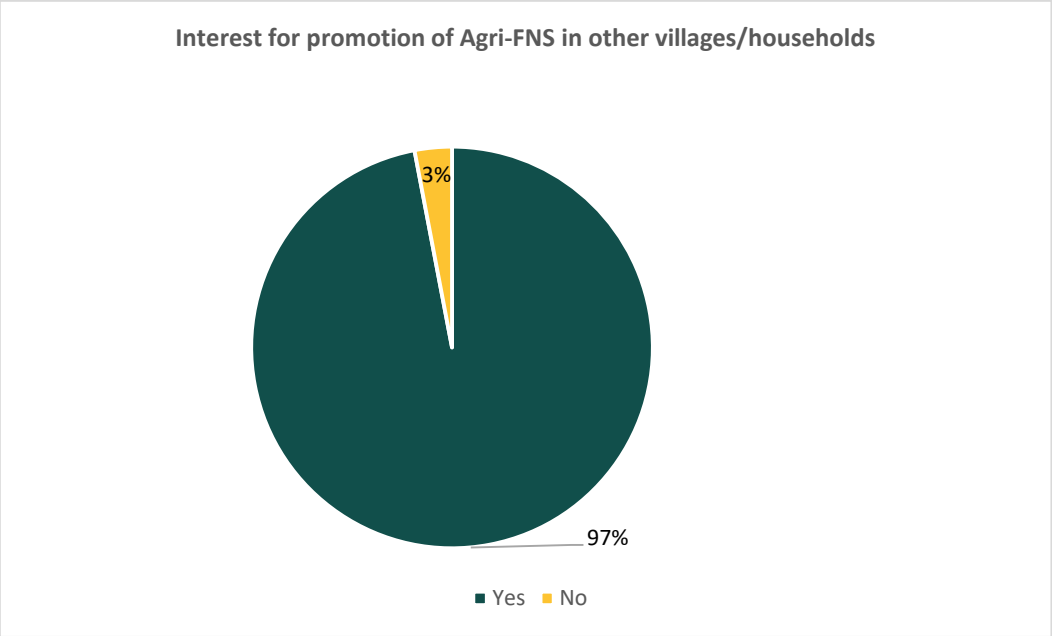


Fig. 19 Households interested in being a part of future promotion

Of the 150 households in the intervention group, 103 (about 66 percent) were constructed. Almost all of them said that multi-layer farming was beneficial and cited different reasons: money saved (which was the opinion of most households), fresh vegetables and more fruit for home consumption, and availability of organic produce (Fig. 20).

