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FARM PRODUCTION DIVERSITY, CONSUMPTION IMPROVEMENT, AND NUTRITION STATUS IN FARMING HOUSEHOLDS

Empirical Evidence from an Action Research Project

Sourya Das, Hardeep Singh, and Marcella D'Souza

Introduction

Hunger and food insecurity are among the most severe socio-economic crises the world faces today (FAO, 2022). According to the FAO (2022), food security has four main dimensions—availability, affordability, utilisation and stability of the consumption goods. Nutritional status is closely linked to food security (Giuseppe, 2015). Unfortunately, millions of people in the Global South persistently face food unavailability, leaving them undernourished and with varying degrees of nutritional deficiencies. The underlying reasons include poverty, socio-economic disparity, degradation of land resources, vulnerability to climate and market shocks and agro-biodiversity loss (Ashley, 2016). A majority of the population in developing and emerging countries continues to depend on agriculture and allied activities for their livelihood. Agriculture in these countries is highly sensitive to fluctuations in rainfall and temperature. A lack of proper adaptation and mitigation mechanisms jeopardises the income, food security, and consumption patterns of agricultural households (Dercon, 2004; Tesfaye and Tirivayi, 2020). India has approximately 51% of its cultivable land that is rainfed (Government of India, 2022; MoA&FW, 2022), while in Maharashtra, this area is about 81%, which leaves 77% of the farmers dependent on rainfall for their farming operations. Any variation in the weather conditions has an impact on crop production, which further influences food consumption and nutritional outcomes (Birthal et al., 2015).

To protect themselves from climate risks and sustain their food consumption needs, farming households avail themselves of formal and informal instruments. Several studies have documented the adoption of crop

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insurance schemes against weather vagaries. These have also captured how agricultural households diversify their income sources and access both farm and non-farm interventions in an environment where capital markets are incomplete and social safety nets are inefficient in providing the necessary support (Morduch, 1995; Dercon, 1996; Kurosaki and Fafchamps, 2002). These studies have further documented that some agricultural households pursue multi-cropping/crop diversification as an informal insurance mechanism to mitigate the crop yield losses accruing from weather variability and to meet their food consumption requirements (Arslan et al., 2015). Others follow temporary migration as agricultural labourers in water-secure areas or as non-farm wage labour in urban areas. In extreme situations, some are forced to sell off assets such as livestock and even land.

Furthermore, a study by UNICEF (2021) has reported that nutritional deficiency is mostly prevalent in semi-arid regions, particularly in developing countries where most agricultural households depend upon rainfed agriculture. Todd and Narrod (2006) have reported that nutritional deficiencies led to many premature deaths and poor child growth in these regions. To improve the nutritional status of households, the United Nations Development Programme (UNDP) has focused on achieving the Sustainable Development Goals, where target 2.2 states, 'End all forms of malnutrition by 2025…'. We are a few months away from this deadline; it is critical to understand where we stand at present. To achieve this SDG goal, the UNDP has started focusing on Food Systems Transformation since the UN Food Systems Summit in September 2021.

Recent studies include attention to the adaptation and mitigation measures used by farming households to protect agricultural income and sustain their livelihoods. Multi-cropping is considered an important strategy to this end. For instance, in their study focusing on India, Birthal et al. (2015) reported that diversification into high-value crops such as vegetables might help increase the income for agricultural households. Using a nationally representative survey, they found that households pursuing diversification into high-value crops were less likely to be poor, implying that high-value crop cultivation acts as an informal insurance mechanism for these farmers. It is also reported that monocropping might lead to a decline in agricultural productivity, which exposes farmers to production and price risks (Chibwana et al., 2012; Teklewold et al., 2013). Others have mentioned that while crop diversification might protect farmers from production and price risks and reduce poverty, it also enhances food security. However, despite the numerous benefits of crop diversification, there is scant literature about the link between crop diversification and the nutritional status of the members of these households. This chapter, through action research, attempts to provide evidence on the impact of crop diversity on nutritional outcomes of

agricultural households. For this action research, we used an approach different from that pursued in previous studies. Studies that have dealt with the relationship between production and consumption diversity have mostly focused on different measures of diversity by calculating indices such as the Herfindahl index, Count index, and Shannon index (Tesfaye and Tirivayi, 2020; Chinnadurai et al., 2016; Kavitha et al., 2016; Kumar et al., 2016). In these studies, the diversity measures were calculated in an abstract manner by taking the sum of number of crops grown by an agricultural household across different seasons. Sometimes, however, farmers adopt mixed cropping or intercropping to meet their dietary requirements. One of the techniques to meet the food diversity requirements through multiple cropping is multi-layer farming (MLF), which is considered in this study. In MLF, backyard kitchen gardens or plots on farmland are prepared and maintained with some technical and financial inputs by participant households. In MLF plots, different types of tubers, vegetables, and fruits are cultivated. This helps meet complementary needs, such as managing litter, providing shade/canopy, and increasing the moisture-holding capacity of the soil while nurturing microflora. The cultivated plants and trees have different life cycles; seasonals and annuals need to be replaced at varying times, whereas others have a longer life cycle. The horticultural crops are cultivated to ensure that fruits are also available in different seasons. Some plants are cultivated as trap crops to prevent pest attacks.

