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Coalition for Food-Systems Transforma(c)tion in India

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WORKING PAPER

IMPACT OF DIVERSIFIED AGRICULTURE AND NUTRITION BEHAVIOUR CHANGE ON WOMEN IN REPRODUCTIVE AGE GROUP IN WARDHA, MAHARASHTRA

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Impact of Diversified Agriculture and Nutrition Behaviour Change on Women in Reproductive Age Group in Wardha, Maharashtra

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About CoFTI

The **Coalition for Food-Systems Transforma(c)tion in India (CoFTI)** was born out of the United Nations (UN) Food Systems Summit 2021 with a commitment to reshaping India's food system so that safe and nutritious food is accessible to all. Its mission addresses hunger and malnutrition while championing biodiversity, climate resilience, and the protection of livelihoods. By bringing together diverse stakeholders, CoFTI works to create sustainable and equitable solutions that balance the needs of people, planet, and economy. Grounded in the Sustainable Development Goals (SDGs), the Coalition drives positive change across seven key areas of work, ensuring that India's food systems remain resilient for both present and future generations.

CoFTI's approach is anchored in **three core objectives**.

1 **THOUGHT LEADERSHIP**	**USING RESEARCH, INNOVATION, AND EVIDENCE-BASED INSIGHTS TO SHAPE EFFECTIVE POLICIES AND GUIDE THEIR IMPLEMENTATION.**
2 **COLLECTIVE ACTION**	**OFFERING A COLLABORATIVE SPACE WHERE STAKEHOLDERS CAN UNITE, SHARE RESOURCES, AND WORK TOGETHER ACROSS ITS AREAS OF FOCUS.**
3 **BUILDING CONNECTIONS**	**FOSTERING STRONG LOCAL AND INTERNATIONAL NETWORKS TO ENABLE THE EXCHANGE OF KNOWLEDGE AND STRENGTHEN PARTNERSHIPS**

Through these objectives, CoFTI serves as both a catalyst and a convener, ensuring that India's journey towards a just, sustainable, and nourishing food future is grounded in shared purpose and actionable solutions.

CoFTI Core Group comprises of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Welthungerhilfe India (WHH), Food Future Foundation (FFF), and Watershed Support Services and Activities Network (WASSAN), which hosts the Secretariat of CoFTI.

The Core Group has evolved to CoFTI's Transformation Council (2025–26), a strategic advisory body driving high-potential initiatives through a cross-sector cohort. It unites civil society, government, academia, and private sector stakeholders to advance collaborative food systems transformation in India.

The CoFTI Fellowship Programme

The CoFTI Fellowship Programme (2025) was conceptualized to nurture early-career researchers in India by supporting them to explore and generate evidence on critical food systems issues. Designed as a structured three-month fellowship, it combined rigorous selection, thematic focus, and a mentorship model curated, hosted and implemented by CoFTI Secretariat with support from WASSAN and Welthungerhilfe (WHH) India. Through guided research and collaborative knowledge creation, the programme culminated in the Fellows producing six working papers, an Issue Brief, and a detailed survey-based analytical report.

The CoFTI Fellowship Programme was carried out from August to November 2025 followed by a rigorous process of review and finalisation of the outputs. Applications were invited from early career researchers for specific thematic areas identified through consultations with CoFTI members. The programme received nearly 500 applications from which eight fellows were selected by a panel including the CoFTI Core group members and other subject experts who are also members of the Coalition. A team of subject experts was invited to mentor the Fellows. The CoFTI Fellows received an honorarium to support their research during the Fellowship, and the final topics were decided jointly by the Fellows and their assigned mentors.

Of the eight fellows selected, seven successfully completed the CoFTI Fellowship programme. Five Fellows undertook original research projects from conceptualisation to manuscript preparation, while two contributed to the development of a CoFTI Issue Brief and a survey-based analytical report.

Voluntary mentorship by CoFTI members: A defining feature of the fellowship was its mentorship model. Members of CoFTI, Core Group, and the Secretariat have voluntarily mentored the fellows throughout the programme.

The fellowship culminated in the presentation of findings, followed by review, revision, and publication as part of the CoFTI Working Paper Series, with opportunities for further research collaboration and publication.

The CoFTI Secretariat was responsible for the overall design and coordination of the Fellowship programme. This included developing the fellowship framework, managing the selection process, facilitating mentor–fellow engagement, and coordinating the review, editing, design, publication, and communication of the Fellows' outputs. As the institutional anchor of the Secretariat, WASSAN also played a significant role in the operational management and smooth implementation of the fellowship programme by providing administrative, human resource, and design support, which was instrumental in ensuring the effective delivery of the programme.

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The views expressed in this working paper are those of the authors and do not necessarily reflect the views of all contributors, participants, or partner organisations.

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List of Abbreviations

ABBREVIATION	FULL FORM
ASHA	Accredited Social Health Activist
BMZ	German Federal Ministry for Economic Cooperation and Development
CoFTI	Coalition for Food Systems Transformation in India
FAO	Food and Agriculture Organization
FFF	Food Future Foundation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
Hb	Hemoglobin
IFA	Iron and Folic Acid
IIPS	International Institute for Population Sciences
LANN+ PLA	Linking Agriculture and Natural Resource Management towards Nutrition Security plus WASH through
MDD-W	Minimum Dietary Diversity for Women
NSIFS	Nutrition-Sensitive Integrated Farming Systems
SD	Standard Deviation
SDGs	Sustainable Development Goals
UN	United Nations
UPAVAN	Upscaling Participatory Action and Videos for Agriculture and Nutrition
WaSH	Water, Sanitation and Hygiene
WASSAN	Watershed Support Services and Activities Network
WHH	Welthungerhilfe

Executive Summary

Wardha district in Maharashtra provides an important setting for examining the relationship between agriculture and nutrition because farming in the area is closely linked to cotton-based production systems. Within this setting, the intervention integrated nutrition-sensitive agriculture with nutrition and WASH learning, nutrition gardens, diversified household production, ecological farming practices and community-based facilitation through **Linking Agriculture and Natural Resource Management towards Nutrition Security plus WASH through Participatory Learning and Action, LANN+ PLA, Nutrition-Sensitive Integrated Farming Systems and Farmer Field School activities (here onwards the Programme or Wardha study)**.

The study examines whether women of reproductive age participating in the Programme experienced changes in hemoglobin concentration and anemia severity, and whether these changes occurred alongside differences in dietary diversity, household food production, food sourcing, agricultural practices and Programme participation. It also considers how women and community facilitators described the translation of Programme learning into everyday practice, including changes in nutrition-related behaviours, greater confidence in participating in meetings and community activities, increased recognition within villages, and, in some cases, a stronger voice in household food-related decisions.

A mixed-methods observational approach was used across 12 intervention villages and two comparison villages in Wardha. The analysis included 108 women aged 15–49 years, comprising 86 intervention and 22 comparison participants. Paired before and after Hb measurements were available for 69 intervention participants. Quantitative analysis covered hemoglobin, anemia status, MDD-W, food-group consumption, household production, food sourcing and agricultural practices, while qualitative enquiry explored Programme experiences and household-level changes.

Among women with paired measurements, mean Hb increased from 10.59 to 11.51 g/dL, representing a mean within-person increase of 0.93 g/dL. Overall, 91.3% recorded an increase and none recorded a decline. Anemia severity also improved, with 36.2% moving to a less severe category. Dietary diversity was substantially higher among intervention participants: 87.2% met the MDD-W threshold compared with 9.1% in comparison villages. Intervention households also reported greater access to nutrition gardens and more diversified household production, while consumption of pulses, dairy, vitamin A-rich fruits and vegetables, other vegetables and other fruits was significantly higher.

The study indicates that agricultural participation alone does not fully capture the nutritional relevance of farming systems. What appears to matter is whether household production includes foods relevant to family diets, whether these foods are available for consumption, and whether nutrition knowledge and behaviour-change learning support their use. The Wardha study therefore adds evidence on how agricultural, dietary and biological outcomes can be examined together within a nutrition-sensitive Programme, while also highlighting the role of locally embedded community facilitation.