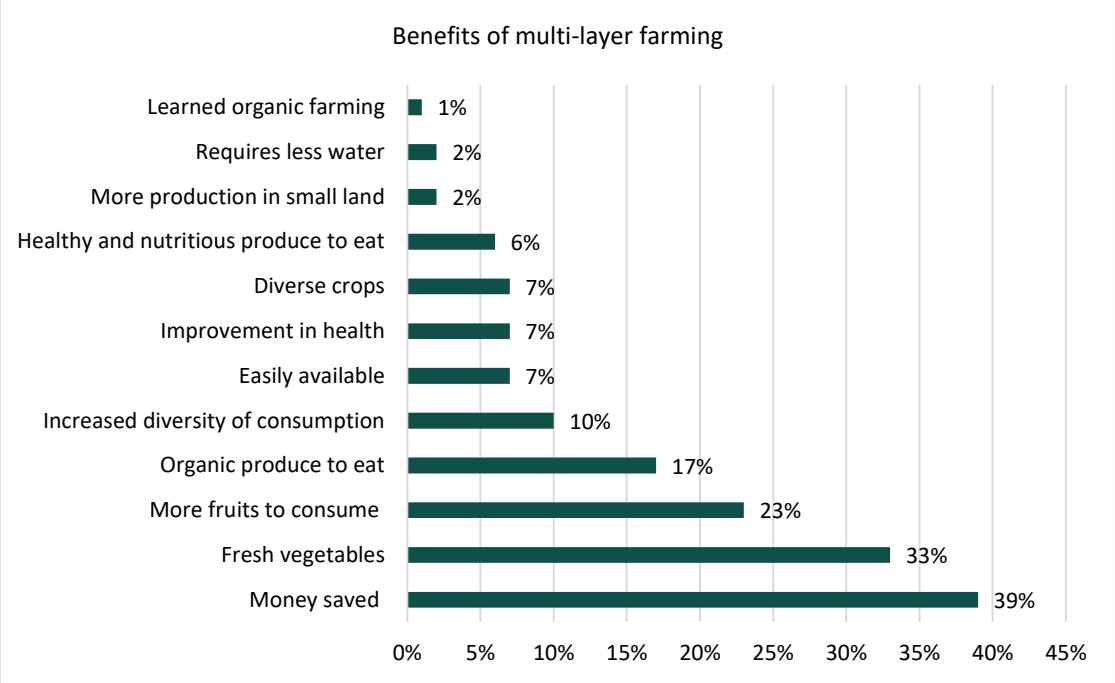


Fig. 20 Opinion on the effectiveness of multi-layer farming by the intervention group

The most prominent feedback (given by 30 percent of the respondents) on MLF was "farmer satisfaction" and that "no change is needed". However, around 12 percent of the respondents indicated that the MLF could be more effective with modifications such as more spacing, fewer crops, and better-quality seeds (Fig. 21).

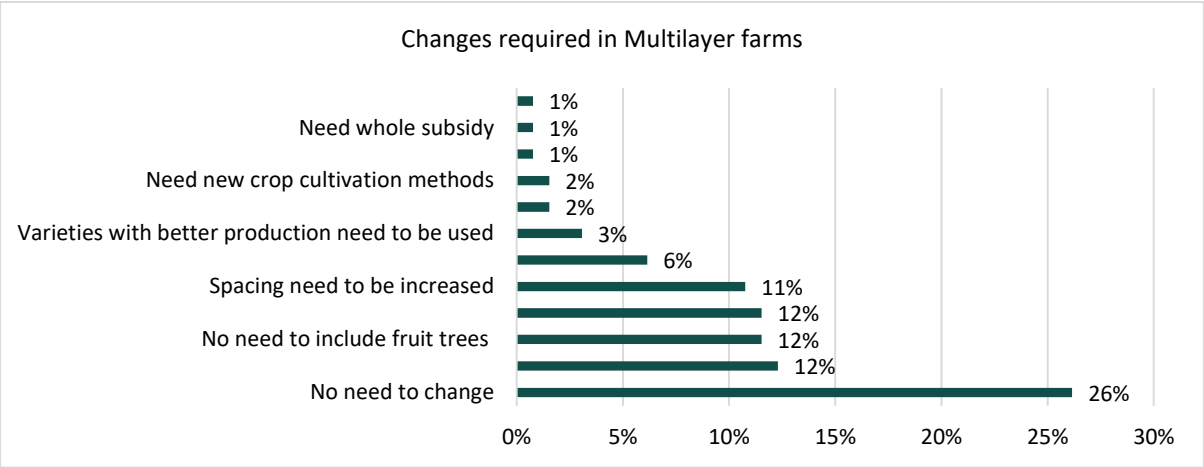


Fig. 21 Suggestions to improve the multi-layer farms by the implementers

We conducted a household survey during the 1st lockdown (from 1st May 2020 to 15th May 2020) among a small sample of the farmers (32 farmers) cultivating fruits and vegetables and a small proportion of the farmers (28 farmers) who were not a part of the Agri-FNS project and did not farm on multi-layer farms. The response of the two groups of farmers is given in Fig. 22, which reflects the efficacy of the multi-layer farm as it helped the FNS farmers consume more fruits and vegetables during lockdown (Fig. 22 and Fig. 23).