In 2022, India stood 107th among 121 countries in the Global Hunger Index (Grebmer et al., 2022). Hunger, food insecurity, and malnutrition in India arise due to several reasons—poor hygiene, poverty, unemployment, illiteracy, patriarchy, lack of women's empowerment, climate events, and reduced crop diversity (Upadhyay and Palanivel, 2011). Despite being a major contributor to India's gross domestic product, the state of Maharashtra has a high prevalence of under-nourishment. According to the National Family Health Survey-5 Report (NFHS-5), the prevalence of anaemia has worsened since the NFHS-4 (Phadtare et al., 2022). Empirical evidence suggests that anaemia is common in adolescent girls in different parts of Maharashtra (Deshmukh et al., 2008; Ahankari et al., 2017; Bharati et al., 2009).

Considering the importance of understanding the link between crop diversity and nutritional requirements of an agricultural household, we attempted to assess the effect of guidance on crop selection for household consumption and their food and nutrition security (FNS). This study used the difference-in-difference (DID) regression framework to assess food intake in the baseline and endline periods. In the study villages, the Watershed Organisation Trust (WOTR)[1] promoted soil health improvement to enhance agricultural productivity through a project titled 'Soil Protection and Rehabilitation of Degraded Soils for Food Security in India'[2] in 21 villages located in three

agro-climatic zones of Maharashtra. All 21 villages had earlier implemented participatory watershed development (WSD), which greatly contributed to soil and water conservation. WSD, together with the project on soil protection, was observed to have improved agricultural productivity. For this study, 6 of the 21 villages were selected with the objective of assessing the efficacy of a package of activities related to agriculture and nutritional security on the dietary diversity of individuals and its impact on haemoglobin (Hb) levels.

Focus of the Action Research

The study considered three dimensions of food security, as defined by the FAO—availability, affordability, and utilisation of food. The fourth dimension, 'stability', requires a longer period for assessment; hence, it was not considered in this study. Cultivation and consumption of nutritious food was encouraged through the promotion of a package of activities. Interventions selected were such that they should not become an economic burden to households. The activities created awareness of the nutritive values of local farm produce, the nutritional requirements of humans, and food preparation demonstrations. Capacity-building for crop planning was included for household FNS. Furthermore, people were motivated to have their Hb levels assessed. Details of each activity are given in Table 5.1.

Study Area and Action Research Process

Action research was planned to explore the impact of planned interventions on household income, dietary diversity, and nutrition levels of agricultural households. The population of interest for this study includes rural households in the poverty-ridden, semi-arid, and humid tropics of India. The villages selected for the study were facing the problems of poor soil quality and reduced availability of water resources. Additionally, the selected villages were part of one of the projects implemented by WOTR, which was conducted to protect the natural resources of these regions.

Study Area

We conducted this study in six villages from three districts of Maharashtra—Ahmednagar, Jalna,and Dhule (Table 5.2), where WOTR implemented the 'Soil Protection and Rehabilitation of Degraded Soils for Food Security in India' project.

Upon examining the characteristics across different regions, we found that most of the households are employed in farming and livestock rearing, except for a few that are employed in non-farm activities. Based on

TABLE 5.1 Structure of the Interventions for the Food and Nutrition Security (FNS) Action Research with the Expected Outputs

Description and Relation to FNS	*Key Activities*
1. Availability: Quantity and quality of nutritious foods available at the homestead, within easy reach, or available within the village.	• Identification of (a) crops and farm produce that can be grown locally to meet the balanced diet requirements and (b) local agro-biodiversity and indigenous crop varieties if still available, and promotion of their cultivation for home consumption. • Capacity building of farmers (intervention group) on applying the appropriate package of practices (PoP) for both indigenous and other crops promoted for home consumption. The respective PoPs include soil nutrient assessment and promotion of integrated nutrient and pest management.
2. Accessibility: Nutritious food produce physically accessible; thus reduces the need to purchase the same.	• Seasonal crop planning (preferably local/indigenous varieties) for household food requirements, based on water availability. Crops include cereals, pulses, vegetables, oilseed, also fodder for livestock. • Implementation of kitchen garden or multi-layer farms promoted mainly through women, to ensure accessibility to vegetable, tubers, and fruit for year-round accessibility for the daily diet.
3. Utilisation: People have knowledge of a healthy diet composition, and methods of preparing the same using locally available produce.	• Promote nutrition and health literacy of a balanced diet through training events, food demonstrations, and encourage its consumption at home. • Build the capacities of Self-Helf Groups together with the Anganwadi workers to promote food and nutrition security models among their members and ensure its continuity and replicability. • Haemoglobin assessment of all villagers.

Source: Authors' own, based on project activities.

PoP: Package of practices for respective crops.

An Anganwadi worker is a local village-level worker of the Integrated Child Development Service. She is responsible for the health and nutrition education counselling of the mothers having children up to the age of three years.

the geographic location of the villages, the characteristics of soil and crops cultivated in the villages also vary. The soil type in the Parner block villages is coarse, shallow, medium-black to deep-black. The main crops cultivated are green gram, onion, and pearl millet in the kharif (monsoon) season; wheat, sorghum, onion, and chickpea in the rabi (winter) season; and some fodder crops in the summer season. In Bhokardan block villages, the soil type is typically medium-black to deep-black. The main crops cultivated are

TABLE 5.2 Administrative Jurisdiction and Agro-climatic Zones of the Study Villages

Study Villages[a]	*District*[a]	*Block*[a]	*Agro-climatic Sub-Regions*[b]
Kutewadi-Bhangadewadi Hivre Korda	Ahmednagar	Parner	Western Maharashtra (Water Scarcity Zone)
Deulgaon Tad Chandai Tepli	Jalna	Bhokardan	Central Maharashtra (Assured Rainfall Zone)
Pimpalpada Mohgaon	Dhule	Sakri	The North Western Ghats (High Rainfall Transition Zone 2)

[a]District Socio-economic Report, Govt of Maharashtra.
[b]Rainfall distribution map of Maharashtra (GSDA).

soybean, cotton, and maize in the kharif season and chickpea and wheat during the rabi season. In Sakri block villages, the soil is light in nature, slightly acidic, with slightly higher organic carbon content. The main crops cultivated are paddy, soybean, and maize in the kharif season and wheat and chickpea in the rabi season.