Future evaluations should strengthen this evidence through prospective Hb measurement in both intervention and comparison groups, repeated dietary assessment, standardized biological measurement and longer-term follow-up. Further research could also assess whether similar approaches can be adapted to other commercially oriented agricultural settings where agricultural production coexists with persistent nutritional challenges.

1 INTRODUCTION

Agriculture is a major source of livelihood and food access in rural settings, yet participation in farming does not necessarily translate into nutritionally adequate diets. Agricultural production may be shaped primarily by income, market demand, land, water availability and agroclimatic conditions, and may not always align with the diversity of foods required for good nutrition. This disconnect has contributed to growing interest in nutrition-sensitive agriculture, which integrates explicit nutrition objectives into agricultural programmes and examines pathways linking production, food access, dietary quality and health (Ruel and Alderman 2013; Sharma *et al.* 2021).

Diversified agriculture may influence this pathway by increasing household access to a wider range of nutritionally relevant foods. However, greater production diversity alone may not be sufficient to change diets unless households also retain or acquire nutrient-rich foods and incorporate them into regular consumption. Nutrition behaviour-change approaches may support this translation from food availability to dietary practice, particularly when delivered through community-based learning and women's participation (Ruel and Alderman 2013; Prost *et al.* 2022).

Women of reproductive age are particularly relevant to examining the agriculture–nutrition relationship because dietary diversity during the reproductive years is associated with a greater likelihood of micronutrient adequacy (FAO 2021). Dietary diversity can therefore provide an indication of whether differences in food access and consumption are reflected in diet quality. However, dietary measures alone do not capture all dimensions of nutritional status. Anemia is an important nutritional concern among women of reproductive age, although its causes are multifactorial and dietary diversity does not directly measure iron intake or hemoglobin status. Examining dietary diversity together with Hb and anemia can therefore provide complementary evidence on dietary and biological dimensions of women's nutritional status (FAO 2021; WHO 2024).

Wardha district in Maharashtra provides a distinctive setting for examining the agriculture–nutrition relationship because the study villages were already embedded within a cotton-production system linked to the Better Cotton Initiative and Welspun's work with cotton-growing communities. While these arrangements focused principally on sustainable cotton production and farmer livelihoods, Programme assessments also identified persistent nutritional concerns among women and children in the region. This provided the context for a complementary nutrition-sensitive intervention led by Deutsche Welthungerhilfe (WHH), with Swayam Shikshan Prayog (SSP) as the local project holder and implementation partner, Welspun Foundation for Health & Knowledge as a cooperation partner, and support from GIZ. The intervention extended the existing agricultural engagement beyond cotton production to nutrition-sensitive integrated farming, household food diversification, nutrition gardens, behaviour-change learning and WASH. This makes Wardha particularly relevant for examining whether diversified household production and nutrition behaviour change are reflected not only in dietary outcomes, but also in dietary and biological indicators among women of reproductive age.

This study and its respondents are drawn from a program that was implemented in Wardha by convenient and purposive sampling. The Programme examined in the present study combined **Linking Agriculture and Natural Resource Management towards Nutrition Security plus WASH through Participatory Learning and Action (LANN+ PLA), Nutrition-Sensitive Integrated Farming Systems (NSIFS) and Farmer Field School activities**. Through this integrated approach, households were exposed to nutrition and WASH learning alongside support for nutrition gardens, diversified production and ecological farming practices. In the remainder of this paper, these integrated activities are referred to collectively as the **Programme**.

Improvement in hemoglobin was not established a priori as the Programme's principal outcome. During implementation, repeated Hb records were available for a subset of participating women, providing an opportunity to examine within-person changes in Hb alongside dietary diversity, household food production, Programme participation and adoption of nutrition-sensitive agricultural and WASH practices.

The present study primarily examines within-person changes in hemoglobin concentration and anemia severity among women with available earlier and follow-up Hb measurements. Dietary diversity, household food production, food sourcing, Programme participation, and adoption of nutrition-sensitive agricultural and selected WASH practices are examined as supporting domains to contextualise the observed Hb changes. Qualitative evidence is used to interpret how learnings and understanding from the Programme were translated into household practices.

The study further considers whether patterns across these agricultural, dietary and biological domains are consistent with the Programme's proposed agriculture–nutrition pathway, in which programme exposure and behaviour-change learning support the adoption of nutrition-sensitive agricultural practices, stronger household food production and dietary diversity, and, ultimately, improved nutritional outcomes.

1.1 Study Objectives

The objectives of the study are the following:

- To examine changes in hemoglobin concentration and anemia status among women aged 15–49 for whom both before and after measurements were available.
- To understand whether observed changes in Hb were associated with dietary diversity, household food production, participation in LANN+ PLA activities, adoption of nutrition-sensitive and ecological agricultural practices, and selected Water, Sanitation and Hygiene (WASH) practices.
- To explore how Programme learning was understood and translated into household nutrition, agricultural, WASH and community practices.

1.2 Research Questions

Primary research question

What changes in hemoglobin concentration and anemia status were observed among women with available earlier and follow-up measurements?

Supporting research questions

1. Were observed changes in Hb associated with dietary diversity, household food production, adoption of nutrition-sensitive and ecological agricultural practices, and selected WASH practices?
2. How did dietary diversity, household food production, food sourcing and adoption of nutrition-sensitive agricultural practices differ between women in intervention and comparison villages?
3. How did participating women and community facilitators perceive changes in diets, farming practices, WASH practices, confidence and participation?

Limitations

The study does not treat the Programme as a proven cause of improved Hb. Villages were not randomly assigned, follow-up Hb measurements were unavailable for comparison participants, and hemoglobin is influenced by multiple dietary, reproductive, infectious and health-related factors. The findings are therefore interpreted in terms of whether dietary, agricultural and WASH-related changes occurred alongside observed Hb improvement, rather than as evidence of a direct causal effect.



Source: Payal Thakur

Figure 1. Overview of the key components of the Wardha nutrition-sensitive agriculture and behaviour-change intervention.

2

LITERATURE REVIEW

The literature points out that persistent nutrition challenges in India are shaped by interconnected factors including agriculture, food systems, livelihoods, women's agency and health. National survey data indicate that 57 percent of women aged 15–49 were anemic in 2019–2021, compared with 53.1 percent in the preceding National Family Health Survey (IIPS and ICF 2021). This literature review explores the interlinkages among these factors and their implications for nutritional outcomes.

2.1 Nutrition-sensitive agriculture and dietary outcomes

Nutrition-sensitive agriculture refers to approaches that integrate explicit nutrition objectives into agricultural Programmes. Potential pathways include household food production, agricultural income improvement, nutrition knowledge, women's control over resources and the role of local institutions. A systematic review found that such intervention outcomes were more consistently associated with improvements in dietary practices and other underlying determinants of nutrition than with anthropometric or biochemical outcomes (Sharma *et al.* 2021).

Agricultural interventions do not improve nutritional status simply by increasing overall production. Micro-level public interventions, including household level interventions can have positive impacts on nutritional outcomes on individuals. Their effects depend on whether households produce or acquire nutrient-rich foods, retain them for consumption, understand their nutritional value and incorporate them into everyday diets. Studies suggest that nutritional effects may vary according to intervention design, including the integration of nutrition-related behaviour change, attention to women's nutrition and empowerment, and complementary nutrition and health components (Ruel and Alderman 2013; Sharma *et al.* 2021).

Studies from India support this integrated approach. The UPAVAN trial in rural Odisha combined nutrition-sensitive agricultural content with participatory videos, women's group meetings and participatory learning and action. The trial reported improvements in dietary diversity, particularly in the more intensive intervention arms, while effects on measured nutritional status were limited. Its process evaluation showed that repeated engagement, locally relevant content and collective discussion helped women interpret and apply agricultural and dietary messages within their own circumstances (Kadiyala *et al.* 2021; Prost *et al.* 2022).

Dietary diversity is therefore relevant both as an outcome of nutrition-sensitive programming and as an intermediate pathway through which nutritional status may change, without implying that dietary change will necessarily translate into measurable biological improvement.

2.2 Production diversity, household consumption and market access

The relationship between farm-production diversity and dietary diversity is generally positive but neither strong nor automatic. Jones's review of studies from low- and middle-income countries found that greater agricultural biodiversity was associated with more diverse diets, although the magnitude varied across settings and according to existing farm diversity and market conditions (Jones 2017).