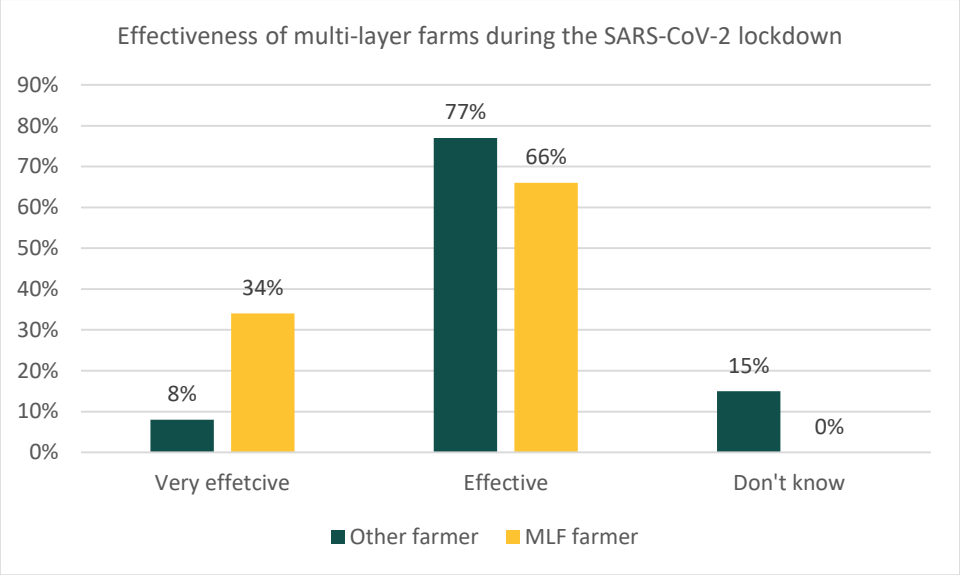


Fig. 22 The effectiveness of multi-layer farming during the 1st lockdown in 2020

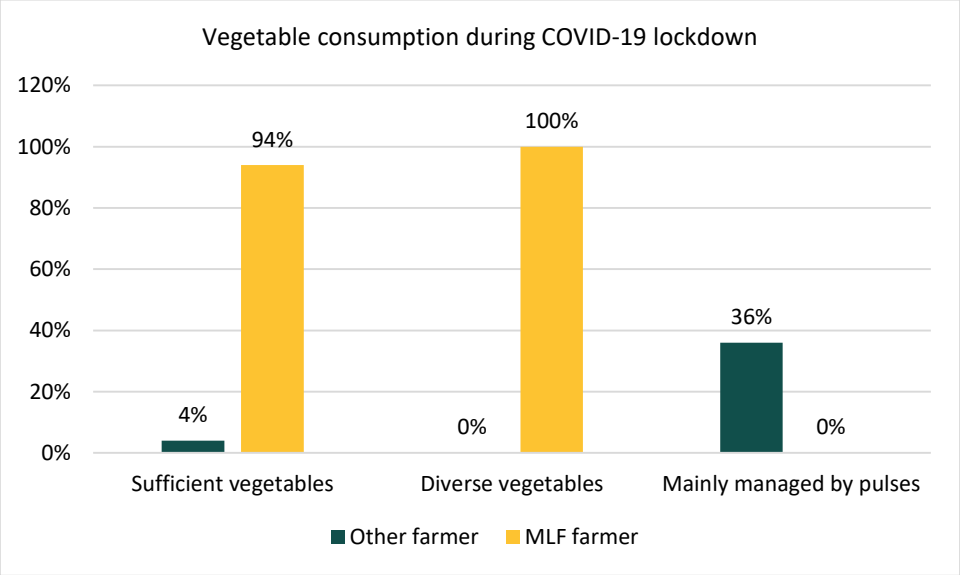


Fig. 23 Opinion on the consumption of vegetables during the 1st lockdown in 2020

A relatively low percentage of individuals (57 percent) participated in the cultivation of indigenous crops. Nevertheless, they said that it was helpful for them. Some important reasons they listed are increased crop production, better crop management, and crop diversification (Fig. 24).