Action Research Process

The 'Soil Protection and Rehabilitation for Food Security (Pro-Soil)' project was implemented between 2015 and 2021. The objective of the Pro-Soil project was to improve soil health and crop productivity. To improve the productivity of selected crops, farmers were guided to adopt the appropriate package of agricultural practices. All 21 villages had earlier implemented watershed development (WSD), i.e., sustainable land and water conservation measures to rejuvenate degraded lands. In the Parner villages, WSD was between 1995 and 2002, and in the Bhokardan and Sakri blocks between 2008 and 2015. This FNS action research study was conducted in 6 of the 21 project villages. It aimed to improve the nutritional intake of the targeted groups. The criteria for selecting households for the study were based exclusively on their landholding sizes and water availability, since all households benefited from the WSD and soil health improvement projects. We pursued a stratified random sampling approach to select 25 farming households from each study village, members of which consented to be part of this study and

implement the proposed set of activities. These households were identified according to the farm size owned: ten each were smallholder and medium holder households, and five were largeholder households. Similarly, from the same villages, a control group of 25 households was identified, which also fit into the landholding groups. The activities and the timeline of the action research project implemented are presented below.

September 2019–March 2020

The survey was conducted in two stages. In the selected 6 villages, a baseline survey was conducted between September and December 2019 for the 150 'intervention' group of households that agreed to implement all proposed activities proposed and were willing to contribute to the same. The control group was identified, and similar households were selected. They did not agree to implement the activities but were willing to participate in the interviews. Between January and March 2020, the (baseline) survey was conducted for the 150 'control' group households. Due to budgetary constraints, the sample size was restricted to a total of 300 households, comprising both intervention and control households.

(a) *Activities targeting food availability and accessibility*

- For the 'intervention' group of households, crop planning was done based on their economic conditions and food and nutritional requirements. Wherever possible, preference was given to indigenous crop varieties of millets, pulses, oilseeds, vegetables, and fodder crops. In the rabi season of 2019, crops that contribute to food security were selected. These plots were geo-tagged and demarcated to document the food crops cultivated. A booklet on the package of practices and farmer diaries was provided to the respective farmer households. Furthermore, monitoring and guidance were provided to the participating farmers.
    - Multi-layer farms and kitchen gardens: The kitchen gardens generally found in the backyards of rural houses were improved to help the households have at least some vegetables and fruits for part of, or the whole year. MLF plots were initiated where possible. The design of the MLF is such that the plants and trees cultivated have different productive seasons and life cycles and ensure a year-round availability of leafy vegetables, roots, tubers, and fruits to meet the vitamin, mineral, and carbohydrate needs of household members. The MLF is well designed and includes organic and integrated agricultural practices to be followed.

(b) *Interventions targeting food utilisation*

- Capacity-building to improve household nutritional status: Motivation with capacity-building is essential to improve the nutritional status of all members of the intervention group of households. Women, adolescents, and children are important participants. Different approaches such as meetings and exposure visits to groups implementing such interventions were conducted. We used training and audio-visual tools to create awareness, mobilise the people, and build capacities, especially of women on nutrition. Women were taken on exposure visits to villages where such interventions were in progress. Campaigns were conducted in all six villages to disseminate the importance of food and nutrition security through rangoli,[3] drawing, rallies by school children, and discussions. While members of the 'intervention' study group were required to participate in the capacity-building activities, anyone who wished to participate (even those from the control group) was permitted.
    - Food preparation demonstration: Food demonstrations were conducted for the intervention households; however, any women from the village who turned up for the demonstration, even if from the control group, were accepted. Participants were given demonstrations on the preparation of nutritious foods and a balanced diet using locally available and affordable ingredients; information on the nutritional benefits of the ingredients used was provided. Some traditional recipes were modified; some recipes were new to the village. The food demonstrations helped women to be creative while maintaining a balance between taste and nutrition.
    - Nutrition assessment and health-related interventions: Hb assessment was open to all the villagers. However, members of the 50 participant households (25 control and 25 intervention groups) of each village that accepted to be a part of the study were encouraged to have their Hb tested. Each participant who came to have their Hb tested was immediately informed about their Hb status and was advised on food consumption or treatment as required. Sahli's method[4] was used, and the standard Hb range norms were applied to assess anaemia levels.
- The COVID-19 lockdown was imposed from the third week of March 2020 until September 2020, which restricted movement and the follow-up of the action research project. Activities implemented by the 150 participant households (25 per village) in the 6 study villages were continued by the respective households. From October 2020 to March 2021, the partial opening of the lockdown permitted some movement

of the project facilitators. Agricultural planning for the rabi season of 2020 was conducted, and late in March, a farmers' diary was prepared for the following kharif season (monsoon 2021) for the intervention households. A strict lockdown was imposed once more from April to September 2021, and again households continued the activities on their own.

September 2021 Onwards

The end-of-action research project assessment started; it included the endline household survey for both the intervention and control[5] groups. The Hb assessment was open to all who wished to participate. This time too, the participants were immediately given their Hb results with nutritional advice, vitamin and mineral tablets, or medical guidance, as required.

In the endline survey, the opinions of members of the intervention households on the various activities were taken.