A meta-analysis of smallholder farm households found that greater production diversity was positively associated with dietary diversity, although the average relationship was modest and varied across settings. The findings indicate that the nutritional relevance of diversified production depends not only on the number of crops or livestock species produced, but also on household income, market participation and the wider local food system (Sibhatu and Qaim 2018).

Own production and market access can therefore represent complementary pathways to dietary access. Household production can increase access to foods that households are able to produce themselves, while markets remain important for foods constrained by seasonality, production conditions or household resources. Their relative importance varies with household resources, irrigation and market access. (Jones 2017; Sibhatu and Qaim 2018).

Studies from rural India further demonstrates the importance of distinguishing between overall production diversity and the types of foods produced. In a study of 3,600 households, on-farm production involving pulses, livestock and kitchen gardens was associated with greater dietary diversity, while market purchases of non-staple foods such as pulses and dairy were also positively associated with dietary diversity (Gupta *et al.* 2020). These findings reinforce the importance of considering both the composition of household production and market sourcing when examining dietary outcomes.

An earlier Farming System for Nutrition study conducted in Wardha, Maharashtra, and Koraput, Odisha, provides relevant Indian Studies on diversified production systems. The initiative integrated crops, horticulture and animal-source foods with nutrition awareness and community demonstrations. It reported improvements in the production and consumption of nutrient-rich foods and household dietary diversity, while positioning diversified farming as one component of a broader nutrition strategy (Pradhan *et al.* 2021).

This study supports examining household production and market sourcing together when assessing pathways to dietary diversity.

2.3 Dietary diversity, micronutrient adequacy and hemoglobin

The Minimum Dietary Diversity for Women (MDD-W) indicator assesses whether individual women consumed at least five of ten defined food groups during the preceding 24 hours and is used to describe dietary diversity at the population level. Reaching this threshold is associated with a greater likelihood of micronutrient adequacy, but the indicator does not measure portion size, nutrient quantities, habitual intake or individual clinical status (FAO 2021).

Validation studies support the use of women's dietary diversity as an indicator associated with micronutrient adequacy at the population level. Across diverse resource-poor settings, dietary-diversity indicators were associated with the adequacy of women's micronutrient intake, providing part of the empirical basis for MDD-W (Arimond *et al.* 2010).

MDD-W cannot be interpreted as a direct measure of iron intake or Hb status. It is a population-level dietary-diversity indicator associated with the likelihood of micronutrient adequacy and does not measure nutrient quantities or individual clinical status (FAO 2021).

A woman may consume a diverse diet but still have inadequate intake or absorption of iron and other nutrients required for blood formation. Conversely, Hb may change because of factors such as infection, reproductive status, blood loss, supplementation or medical treatment, even when dietary diversity remains unchanged (Owais *et al.* 2021).

Compared with the literature on food production, dietary diversity and child nutrition, relatively limited studies examine repeated Hb measurements among adult women within nutrition-sensitive agricultural interventions. Where Hb changes are observed, separating the contribution of agricultural and dietary change from reproductive factors, clinical care and underlying health status remains difficult.

2.4 Women's agency and community-based delivery

Women's agency may influence whether agricultural and nutrition knowledge is translated into household practice through decisions about production, food use, expenditure and healthcare. Agency is multidimensional, however, and cannot be inferred from Programme attendance, group membership or leadership roles alone.

A mixed-methods systematic review found heterogeneous relationships between gender equity in agricultural income, land, livestock and workloads and nutrition or food-security outcomes. The findings suggest that access to agricultural resources alone may not translate into improved nutrition; control over those resources and the workload associated with agricultural participation also appear relevant (Harris-Fry *et al.* 2020).

Studies from rural India similarly indicate that women's participation in agricultural decision-making can be relevant to dietary outcomes. Analysis of 3,600 households found higher dietary-diversity scores among women with greater empowerment in agricultural decisions, particularly in relation to production decisions and self-help-group membership, after accounting for household market purchases and other characteristics (Gupta *et al.* 2019).

Community-based delivery may help women interpret agricultural and nutrition messages in relation to their own circumstances. The UPAVAN process evaluation found that repeated, dialogue-based engagement increased women's knowledge, motivation and confidence, while adoption remained constrained by factors including land, irrigation and family support (Prost *et al.* 2022).

These findings indicate that participation and access to resources do not, by themselves, establish women's agency or the extent to which Programme learning is translated into household practice.

2.5 WASH and other health-related influences

Women's nutritional status is shaped by both dietary and non-dietary factors. Infection, reproductive conditions and the household water, sanitation and hygiene environment may influence anemia and Hb alongside dietary factors. Studies from low- and middle-income countries indicate that improved sanitation has been associated with reductions in anemia among women of reproductive age, although the magnitude and importance of these relationships vary across settings (Owais *et al.* 2021).

Water supply and handling, sanitation and handwashing can therefore be considered part of the broader household health environment within which dietary and agricultural changes occur. Their relationship with Hb is likely to operate through indirect health pathways and should be interpreted alongside dietary, reproductive and other health-related influences rather than as an isolated determinant of Hb.

2.6 Research gap

The literature reviewed here issubstantially stronger on intermediate dietary outcomes than on repeated Hb measurements among adult women within nutrition-sensitive agriculture Programmes. Uncertainty also remains around how household production and food sourcing interact with dietary diversity in Programme settings, particularly in agricultural contexts oriented towards cash crops. Studies are more limited where repeated Hb measurements are considered alongside agricultural practices, WASH and women's experiences of Programme participation.

These gaps are relevant to the Wardha study, which considers repeated Hb and anemia measurements alongside dietary diversity, household production and food sourcing, agricultural-practice adoption, WASH and qualitative responses of Programme participation. The studyexplores whether observed patterns across these domains are consistent with Programme exposure (LANN+ PLA, NSIFS), while maintaining a clear distinction between association and causation.

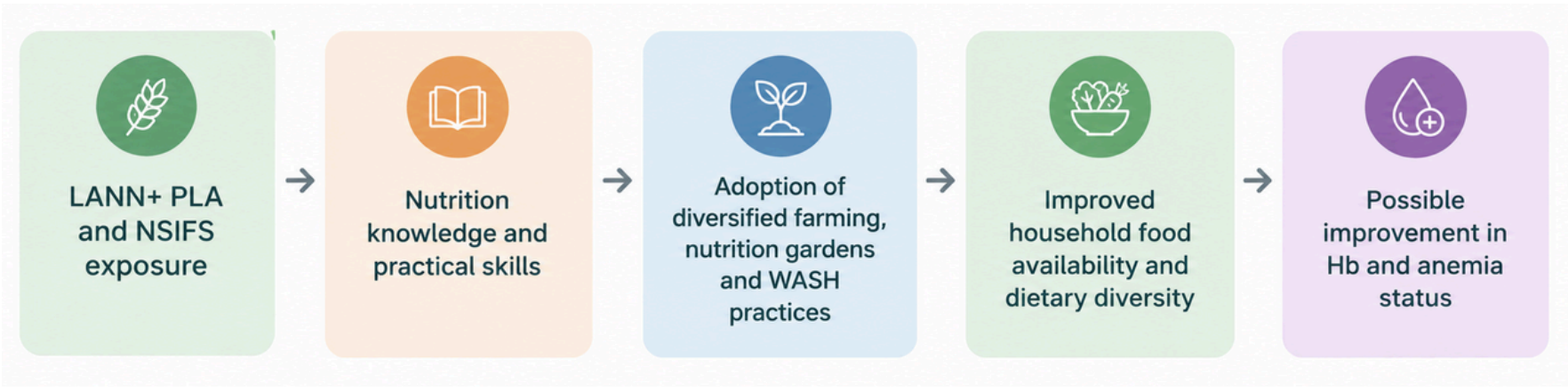


Figure 2. Analytical pathway linking Programme exposure with hemoglobin status.

3 METHODOLOGY

The study focuses on Programme exposure, which includes nutrition gardens and diversified household production, ecological and organic farming practices, food-consumption and food-source patterns, WASH practices, and women's responses to changes in knowledge, confidence, decision-making and community participation. It also compares selected dietary, agricultural and behavioural indicators between women in intervention villages and women in two comparison villages where the assessed Programme activities had not been introduced.