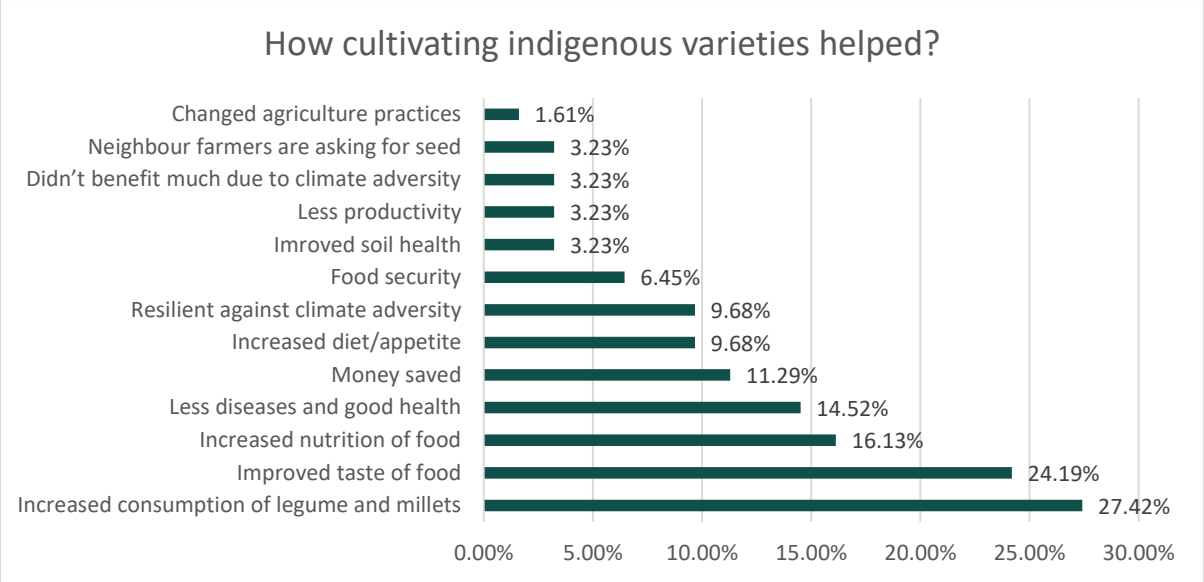


Fig. 24 Perception of the efficacy of cultivation of indigenous varieties

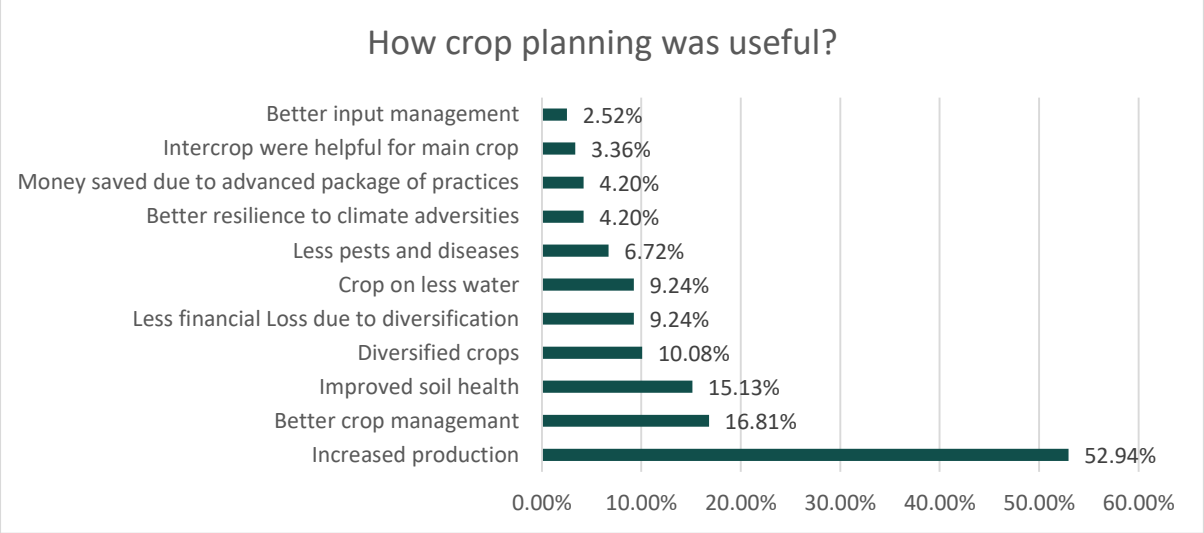


Fig. 25 Perception of the efficacy of crop planning

Only a few respondents (around 17 percent) said that the availability of better crop management and improvement of soil health could make crop planning more effective (Fig. 26).