Ethical Considerations

Written consent was taken from every household and individual participating in the study during the household surveys. After data collection, codes were used to replace the participants' names to maintain anonymity. As part of the package of nutrition promotion to incentivise people to improve their health status, the Hb test was performed routinely but only for those who willingly came for it. The results were immediately given back to the individual/family member with advice on means to improve or maintain the Hb levels. No separate consent was sought for the Hb test.

Data and Variables

This study involved 300 households, 150 in each in the control and intervention groups. From these households, both women and men participated in structured interviews. A total of 679 and 739 individuals were from the control and intervention groups, respectively.

Dietary Diversity Score

We assessed the nutritional intake across different households using the dietary diversity score (DDS) (Krebs-Smith et al., 1987; Rathnayake et al., 2012). The DDS was obtained from the data gathered from structured interviews with the female member of a household. We recorded the number of food items consumed by all individuals in each household. Based on the

household survey of every individual's diet in the baseline and endline (diet recall for a normal day), data on the diet were analysed to extract information on the number of food categories the diet provided. The food consumed by the individuals was grouped into cereals; roots and tubers; pulses; milk and milk products; eggs, fish, and meat; oil and fat; fruits and vegetables containing vitamin A; and fruits and vegetables containing vitamin C and iron. We used the count method to measure the dietary diversity of each person, whereby we calculated the number of items consumed by each. When calculating the DDS of any individual, we assigned a score of 1 for each of these food groups if the individual consumed any of these food groups.

Haemoglobin Testing

This was organised in the villages to facilitate ease of access and to encourage as many people as possible to participate. The Hb test was conducted twice during the project period—the baseline (September 2019) and endline (December 2021) periods. Of the many people who participated, 486 participants from 300 households of the study villages were present for both the baseline and endline Hb tests, whose data were used for the analysis. Of these, 216 were from the control households and 270 from the intervention households.

Opinion of the Households Regarding the Activities Undertaken

The respondents' opinions on the efficacy of the Agri-FNS activities and their willingness to continue these were gathered through household interviews during the endline survey.

Empirical Model

Using the quasi-experimental framework, we attempted to obtain unbiased causal estimates. To examine the impact of the intervention, we focused on the average difference in the outcome of interest variable between the intervention and control groups. To carry forward the analysis, we compared the difference between the pre-intervention and post-intervention periods. This is similar to running a double-difference regression framework. Considering the properties of the DID regression framework, we applied it to examine the impact of the intervention. 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).

We focused on the following regression framework to carry out our objectives:

$$Y_{ivt} = \alpha + \beta.T_{ivt}.Post + \rho.T_{ivt} + \gamma.Post + \mu_v + \varepsilon_{ivt},$$

where Y_{ivt} is our outcome of interest variable for household i residing in village v during time t; T_{ivt} indicates whether the household has been intervened or not; $Post$ is the intervention time period; μ_v controls for the village-level fixed effects that might influence the treatment and outcome of interest; and ε_{ivt} is the error term. β is our coefficient of interest that provides the coefficient of the interaction term of the treatment and time dummies. The estimates obtained using the DID framework can be interpreted as causal, as we have controlled for potential biases. For instance, to avoid the biases arising from passing out the information to the agricultural households, we handed out booklets and diaries on the preparation of the land for MLF, as well as preparation of food. Information was further disseminated to the farming households through periodic focused group discussions.

Empirical Results

Impact of Agri-FNS Activities on the DDS

Dietary recall data were collected for 739 individuals in the intervention group and 679 individuals in the control group. During the baseline study, the average DDS of the control and intervention groups was found to be almost similar (Figure 5.1). In the endline assessment, except for Sakri, an improvement was observed in the DDS of the intervention group. In the Sakri block households, a decline in dietary diversity score was noted in both the control and intervention groups, with a greater decline in the former. Results suggest that the intervention group in all the blocks except Sakri improved their dietary intake as compared to the control group. During the COVID-19 lockdown and the associated disruption in normal life, livelihoods and daily transactions were greatly affected, influencing overall food and nutrition security. Families within the villages were cautious, and interaction between them was limited; this reduced information flow from the intervention group to the control group. During this period, it appears that the intervention group had resources and managed to increase or maintain their DDS.

The highest DDS value for an individual is 9, whereas the lowest theoretically possible DDS is 1. Therefore, we grouped the DDS into four categories: category 1—DDS 1 to 4; category 2—DDS 5 and 6; category 3—DDS 7 and 8; and category 4—DDS 9 and above. The distribution of individuals across these categories is shown in Figure 5.2.

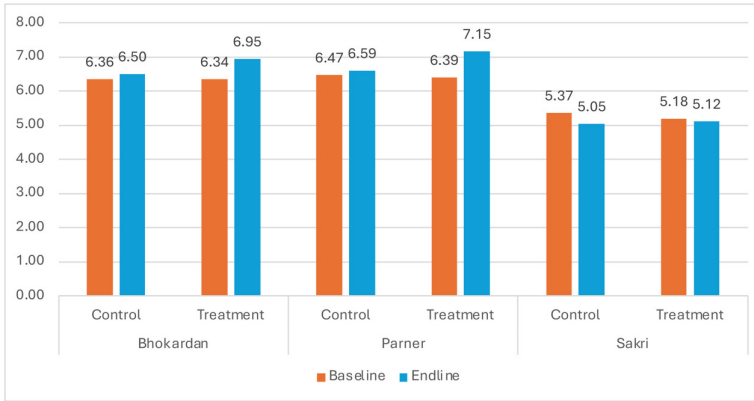

FIGURE 5.1 Average DDS change for members of households in the control and intervention groups

Source: Analysis by authors from primary data.