3.1 Study design and setting

Fieldwork was conducted in Wardha district, Maharashtra, from 25 to 31 August 2025. The study covered 12 villages in which the LANN+ PLA and Nutrition-Sensitive Integrated Farming Systems Programme had been implemented and two comparison villages, where the assessed Programme activities had not been introduced.

The study was conducted within an existing nutrition-sensitive agriculture and behaviour-change Programme and was not a randomized trial. Respondents of the study were identified through convenient and purposive sampling. The comparison villages provided a descriptive reference for examining differences in dietary diversity, food sourcing, nutrition-garden access, household production and selected agricultural and WASH practices. Changes in Hb were assessed only among intervention participants with both earlier and follow-up measurements because paired Hb records were not available for women in the comparison villages.

3.1.1 Study sample

The intended study population comprised women aged 15–49 years residing in the selected villages. During field visits, meetings were organised at participants' homes or other locally convenient community spaces. Women who were present, available and willing to participate were invited to complete the questionnaire. Recruitment therefore followed a non-probability, convenient and availability-based approach within purposively selected intervention and comparison villages.

The study covered 12 intervention villages- Shivangoan, Pimplegaon, Zadashi, Zungad, Khapri, Pavnur, Peth, Anji, Goji, Gaymukh, Dahegaon and Narsula, where the LANN+ PLA and Nutrition-Sensitive Integrated Farming Systems programme had been implemented, and two comparison villages, Karanji Bhoge and Nandora, where the assessed programme activities had not been introduced.

The field dataset contained 124 participant records: 102 from intervention villages and 22 from comparison villages. Sixteen respondents were older than 49 years and were excluded from the primary reproductive-age analyses. The resulting analytical sample comprised 108 women aged 15–49 years, including 86 intervention and 22 comparison participants. Complete MDD-W information was available for all 108 women. Earlier Hb values were available for 78 intervention and five comparison participants. Paired earlier and follow-up Hb measurements were available for 69 intervention participants; no comparison participant had both measurements.



Source: Payal Thakur

Figure 3. Gram Panchayat office in an intervention village, Wardha district, Maharashtra.

Source: Author



Figure 4. Group discussion with women during the field enquiry at a participant's home in an intervention village, Wardha district, Maharashtra.

Analysis

The study used a mixed-methods observational design to examine hemoglobin (Hb), dietary diversity, household food production, agricultural-practice adoption, Water, Sanitation and Hygiene (WASH) practices and Programme experiences among women of reproductive age. Quantitative data were obtained through a structured field questionnaire and available earlier and follow-up Hb records, while qualitative evidence was drawn from facilitated discussions and contemporaneous field notes. Quantitative and qualitative evidence were analysed within their respective domains and considered together during interpretation to assess whether measured patterns corresponded with participants' and community facilitators' responses of Programme exposure and changes in practice (Creswell and Plano Clark 2018).

TABLE 1. PARTICIPANT FLOW AND ANALYTICAL SAMPLES

Analytical stage	Intervention	Comparison	Total
Records collected	102	22	124
Women aged 15–49	86	22	108
Complete MDD-W data	86	22	108
Earlier Hb available	78	5	83
Paired earlier and follow-up Hb available	69	0	69

Source: Author

3.2 Programme intervention, participants and field recruitment

The Programme was designed and guided by Deutsche Welthungerhilfe (WHH) and implemented in Wardha by Swayam Shikshan Prayog (SSP), with Welspun Foundation for Health & Knowledge serving as a cooperation partner and GIZ providing financial and technical support (Welthungerhilfe and Swayam Shikshan Prayog 2023). The Programme combined **Linking Agriculture and Natural Resource Management towards Nutrition Security plus WASH through Participatory Learning and Action (LANN+ PLA) with Nutrition-Sensitive Integrated Farming Systems (NSIFS)**, including Farmer Field School activities. LANN+ PLA provided participatory learning on nutrition, dietary practices, hygiene and sanitation, while NSIFS supported nutrition-sensitive household and farm production through nutrition gardens, diversified cropping, livestock-related practices and ecological/organic agricultural approaches. (Welthungerhilfe and Swayam Shikshan Prayog 2023; Welthungerhilfe 2025).

LANN+ PLA sessions facilitated discussions, visual materials, demonstrations and participatory exercises focused on locally available foods, balanced diets, nutrition-related household practices and WASH.NSIFS activities were delivered through training sessions, Farmer Field Schools, demonstration plots and household-level support. Vegetable seed kits and selected agricultural inputs were also provided to support adoption of Programme practices.

The Programme promoted an organic/ecological farming approach operationalised through practices including mixed cropping, vermicomposting, biofertiliser preparation and use, and biopesticide use. Other promoted practices included crop diversification, nutrition-garden establishment, livestock integration, soil and water management, seed treatment and sprinkler irrigation. Lead farmers supported practical and seasonal learning through demonstration plots and Farmer Field School activities.

Programme delivery followed a cascade capacity-building model. Master trainers trained community resource persons, including Accredited Social Health Activist (ASHA) workers, Anganwadi workers, women's group leaders and lead farmers. These facilitators subsequently supported LANN+ PLA meetings, Farmer Field School sessions, demonstrations and follow-up activities with women and farming households.



Source: Payal Thakur

Figure 5. 'Sakhi Anna Suraksha Sheti' model indicates diversified food-crop production for household nutrition and food security.

TABLE 2. PROGRAMME COMPONENTS AND PRINCIPAL ACTIVITIES

Programme domain	Principal activities
Participatory nutrition learning	LANN+ PLA meetings, balanced-diet education, locally available foods and participatory nutrition learning
WASH learning	Water handling, hygiene, sanitation, toilet use and handwashing
Nutrition gardens	Garden planning, crop selection, demonstrations and seed kits
Diversified farming	Crop diversification, pulses, horticulture and integration of food crops within existing farming systems
Livestock and integrated farming	Livestock-related practices and integration of farm subsystems
Organic/ecological farming	Mixed cropping, vermicomposting, organic manure, biofertilisers, biopesticides, seed treatment and natural-input preparation
Soil and water management	Sprinkler irrigation and other soil- and water-management practices
Farmer Field Schools	Demonstration plots, seasonal training and practical agricultural learning
Community facilitation	ASHA workers, Anganwadi workers, women's group leaders, lead farmers and community resource persons

Source: Payal Thakur



Figure 6. RO water facility at the Gram Panchayat in an intervention village, Wardha district, Maharashtra.

3.3. Quantitative data collection and measures

The questionnaire collected information on demographic and household characteristics, Programme participation, food consumption and food sources, nutrition gardens, crop and farming practices, WASH, household food-related decision-making, Hb awareness and perceived changes in household and Programme-related practices. Maternal-health and supplementation information was also collected. The same questionnaire was used in the intervention and comparison villages.

"Hemoglobin concentration and anemia status"

Earlier and follow-up Hb values were obtained from records made available to the study by the Programme. Available Programme records document that earlier Hb measurements were collected in December 2024, while follow-up measurements were collected during July–August 2025. Paired values were available for 69 age-eligible women from intervention villages.

Hb change = follow-up Hb − earlier Hb

Positive values indicated an increase in Hb, zero indicated no recorded change and negative values indicated a decline.

Anemia status for the paired-Hb analysis was classified using WHO thresholds for non-pregnant women aged 15 years and older (WHO 2024); no pregnant women were identified among the intervention participants included in the paired-Hb analysis.

TABLE 3. HEMOGLOBIN THRESHOLDS USED TO CLASSIFY ANEMIA

Population group	No anemia	Mild anemia	Moderate anemia	Severe anemia
Non-pregnant women aged ≥15 years	≥12.0 g/dL	11.0–11.9 g/dL	8.0–10.9 g/dL	<8.0 g/dL

Source: World Health Organization (2024).