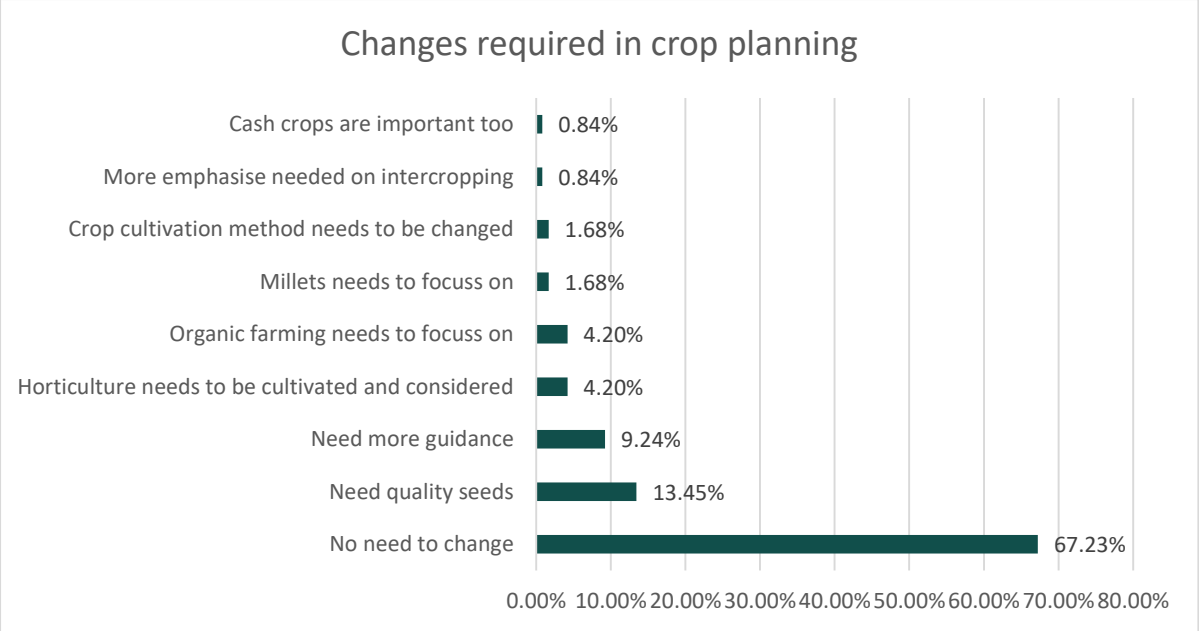


Fig. 26 Suggestions of farmers in intervention group on how to improve the crop planning

Almost 70 percent of the households in the intervention group also participated in the Farmers' Field School (FFS). The two most prominent reasons they cited for their participation are organic formulations and fertilizer preparation training; and pest management-related information (Fig. 27).