Note: The graph shows the change in diversity scores for members of households across different blocks for both the control and intervention groups.

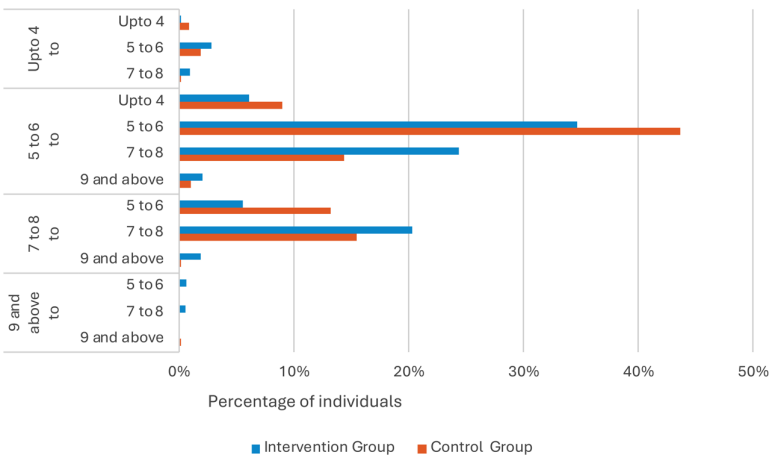

FIGURE 5.2 Percentage of individuals whose DDS changed between groups, from baseline and endline periods

Source: Analysis by authors from the primary data.

Table 5.3 shows the percentage of individuals in the control and intervention groups under different DDS categories for the baseline and endline periods. At the onset, the status of both intervention and control groups was somewhat similar. Between the different categories, there was approximately 1% variation. A marked change was noted at the endline assessment, with a larger percentage (50%) of the intervention group consuming a greater

TABLE 5.3 Percentage Shift of Individuals in Different DDS Groups between the Baseline and the Endline Periods

DDS	*Control Group*			*Intervention Group*		
	Baseline	*Endline*	*Change*	*Baseline*	*Endline*	*Change*
	A	*B*	*C = B – A*	*D*	*E*	*F = E – D*
Category 1: (upto 4)	2.9	9.7	*6.8*	3.9	6.2	*2.3*
Category 2: (5–6)	68	58.8	*–9.2*	67.1	43.8	*–23.3*
Category 3: (7–8)	28.9	30.1	1.2	27.8	46.1	18.3
Category 4: (9 and above)	0.1	1.3	1.2	1.2	3.9	2.7

Source: Analysis by authors from primary data collected.

variety of foods (7 and above) compared to 31% in the control group. It is to be noted that the DDS score of the control group dropped, i.e., a greater percentage now consumed only 1–4 food varieties (category 1), while the DDS score of the intervention group declined for category 2 (i.e. they shifted either to category 1 or to categories 3 or 4). Categories 1 and 2 are the low diversity groups. The increase in households in category 1 of the control group indicates a drop in food varieties consumed. Similarly, the declining DDS score for category 2 in the intervention group is an improvement for the households, as there is a greater shift to the higher diversity categories. To conclude, we find that there is an improvement in the dietary diversity scores of the intervention group who shifted from the lower DDS score group to the higher DDS score group.

For empirically examining the impact of the intervention on the change in the DDS of the intervention group, we used the DID regression framework. Here, our dependent variable, i.e., DDS, was constructed in a way that reflected the diversity scores from low to high. Therefore, to further refine our empirical strategy, we used the ordered probit model, which is preferred when the dependent variable shows a specific order. The results of the ordered probit model are shown in Table 5.4. We controlled for gender, age, and education level of the individuals; village-level fixed effects; occupation level of the individuals; and household size. Our main variable of interest was the parameter associated with the interaction of baseline and endline variables, which shows the change in DDS among the intervention groups

TABLE 5.4 Empirical Results of the Gender Disaggregated DDS for the Ordered Probit Model

	(1)	*(2)*	*(3)*
Variables	*DDS*	*DDS-Male*	*DDS-Female*
Intervention	−0.145**	−0.179**	−0.152**
	(0.0612)	(0.0730)	(0.0752)
Endline	−0.115**	−0.117	−0.0365
	(0.0581)	(0.0759)	(0.0837)
Intervention × Endline	0.537***	0.681***	0.472***
	(0.0871)	(0.113)	(0.116)
Observations	2,476	1,470	1,366
Village FE	Yes	Yes	Yes

Source: Analysis by authors from primary data.

Note: Table 5.4 shows the results of the empirical specification where we have performed the ordered probit model. The diversity score is considered as the dependent variable. In this specification, we have controlled for gender, age, and education level of the individuals, village-level fixed (Village FE) effects, occupation level of the individuals, and household size. Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

after the activities were rolled out. We found that the coefficient associated with the interaction term was positive and statistically significant, further suggesting that the interventions increased the DDS status of the households participating in the project (see Table 5.4, column 1). Furthermore, we carried out the same analysis for women and men, where we found that for both genders, the set of activities increased the DDSs across the intervention groups. Additionally, we reported the empirical results across different blocks considered in the study (see Table 5.5). Results from the different blocks also reflect the importance of the set of activities performed to improve the dietary diversity of farming households.