Dietary diversity and food sources

Dietary diversity was assessed using the Minimum Dietary Diversity for Women (MDD-W) indicator in accordance with FAO guidance (FAO 2021). Participants reported whether they had consumed foods from each of ten defined food groups during the preceding day or night: (1) grains, white roots, tubers and plantains; (2) pulses; (3) nuts and seeds; (4) dairy; (5) meat, poultry and fish; (6) eggs; (7) dark green leafy vegetables; (8) other vitamin A-rich fruits and vegetables; (9) other vegetables; and (10) other fruits.

Each consumed food group contributed one point to a score ranging from 0 to 10. Women consuming foods from at least five groups were classified as meeting minimum dietary diversity. For each consumed food group, the questionnaire also recorded whether the food was obtained from a nutrition or kitchen garden, household farm, livestock or market.

Nutrition gardens and household food production
The questionnaire recorded whether respondents had access to a nutrition or kitchen garden, a household farm or both, together with the crops and vegetables grown and reported changes in household food production.

Reported possession of a nutrition garden or household farm was treated as evidence of access to production, while crop entries were used to characterise reported household production. Training attendance or awareness of nutrition gardens alone was not classified as garden adoption.

Open-ended crop entries were standardised and classified, where possible, into categories corresponding with MDD-W food groups:

- dark green leafy vegetables;
- vitamin A-rich fruits and vegetables;
- other vegetables;
- pulses and legumes;
- cereals, roots and tubers;
- Fruits; and
- animal-source foods.

A formal crop-diversity index was not constructed because the number and specificity of open-ended crop responses varied across participants.

Agricultural-practice adoption
Participation in training or knowledge of a practice was not treated as evidence of adoption. A practice was classified as adopted only where the respondent reported that it was being used or implemented by their household.

Recorded adoption measures included nutrition gardens, crop diversification, mixed cropping, livestock-related practices, vermicomposting, biofertiliser preparation or use, biopesticide use, cattle-feed preparation, seed treatment and sprinkler irrigation.
Mixed cropping, vermicomposting, biofertilisers and biopesticides were treated as Integrated farming components. Responses were harmonised into common analytical categories. The dataset's indicator of adoption of at least two integrated-farming components was retained as a summary measure of the breadth of self-reported practice adoption; it did not measure the intensity, duration or technical quality of implementation.

WASH and food-related decision-making
WASH measures included drinking-water source and treatment, toilet facilities and use, and handwashing with soap.

Participation in household food decisions was assessed by identifying the person or persons who decided which foods were purchased or prepared. Responses were grouped into respondent-led, joint, male household member-led and senior female household member-led.

3.4 Qualitative Key Informant Interviews

Qualitative key informant interviews were conducted in intervention villages with ASHA workers, Anganwadi workers, women's group or team leaders and community facilitators who were available during fieldwork and had direct involvement in Programme activities. Key informant interview respondents were included because of their involvement in Programme activities and familiarity with women's participation, nutrition and agricultural practices, and village-level implementation. The discussions were conducted separately from the individual questionnaire survey. The semi-structured interviews focused on women's health and anemia, dietary practices and food sourcing, nutrition gardens and household production, agricultural-practice adoption, market dependence, WASH, access to health services, food and farming decisions, women's confidence and community participation, perceived Programme changes and barriers to adoption.

Interviews were conducted mainly in Marathi. A female field-team member assisted with interpretation where participants used locally specific expressions. The interviews were documented through contemporaneous written field notes rather than audio recordings or verbatim transcripts to respect the privacy of the respondents and to ensure fear-free expression of their perspectives.

The field notes were reviewed iteratively and organised into recurring thematic domains, informed by principles of thematic analysis (Braun and Clarke 2006). The thematic organisation covered nutrition and dietary practices, household food production, agricultural practices, WASH, food-related decision-making, confidence and community participation, and barriers to adoption. Findings were synthesised thematically, with direct quotations used only where participants' wording had been recorded with sufficient accuracy.

3.5 Data management, analysis and integration

Questionnaire responses and Hb records were entered into a spreadsheet. Data preparation included standardisation of village names, categorical responses, crop names and agricultural-practice terminology; separation of missing observations from negative responses; and checks of Hb values and dates for internal consistency.

The primary reproductive-age and MDD-W analyses were restricted to the 108 women aged 15–49 years, all of whom had complete MDD-W information. Paired-Hb analysis was restricted to the 69 age-eligible intervention participants with both earlier and follow-up measurements; the five comparison participants with an earlier Hb value had no corresponding follow-up measurement and were therefore not included in the change analysis.

Participant characteristics and study measures were summarised using frequencies and percentages for categorical variables. Continuous variables were presented as means and standard deviations and, where distributions were skewed, as medians and interquartile ranges.

Quantitative analyses examined participant characteristics, intervention–comparison differences in MDD-W and individual food-group consumption, food-source patterns, nutrition-garden and household-farm access, reported agricultural-practice adoption, WASH measures, and within-person changes in Hb and anemia severity. Exploratory descriptive analyses also examined Hb change according to selected dietary, agricultural and WASH characteristics.

Within-person Hb change was calculated as follow-up Hb minus earlier Hb. Normality of the paired differences was assessed using the Shapiro–Wilk test. Because the distribution of Hb change was non-normal, earlier and follow-up Hb measurements were compared using the Wilcoxon signed-rank test. Intervention–comparison differences in categorical outcomes were assessed using Pearson's chi-square test, with Fisher's exact test used when expected cell frequencies were small. All statistical tests were two-sided, with statistical significance assessed at $p < 0.05$. Frequencies, percentages, measures of central tendency and dispersion, and 95 percent confidence intervals were reported where applicable.

Given the paired-Hb sample size and sparse variation in Hb-change categories, exploratory subgroup analyses emphasised descriptive patterns rather than extensively adjusted multivariable modelling. Agricultural practices were examined individually and, where applicable, through the summary indicator of self-reported adoption of at least two integrated-farming components.

Quantitative and qualitative evidence were considered together during interpretation. Qualitative themes were used to contextualise patterns in Programme participation, agricultural and household practices, dietary change and WASH, rather than as substitutes for quantitative dietary or Hb measures.

Participation in the field enquiry was voluntary. Individual Hb and health information was treated as confidential.



Source: Author

Figure 7. Field discussion with women participants at a Gram Panchayat office during the Wardha field enquiry.

4

RESULTS

4.1 Characteristics of the analytical sample

The analytical sample comprised 108 women aged 15–49 years, including 86 participants from intervention villages and 22 from comparison villages. Mean age was 36.5 years (SD 7.5) among intervention participants and 35.0 years (SD 7.0) among comparison participants. Mean household size was 4.8 members (SD 2.0) among intervention participants with available information and 4.6 members (SD 1.1) among comparison participants.

Parity information was available for 84 intervention participants and all 22 comparison participants. Two previous births were the most frequently reported category, accounting for 72.6% of intervention participants and 68.2% of comparison participants with available parity information. One previous birth was reported by 25.0% and 22.7%, respectively, while 2.4% of intervention participants and 9.1% of comparison participants reported no previous births.

Complete MDD-W information was available for all 108 women. Earlier Hb measurements were available for 83 women: 78 intervention participants and five comparison participants. Paired earlier and follow-up Hb measurements were available for 69 intervention participants, who constituted the sample for the within-person Hb analysis. No comparison participant had paired Hb measurements.

TABLE 4. CHARACTERISTICS OF THE ANALYTICAL SAMPLE

Characteristic	Intervention	Comparison
Women aged 15–49, n	86	22
Age, mean ± SD, years	36.5 ± 7.5	35.0 ± 7.0
Household size, mean ± SD	4.8 ± 2.0[1]	4.6 ± 1.1
Parity, n (%)	n=84	n=22
No previous births	2 (2.4)	2 (9.1)
One birth	21 (25.0)	5 (22.7)
Two births	61 (72.6)	15 (68.2)
Three or more births	0 (0.0)	0 (0.0)
Complete MDD-W data, n	86	22
Earlier Hb available, n	78	5
Paired earlier and follow-up Hb available, n	69	0

Source: Author's Analysis

1 Household-size information was available for 85 of the 86 intervention participants.

2 Parity information was available for 84 of the 86 intervention participants; intervention percentages for parity use n = 84 as the denominator.