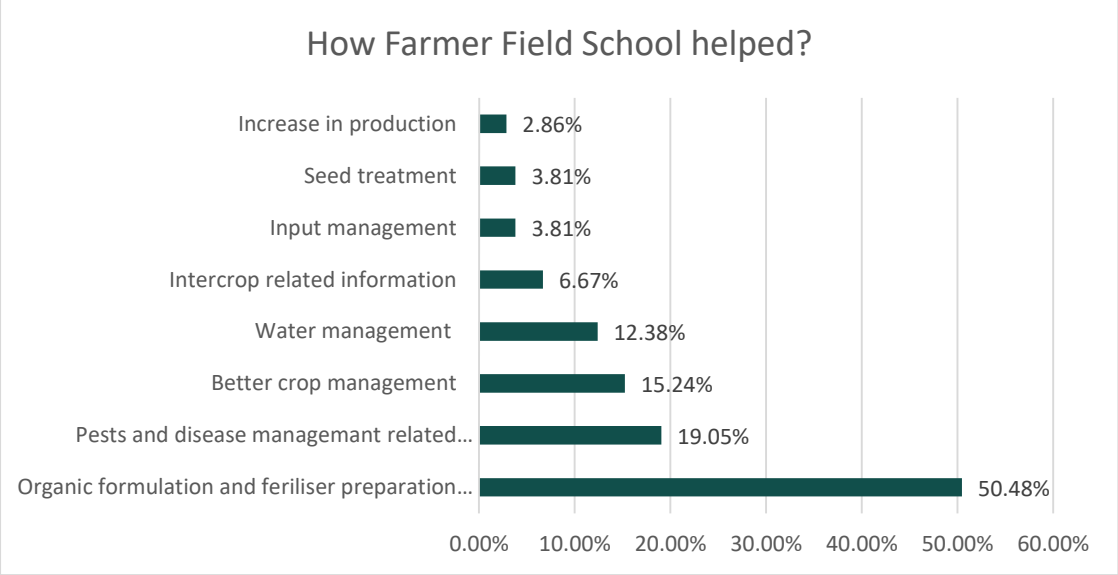


Fig. 27 Different reasons for the efficacy of the Farmers' Field School

Respondents found the food demonstration activity very useful and cited as the most important reason (Fig. 28). It helped them acquire knowledge on food and nutrition.

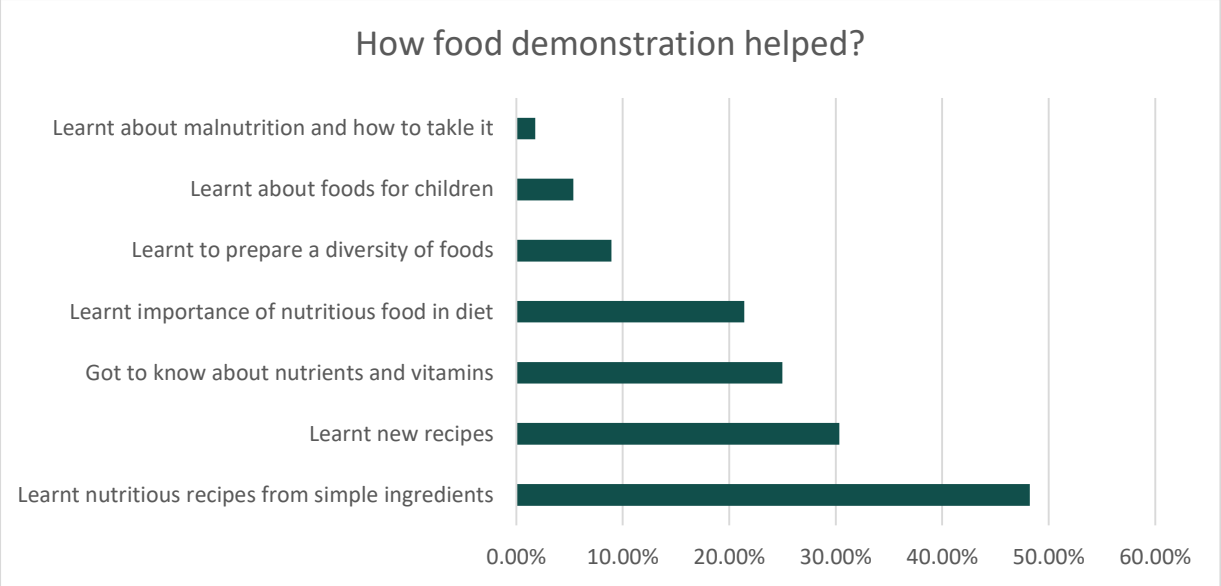


Fig. 28 Reasons for the efficacy of the food demonstration

The child-growth monitoring was also pointed out as useful by the respondents. They mentioned that it taught them about the health status of their children and the diet requirements for improving it.

Findings

1. The Dietary Diversity Score (DDS) is one of the main indicators of food and nutritional sufficiency. It has been found that dietary diversity has increased over the period of the study. The awareness generation, demonstration of multi-layer farming, and crop planning are found to be effective in motivating farmer households to grow diverse food items for their self-consumption. Moreover, the accessibility of a variety of fresh food items has also contributed to the DDS.

2. The economic dimension of the study shows that the agriculture and food nutrition security (Agri-FNS) intervention can also be economically beneficial if implemented well.

3. The involvement of the Self-Help Groups (SHGs) and other community institutions like the Farmer Producer Organisation (FPO) can be effective for higher diffusion of the interventions and the sustainability of the programme.