Agriculture-FNS Package of Practices and Haemoglobin Status of Individuals

The criteria for the selection of the intervention and control study groups were based on landholding. A basic measure to determine whether the set of activities improved nutrition is to check their Hb levels, which informs us about the prevailing anaemia among the agricultural households. The Hb levels of individuals in both the control and intervention groups were tested during the baseline (January 2020) and endline (December 2021) of the study. The Hb assessment was conducted for 2,561 individuals in the baseline and 1,057 individuals in the endline. However, for this study, we

TABLE 5.5 Empirical Results of the Ordered Probit Model across Different Blocks

	(1)	*(2)*	*(3)*
Variables	*Bhokardan*	*Parner*	*Sakri*
Intervention	0.0361	−0.0414	−0.246**
	(0.118)	(0.103)	(0.114)
Endline	0.151	0.158	−0.605***
	(0.0982)	(0.106)	(0.105)
Intervention × Endline	0.565***	0.649***	0.375**
	(0.153)	(0.156)	(0.146)
Observations	808	764	904
Village FE	Yes	Yes	Yes

Source: Analysis by authors from primary data.

Note: Table 5.5 shows the results of the empirical specification where we have performed ordered probit model. Diversity score for each individual is considered as the dependent variable. In this specification, we have controlled for gender, age, and education level of the individuals, village-level fixed (Village FE) effects, occupation level of the individuals, and household size. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

matched the Hb assessment data only for the individuals of the control and intervention groups (a total of 300 households) who participated in both the baseline and endline assessments. There were 270 individuals from the intervention and 216 individuals from the control groups, who were of all ages (see Table 5.6).

The change in Hb levels from the baseline to endline periods (see Table 5.6) as observed for the female population showed the control group having a combined increase in moderate and severe anaemia by 11.14%, and a 4.66% reduction in non-anaemic participants. Meanwhile, the intervention group showed a marked improvement, whereby moderate anaemia reduced by 19.46%, with none having severe anaemia, while non-anaemic participants showed an increase of 12.75%. The analysis disaggregated for the three blocks presents the differences between them. In the Bhokardan and Parner blocks, we find improvements both in the DDS score and Hb levels of participants from the households of both the intervention and control groups, although the improvement is greater in the intervention group of households compared to the control. However, in the Sakri block villages, we find a decline in DDS score in both the intervention group and control groups, with the decline being more for the control group. This is also reflected in the poor improvement of Hb levels in both groups of households. Reasons for the poor performance of Sakri block villages will be taken up in the discussion section below.

We applied the empirical regression framework using the ordered probit model to examine the impact of the package of practices on the Hb levels

TABLE 5.6 Population Categorised Based on Haemoglobin Status across Baseline and Endline Period

Data	*Anaemia Types*	*Control Group*		*Change*	*Intervention Group*		*Change*
		Baseline	*Endline*		*Baseline*	*Endline*	
		A	*B*	*C = B – A*	*D*	*E*	*F = E – D*
Female	Non-anaemic	18.52	13.86	–4.66	7.38	20.13	12.75
	Mild-anaemic	41.67	35.19	–6.48	25.5	32.21	6.71
	Moderate-anaemic	39.81	48.15	8.34	67.11	47.65	–19.46
	Severe-anaemic	0	2.8	2.80	0	0	0
Male	Non-anaemic	20.37	27.78	7.41	34.71	52.07	17.36
	Mild-anaemic	41.67	33.33	–8.34	38.02	40.5	2.48
	Moderate-anaemic	35.19	32.41	–2.78	27.27	7.44	–19.83
	Severe-anaemic	2.78	6.48	3.70	0	0	0
Bhokardan	Non-anaemic	33.96	11.32	–22.64	0	25	25.00
	Mild-anaemic	37.74	39.62	1.88	0	42.86	42.86
	Moderate-anaemic	24.53	30.19	5.66	100	32.14	–67.86
	Severe-anaemic	3.77	18.87	15.10	0	0	*0*
Parner	Non-anaemic	17.07	68.29	51.22	25.35	63.38	38.03
	Mild-anaemic	36.59	26.83	–9.76	35.21	26.76	–8.45
	Moderate-anaemic	43.90	4.88	–39.02	39.44	9.86	–29.58
	Severe-anaemic	2.44	0.00	–2.44	0	0	0
Sakri	Non-anaemic	45.08	34.43	–10.66	20.47	23.98	3.51
	Mild-anaemic	40.98	56.56	15.57	34.5	40.35	*5.85*
	Moderate-anaemic	13.93	9.02	–4.92	45.03	35.67	–9.36
	Severe-anaemic	0.00	0.00	0	0	0	0

Source: Analysis by authors from primary data.

Note: Table 5.6 shows the categorisation of individuals based on their Hb status across baseline and endline periods and the change, for both the control and intervention groups. The Hb status data is provided for the pooled sample in total, and according to gender; it is also disaggregated according to the blocks.

TABLE 5.7 Impact of the Package of Practices on Anaemia Levels of Individuals According to Sex

	(1)	*(2)*	*(3)*
Variables	*Overall*	*Males*	*Females*
Intervention	0.335**	0.0363	0.954***
	(0.157)	(0.201)	(0.316)
Endline	0.367***	0.0657	0.665***
	(0.134)	(0.191)	(0.182)
Intervention × Endline	−0.922***	−0.691***	−1.260***
	(0.170)	(0.247)	(0.239)
Observations	736	342	394
Village FE	Yes	Yes	Yes

Source: Analysis by authors from primary data.