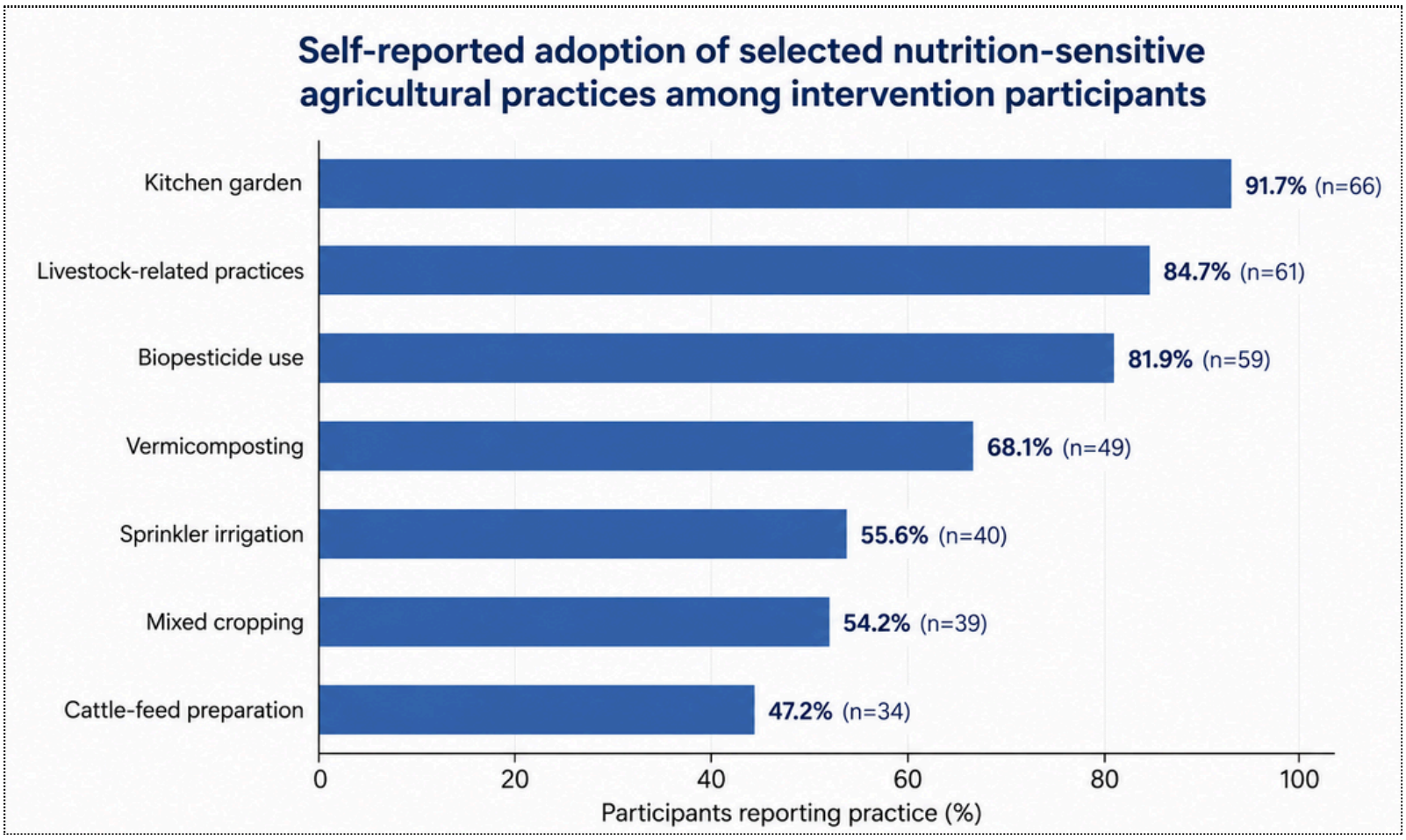
4.2 Programme exposure and adoption of nutrition-sensitive agricultural practices

Participation records were available for 80 of the 86 intervention participants. All 80 women with recorded LANN+ PLA participation information reported having participated in Programme activities; participation data were unavailable for six women. Programme participation was considered separately from reported practice adoption so that attendance at training or meetings was not treated as evidence of household implementation.

Information on integrated-farming adoption was available for 82 intervention participants. Of these, **71 (86.6%)** reported adoption of at least two integrated-farming components, while **11 (13.4%)** reported fewer than two components.

Detailed information on individual agricultural practices was available for 72 intervention participants. Kitchen gardening was reported by **66 women (91.7%)**, livestock-related practices by **61 (84.7%)**, biopesticide use by **59 (81.9%)**, and vermicomposting by **49 (68.1%)**. Sprinkler irrigation, a water-conserving practice promoted as an alternative to direct pipe irrigation, was reported by **40 women (55.6%)**. Mixed cropping was reported by **39 (54.2%)**, and cattle-feed preparation by **34 (47.2%)**. Mixed cropping, vermicomposting and biopesticide use formed part of the Programme's broader organic/ecological farming approach.

These practice-specific percentages use the 72 participants with detailed agricultural-practice information and should not be interpreted as the prevalence of nutrition-garden access in the broader intervention sample, which is reported separately in Section 4.3.



Source: Author

Figure 8. Self-reported adoption of selected nutrition-sensitive agricultural practices among intervention participants

Note: n= 72 intervention participants with detailed practice information. Multiple practices could be reported by the same participants



Source: Payal Thakur

Figure 9. Azolla is grown in a respondent's backyard for use as nutritious feed for livestock and poultry in an intervention village, Wardha district, Maharashtra.



Source: Payal Thakur

Figure 10. Vermicomposting unit in a respondent's backyard in an intervention village, Wardha district, Maharashtra.

4.3 Nutrition gardens, household farming and production orientation

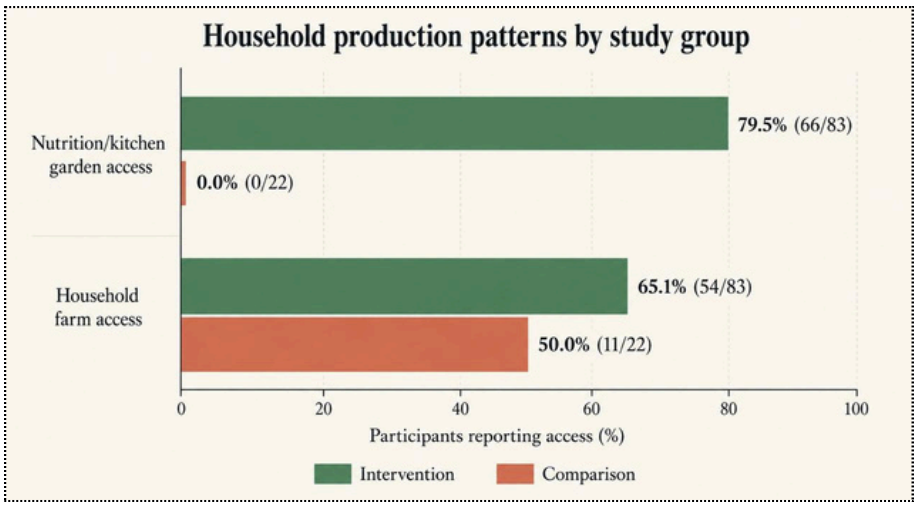
Household production arrangements differed between intervention and comparison participants. Among the **83 intervention participants with recorded production arrangements**, 29 (34.9%) reported a nutrition or kitchen garden without a household farm, 17 (20.5%) reported a household farm without a nutrition or kitchen garden, and 37 (44.6%) reported access to both. Overall, **66 of 83 intervention participants (79.5%) reported access to a nutrition or kitchen garden**, and **54 (65.1%) reported access to a household farm**.

Among the **22 comparison participants, none reported an established nutrition or kitchen garden**, whereas **11 (50.0%) reported access to a household farm** (*Figure 3*). Field enquiry further indicated limited practical familiarity with establishing and maintaining nutrition gardens in the comparison villages. Although some participants were aware of household vegetable cultivation, nutrition gardens were not reported as an established feature of household production.

The presence of household farms in both groups indicates that the difference between the groups lay not only in agricultural access, but also in the orientation and diversity of household production. Among comparison households with farm access, field enquiry and production records most commonly identified field and cash crops, particularly cotton and soybean, alongside cereals and pulses. Diversified vegetable cultivation was more limited and, where reported, was often seasonal.