4. The hemoglobin level of the individuals has improved from the baseline to endline, which is encouraging from the programme implementation point of view.

5. Economics of the MLFs suggest that almost 50 percent of the farms (more than 1-year-old) have a B-C Ratio of more than 0.80 considering the fact that MLFs have several environmental benefits like soil moisture conservation, soil health improvement, water conservation, and nutrient cycling.

6. It is assumed that the demonstrations (activities) implemented in a village are adopted by neighbouring households or women through their SHGs.

References

Ahankari, A. S., Myles, P. R., Fogarty, A. W., Dixit, J. V., & Tata, L. J. (2017). Prevalence of iron-deficiency anemia and risk factors in 1010 adolescent girls from rural Maharashtra, India: a cross-sectional survey. *Public Health*, *142*, 159-166.

Ashley, J. M. (2016). *Food security in the developing world*. Academic Press.

Bharati, P., Shome, S., Chakrabarty, S., Bharati, S., & Pal, M. (2009). Burden of anemia and its socioeconomic determinants among adolescent girls in India. *Food and Nutrition Bulletin*, *30*(3), 217-226.

Brambhankar, M., Gaikwad, R., 2020. Does India Know Anemia Is Running Amok in the Country?. The Wire. https://science.thewire.in/health/nfhs-5-anemia-india-maharashtra-increasing-prevalence-government-conservative-attitude/ Accessed on 15.01.2022

Committee on World Food Security (CFS), 2014. Global Strategic Framework for Food Security & Nutrition. https://www.fao.org/fileadmin/templates/cfs/Docs1314/GSF/GSF_Version_3_EN.pdf Accessed on 23.12.2021

Deshmukh, P. R., Garg, B. S., & Bharambe, M. S. (2008). Effectiveness of weekly supplementation of iron to control anemia among adolescent girls of Nashik, Maharashtra, India. *Journal of health, population, and nutrition*, *26*(1), 74.

Drèze, J., Sen, A. (1990). *Hunger and public action*. Clarendon Press.

Fredriksson, A., & Oliveira, G. M. D. (2019). Impact evaluation using Difference-in-Differences. *RAUSP Management Journal*, *54*, 519-532.

GHI Global Hunger Index (GHI), 2019. 2019 Global Hunger Index by Severity

Kane-Potaka, J., Anitha, S., Tsusaka, T. W., Botha, R., Budumuru, M., Upadhyay, S., ... & Nedumaran, S. (2021). Assessing millets and sorghum consumption behavior in urban India: A large-scale survey. *Frontiers in sustainable food systems*, *5*.

Krebs-Smith, S. M., Smiciklas-Wright, H., Guthrie, H. A., & Krebs-Smith, J. (1987). The effects of variety in food choices on dietary quality. *Journal of the American dietetic association*, *87*(7), 897-903.

Menon, P., Deolalikar, A. B., & Bhaskar, A. (2009). *India state hunger index: Comparisons of hunger across states*. International Food Policy Research Institute.

Naandi Foundation, 2011. HUNGaMA. Fighting Hunger and Malnutrition'. The HUNGaMA Survey Report. https://www.naandi.org/wp-content/uploads/2013/12/HUNGaMA-Survey-2011-The-Report.pdf

Nussbaum, M. C. (2001). *Women and human development: The capabilities approach* (Vol. 3). Cambridge University Press.

Phadtare, A., (2017). Crop planning – A tool for climate resilient food system. LEISA INDIA, 14-16.

Rathnayake, K. M., Madushani, P. A. E., & Silva, K. D. R. R. (2012). Use of dietary diversity score as a proxy indicator of nutrient adequacy of rural elderly people in Sri Lanka. *BMC research notes*, *5*(1), 1-6.

Upadhyay, R.P., Palanivel, C., 2011. Challenges in achieving food security in India. *Iranian journal of public health*, *40*(4): 31.

Watershed Organisation Trust, (WOTR)
2nd Floor, 'The Forum', Padmavati Corner
Pune Satara Road
Pune – 411009

Phone: +91 20 24226211; Fax: +91 20 24213530
Email: info@wotr.org ; Web: www.wotr.org