Note: Table 5.7 shows the results of the empirical specification where we have performed ordered probit model. Anaemia level of individuals has been considered as the dependent variable. In this specification, we have also controlled for gender, age, and education level of the individuals, village-level fixed (Village FE) effects, occupation level of the individuals, and household size. Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

of the agricultural households. Here too, we controlled for gender, age, and education levels of the individuals; village-level fixed effects; occupation level of the individuals; and household size. The results for this exercise are shown in Table 5.7. Our focus is on the interaction term of post and intervention variables. We see that the coefficient associated with the interaction term is negative and statistically significant, implying that adopting the package of practices by agricultural households reduced the anaemia levels prevailing among these households (refer to column 1 of Table 5.7). It is interesting to note the difference between the male and female participants; a larger improvement is seen among the females (columns 2 and 3 in Table 5.7). It might be surprising, as in most cases women are generally more undernourished; they ensure that the male members and children eat first and end up eating last and the leftovers (Lentz, 2018). We performed the same analysis for the blocks separately, the results of which are shown in Table 5.8. The package of practices and knowledge given to women appeared to have contributed to reducing the anaemia levels in the Bhokardan and Sakri blocks, where the coefficients were negative and statistically significant. However, in the Parner block, the difference was insignificant.

Participants' Opinion on the Efficacy of Agri-FNS Project Activities

The response to their participation in the Agri-FNS activities and on the efficacy of the Agri-FNS component was sought from the intervention group.

TABLE 5.8 Impact of the Package of Practices on Anaemia Levels of Individuals Block-wise

	(1)	*(2)*	*(3)*
Variables	*Bhokardan*	*Parner*	*Sakri*
Intervention	1.379***	−0.0478	0.0243
	(0.300)	(0.338)	(0.205)
Endline	0.944***	−1.888***	0.347**
	(0.282)	(0.520)	(0.161)
Intervention × Endline	−2.080***	0.462	−0.543**
	(0.377)	(0.561)	(0.215)
Observations	118	138	480
Village FE	Yes	Yes	Yes

Source: Analysis by authors from primary data.

Note: Table 5.8 shows the results of the empirical specification where we have performed ordered probit model. Anaemia level of individuals has been considered as the dependent variable. In this specification, we have also controlled for gender, age, and education level of the individuals, village-level fixed (Village FE) effects, occupation level of the individuals, and household size. Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Male members of the households mainly participated in this segment of the interview. A varying but high percentage of the participants were involved in implementing various activities (see Figure 5.3).

Most of the households responded that they would like to continue with the activities and wish to be part of their continuation. They also expressed the need for its promotion in the rest of their villages, as well as in other villages.

Of the 150 households in the intervention group, 103 (66%) developed MLFs, and the others improved kitchen gardens. Most of the respondents stated that MLF was beneficial, citing different reasons; for most, it was the money saved. Besides this, access to fresh vegetables and fruit for home consumption and availability of organic farm produce were other benefits. While the majority expressed satisfaction with the current practices, 12% of respondents suggested improvements like better spacing, fewer crops, and better-quality seeds. It was encouraging to observe that 57% of participants reported their interest in using indigenous crop varieties. They stated that pursuing MLF was helpful as it improved crop production while increasing crop diversity; 17% of respondents stated that crop planning would have been more effective if they had more guidance on crop management and further improvement of soil health. Almost 70% of the households participated in the Farmers' Field School (FFS), where the appropriate package of practices was promoted. The two most prominent reasons they cited for their participation were the guidance and know-how provided on organic formulations, fertiliser preparation training, and pest management.

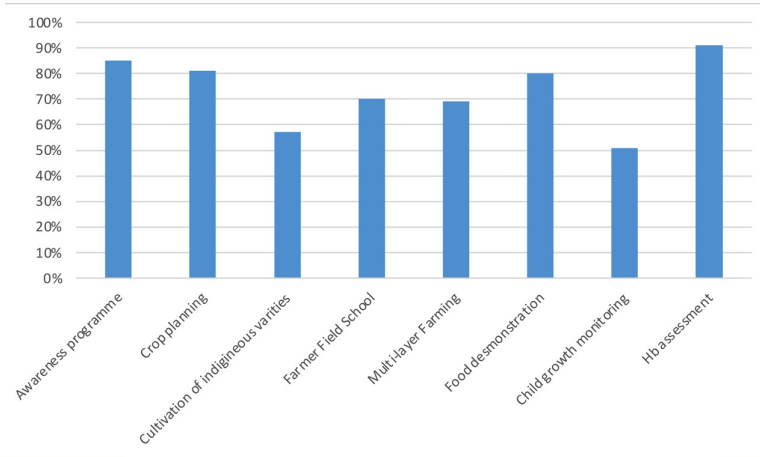

FIGURE 5.3 Percentage of households in the intervention group who participated in the different Agri-FNS activities

Source: Analysis by authors from primary data.

Note: The figure shows the percentage of the implementation group of households in this action research who participated in different Agri-FNS activities. While all activities were offered to the implementation group of households, each selected those that were possible for them. Many adopted multiple activities.

Women members found the food demonstrations useful and important. They acquired knowledge about food and nutrition, the nutritional status of children, as well as Hb and anaemia, and the dietary intake to improve it.

Discussion

This study is set in villages located in the semi-arid region of Maharashtra where sustainable land and water conservation and soil health measures were previously implemented. The initial focus on the rejuvenation of land, soil, and water resources contributed greatly to the overall increase in agricultural productivity. Of the participant households, 40% each belonged to the small and medium landholding categories, and 20% were large land holders; however, all had some water resources. Despite having improved agricultural productivity at the baseline level for reasons explained earlier, the DDS of 71% of households in both control and intervention groups were in categories 1 and 2, i.e., consumed less than six groups of food. The Hb levels were low, i.e., moderate and severe, in both the intervention (49%) and control (38.6%) groups. At the end of the action research, we observed a significant reduction (19.6%) in anaemia levels in the intervention household group, compared to an increase in anaemia by 6% in the control group, except in the Sakri block villages.