Production records from intervention participants reflected a broader range of foods relevant to household diets. Reported production included dark green leafy vegetables such as spinach and fenugreek; other vegetables including eggplant, tomato, chilli and okra; pulses and legumes; and cereals and other field crops. Nutrition gardens thus formed part of a more diversified household-production profile among intervention participants.

These findings distinguish access to agricultural land from the extent to which household production incorporated diversified foods for household consumption. The relationship between household production, dietary diversity and food-group consumption is presented in Sections **4.4** and **4.5**, while broader analysis has been carried out in the Discussion.



Source: Author's Analysis

Figure 11. Household production patterns by study group

Note: Nutrition/kitchen garden access refers to an established household nutrition or kitchen garden. Household farm access refers to agricultural land used by the household and is not restricted to food crops. The two categories are not mutually exclusive.

Source: Author



Figure 12. Women sharing their understanding of the ten food groups used in the Minimum Dietary Diversity for Women (MDD-W) framework during the Wardha field enquiry.



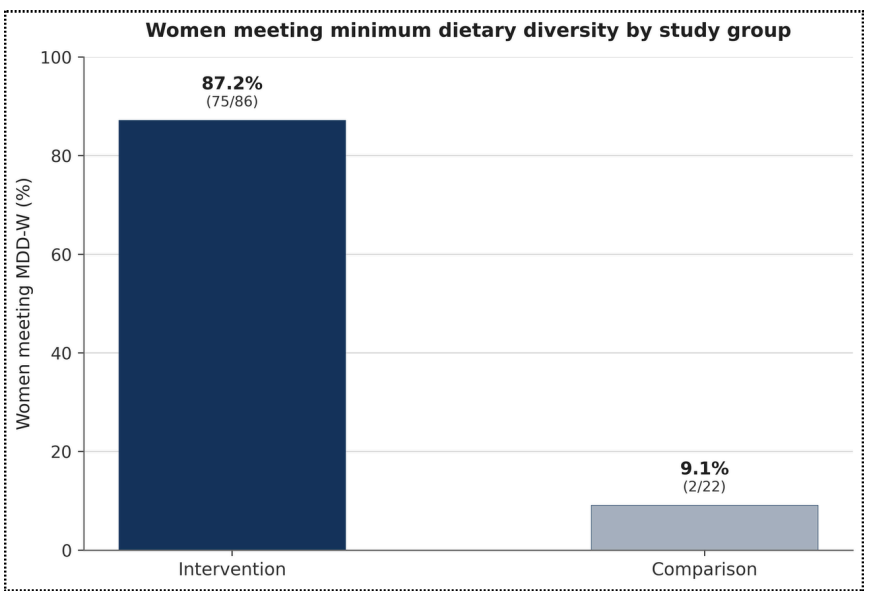
Source: Author

Figure 13. CRP Learning Exchange Workshop held during the final day of field enquiry, where women revisited key learning on nutrition, agriculture and household practices.

4.4 Dietary diversity among intervention and comparison participants

Dietary diversity was substantially higher among women in intervention villages than among those in comparison villages. The mean MDD-W score was 5.37 (SD 0.90) among intervention participants, compared with 3.09 (SD 1.41) among comparison participants.

Using the MDD-W threshold of consumption from at least five of the ten food groups, 87.2% of intervention participants (75/86) met minimum dietary diversity, compared with 9.1% of comparison participants (2/22). This difference was statistically significant (Fisher's exact test, $p < 0.001$) (Figure 14).



Source: Author

Figure 14. Women meeting minimum dietary diversity by study group

4.5 Consumption of individual MDD-W food groups

Differences in overall dietary diversity were also evident in the consumption of individual food groups. Consumption of pulses, dairy, vitamin A-rich fruits and vegetables, other vegetables, and other fruits was significantly higher among intervention participants than among comparison participants (*Figure 17*).

Pulses were consumed by 98.8% of intervention participants, compared with 63.6% of comparison participants ($p < .001$). Dairy was consumed by 77.9% and 18.2%, respectively ($p < .001$). Vitamin A-rich fruits and vegetables were consumed by 31.4% of intervention participants, while none of the comparison participants reported consumption from this food group ($p = .002$).



Source: Author

Figure 15. Field conversations that brought women's experiences to the centre of the study.

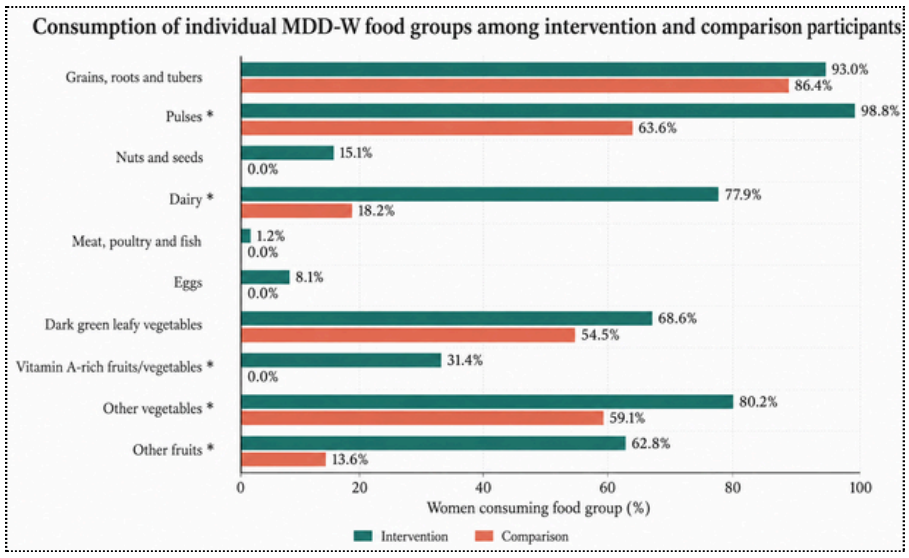


Source: Payal Thakur

Figure 16. Community-prepared rangoli showing diverse food groups during the field enquiry in an intervention village, Wardha district, Maharashtra.

Other vegetables were consumed by 80.2% of intervention participants, compared with 59.1% of comparison participants (p = .038), while other fruits were consumed by 62.8% and 13.6%, respectively (p < .001).

Consumption of grains, nuts and seeds, meat, poultry and fish, eggs, and dark green leafy vegetables did not differ significantly between the two groups. The intervention–comparison difference in MDD-W was therefore accompanied by significant differences in five of the ten component food groups, rather than by higher consumption across all food groups.



Source: Author;s Analysis

Figure 17. Consumption of individual MDD-W food groups by study group

Note:

Intervention n= 86, comparison= 22. Percentage represents consumption during the preceding day or night.

**Statistically significant intervention-comparison difference at p< 0.05.*

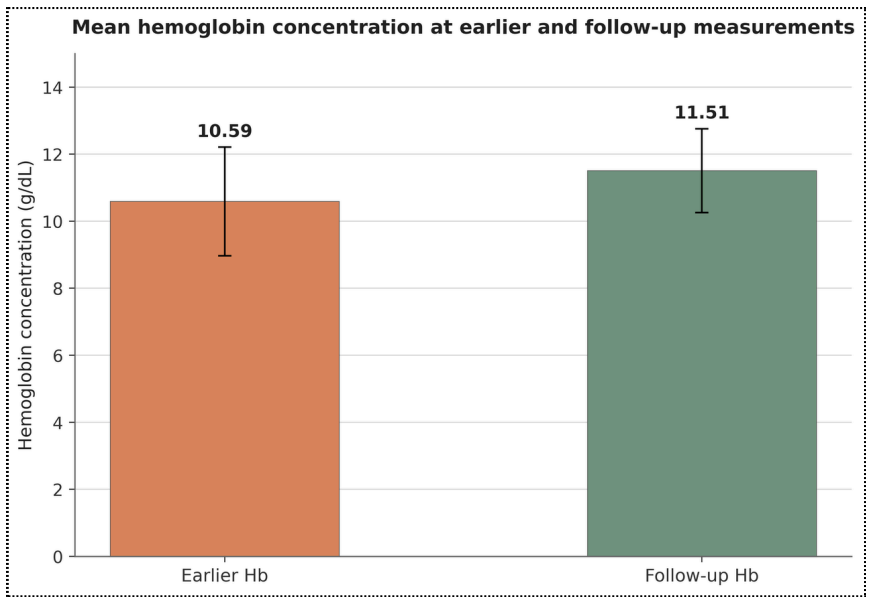
4.6 Change in hemoglobin concentration

Paired earlier and follow-up hemoglobin measurements were available for **69 intervention participants**. Mean Hb increased from **10.59 g/dL (SD 1.62)** at the earlier measurement to **11.51 g/dL (SD 1.25)** at follow-up, representing a mean within-person increase of **0.93 g/dL (95% CI 0.69–1.16)** (*Figure 18*).