While the action research duration for the Agri-FNS interventions was 24 months (September 2019–August 2021), owing to the COVID-19 lockdown restrictions, the activities for the intervention group could only be carried out between September 2019 and mid-March 2020, and partially between October 2020 to March 2021. From September to December 2021, the endline assessment was conducted. During September 2019 to March 2020, activities focused on enhancing food availability and accessibility, such as rabi planning, crop selection for household consumption, and multilayer farms (MLF) and kitchen gardens were promoted, as well as food utilisation, such as cooking demonstrations. While the monsoon rainfall was normal in the Parner and Bhokardan blocks, Sakri block villages received excessively heavy rains during October to December. Investments made in the MLF and agriculture were washed away, and farmers suffered losses, which is reflected in the lowered values of the DDS and Hb levels in both the intervention and control groups. In the Bhokardan and Parner blocks, it was later observed that some control group households also implemented modified MLF and kitchen gardens, learning from their neighbours. Activities demonstrated in the intervention group could not be maintained in total isolation; quite often, others who wished to learn also participated in the various training events. This may have contributed to the improved DDS and Hb in the control groups, although to a lesser extent.

Following the COVID-19 outbreak, visits by the field staff were reduced to a minimum; meetings within the village and between households, as well as interactions with the market, were greatly restricted. Despite these limitations, the activities implemented appear to have benefited households in the intervention group. Food preparation demonstrations played a role in improving nutrition. This is observed in Figure 5.3 where participants shared that knowledge through the food demonstrations (80%) and the awareness of nutrition (85%), which benefited them. These findings are also supported by other studies from developing countries where nutrition-based agricultural interventions (Reinbott et al., 2016; Rosenberg et al., 2018; Hitachi et al., 2020), climate-smart agriculture (Hanley et al., 2021), and nutrition education (Sarrafzadegan et al., 2009; Reinbott et al., 2016) improved the dietary diversity among target groups.

Using the DID regression framework, we found that the adoption of the package of practices increased the dietary diversity levels of the respective households, which in turn reduced the endline anaemia levels in the intervention group compared to the control group.

We also considered the opinion of participants about the various activities that were conducted. Most expressed satisfaction. They stated that the activities helped them improve their understanding of nutritional requirements and ways to enhance their food and nutritional intake. They even expressed

their interest in continuing the activities and in helping disseminate them to their own and neighbouring villages. We further infer that the people found the suite of activities beneficial and easy to implement.

In the DDS, this study captured the consumption of eggs, meat, and fish, however, it was found that the household consumption of these was insignificant across households in both the baseline and endline assessments. Since this study was embedded in a project that focused on soil health improvement through agriculture, attention was given to the link between the availability, accessibility, and utilisation of the diversity of crop produce for home consumption. Moreover, this study focused solely on Hb improvement and did not address the other dietary requirements such as proteins, calcium, minerals, vitamins D, B12, and others.

Limitations

This action research included small, medium, and large landowning farming households, all of whom have some water resources. The marginal landowning household category, which does not have water resources, was not included. Hence, the findings are not representative of villages where good WSD measures have not been implemented. Furthermore, the study did not consider the climate angle; extreme climate events may compromise FNS.

Conclusions and Policy Implications

The present study focuses on how FNS-based agricultural initiatives with knowledge can improve consumption patterns and the nutritional status of farming households. The study cautions against the assumption that only increasing agricultural productivity will inherently improve people's nutritional status. Knowledge of the utilisation of food is equally important. Besides the availability and accessibility of farm food produce through appropriate agricultural activities, improving nutrition requires knowledge, i.e., understanding the nutritional needs of humans, the foods that contain vital nutrients and the ways to cook these. Similar to the promotion of crop diversity and MLF, improving women's knowledge on rearing small ruminants and extended backyard poultry with a minimum of 30 local birds will make eggs and meat produce available and accessible for home consumption and for sale. Findings of the study are encouraging from a policy perspective. It also provides guidance for programmatic intervention through different departments. Considering the increasing land degradation of 29.32% (or 96.4 mha) and the expanding desertification of 82.64 mha of India's total geographic area as of 2013 (Government of India, 2016), the urgency of implementing sustainable land and water management measures through

WSD cannot but be highlighted. Soil and water conservation lends itself to working on the demand-side management of water, together with measures to enhance agricultural productivity. The Integrated Child Development Services offers a space to improve the nutritional status of children by enhancing mothers' knowledge of a nutritious diet. Furthermore, the promotion of MLF in rural schools can contribute to improvement in the mid-day meals in concert with the hands-on training of students, who can take this forward in their own farms and homes. Although challenging, upscaling the cultivation of indigenous crops requires marketing of indigenous varieties of farm produce, which helps to preserve our rich agro-biodiversity. The 'International Year of Millets 2023' promoted the consumption of even minor millets. Given that food (and nutrition) security is a growing global concern, the set of interventions from land and water management to the consumption of a balanced and nutrition-rich diet by rural households can be the foundation for meeting the country's food security needs.

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Notes

1 Watershed Organisation Trust (WOTR), headquartered in Pune, India, is a non-profit organisation that works in rainfed regions of India. Its research unit, the WOTR Centre for Resilience Studies (W-CReS), was responsible for this study.
2 Soil Protection and Rehabilitation for Food Security in India (ProSoil); Special Initiative—One World No Hunger (SEWOH), by the Federal Ministry of Economic Cooperation and Development (BMZ) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
3 '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 limestone, red ochre, dry rice flour, coloured sand, quartz powder, flower petals, and coloured rocks.'
4 Sahli's method of testing haemoglobin is the approved standard used in medical laboratories.
5 Later on, it was found that of the control set of households (150 in total), some implemented kitchen garden and MLF activities on their own.

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