Sixty-three of 69 women (91.3%) recorded an increase in Hb, while **6 (8.7%)** showed no change. No participant recorded a decline between the earlier and follow-up measurements.

The within-person increase in Hb was statistically significant **(Wilcoxon signed-rank test, p < 0.001)**.

Changes in anemia severity within the paired-Hb sample are presented in Section **4.7**.



Source: Author;s Analysis

Figure 18. Mean hemoglobin concentration at earlier and follow-up measurements

Note: n = 69 paired intervention participants. Error bars represent ±1 SD.

4.7 Change in anemia severity

The improvement in hemoglobin concentration was accompanied by a clear shift toward less severe anemia categories among the 69 intervention participants with paired measurements.

At the earlier measurement, 46 women (66.7%) had moderate anemia, 7 (10.1%) had mild anemia, 15 (21.7%) had no anemia, and 1 (1.4%) had severe anemia. At follow-up, the proportion with moderate anemia declined to 25 women (36.2%), while 22 women (31.9%) had mild anemia and 22 (31.9%) had no anemia. No participant remained in the severe-anemia category at follow-up (*Figure 19*).

The paired category transitions showed that 25 women (36.2%) moved to a less severe anemia category, while 44 (63.8%) remained in the same category. No participant moved to a more severe anemia category. Among those who improved, 17 women moved from moderate to mild anemia, 4 from moderate anemia to no anemia, 3 from mild anemia to no anemia, and 1 from severe anemia to mild anemia.

Overall, the increase in Hb documented in Section 4.6 was accompanied by a reduction in anemia severity among intervention participants.

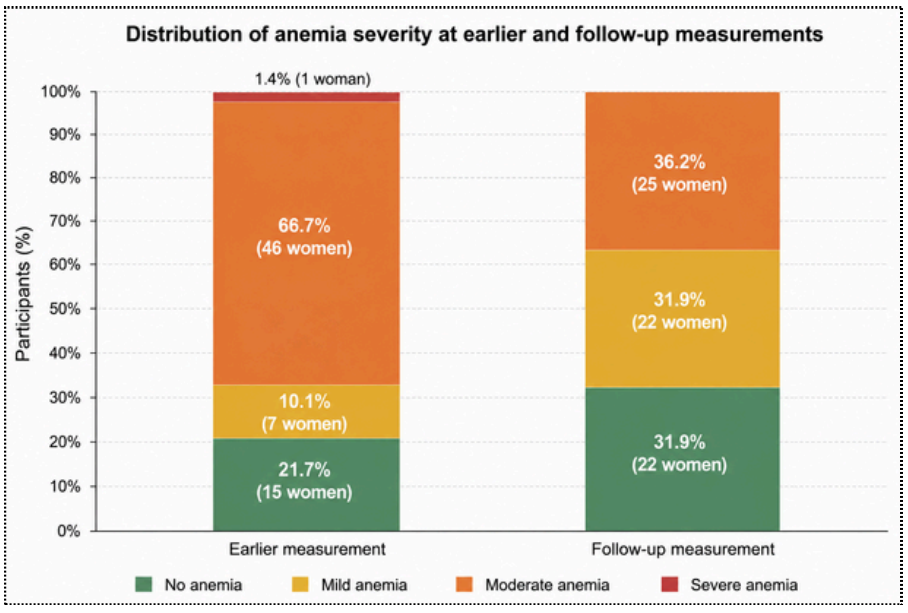


Figure 19. Distribution of anemia severity at earlier and follow-up measurements

Note: *n = 69 intervention participants paired earlier and follow-up Hb measurements. Anemia severity was classified using the WHO hemoglobin thresholds applied in the study.*



Figure 20. Field enquiry with women participants in an intervention village, Wardha district, Maharashtra.

5 DISCUSSION

5.1 Principal findings and overall programme pathway

The findings show a coherent pattern across the principal components of the Programme. High Programme exposure was accompanied by widespread adoption of nutrition-sensitive practices and a broader shift towards more diversified, ecologically oriented and resource-efficient production systems. This included stronger household food production, integrated farming, improved soil-management practices and more efficient water, reflecting changes not only in what households produced but also in how production was organised and managed.

The overall Programme pathway can therefore be understood as a progression from **Programme exposure and behaviour-change learning to the adoption of nutrition-sensitive and ecologically oriented farming practices; from these changes to stronger household food production and nutrition-garden access; and subsequently to higher dietary diversity and greater consumption of several nutrient-relevant food groups**. These changes occurred alongside the observed within-person improvement in Hb and reduction in anemia severity. WASH constituted a complementary household-health pathway, while women's participation and community-based delivery supported the translation of Programme learning into household practice. This interpretation is consistent with the wider nutrition-sensitive agriculture literature, which emphasises that agricultural change is more likely to support nutrition when combined with nutrition knowledge, behaviour change and other enabling conditions (Ruel and Alderman 2013; Sharma *et al.* 2021).

The alignment of findings across these domains supports a plausible Programme contribution to the observed changes, although the study design does not permit definitive causal attribution. The following sections examine the individual pathways in greater depth.



Figure 21. Women demonstrating their understanding of good and bad habits during the field enquiry in Wardha district, Maharashtra.

5.2 From Programme exposure to household production and dietary diversity

Programme exposure was accompanied by a different orientation of household production. Although household farming was present in both study groups, intervention households more frequently combined farming with nutrition gardens and produced a wider range of foods relevant to household diets. Comparison households were more commonly oriented towards field and cash crops, particularly cotton and soybean, while diversified vegetable production was less prominent and often seasonal. The important distinction was therefore not agricultural participation itself, but the extent to which household production incorporated foods with direct dietary relevance.

This distinction was evident in the foods produced. Nutrition gardens in intervention households included vegetables such as spinach, fenugreek leaves, okra, cucumber, tomato, onion, eggplant and chilli, while household farms contributed pulses, wheat and other cereals and field crops. Together, these forms of production extended household access across several food categories represented in the MDD-W framework, including leafy vegetables, other vegetables, pulses and cereals.



Figure 22. Women showing a household nutrition garden during the field enquiry in an intervention village, Wardha district, Maharashtra.

The food-source pattern provides further evidence of the contribution of household production. Among recorded food-group sources in the intervention group, 54.5% came from nutrition gardens or livestock, 24.2% from household farms and 21.2% from markets. In the comparison group, the food-source records were market-sourced. This suggests that own production made a substantial contribution to foods consumed by intervention participants, while market purchase remained relevant where foods were seasonal, unavailable through household production or not locally produced.

These production and sourcing patterns provide important context for the substantially higher dietary diversity observed among intervention women. Greater consumption of pulses, dairy, vitamin A-rich fruits and vegetables, other vegetables and other fruits indicates that the difference extended beyond the number of food groups consumed to the composition of women's diets. Nutrition and behaviour-change learning may also have supported the translation of greater household food availability into consumption. This interpretation is consistent with previous evidence showing that the dietary relevance of agricultural diversification depends on the foods incorporated into production as well as the wider food-access environment (Jones 2017; Sibhatu and Qaim 2018; Gupta *et al.* 2020; Pradhan *et al.* 2021).

Overall, the findings suggest that the Programme's agricultural pathway was associated with greater integration of nutritionally relevant foods into household production, alongside substantially higher dietary diversity among intervention women.

5.3 Interpreting the Hb and anemia findings

The paired Hb analysis showed a substantial within-person improvement among intervention participants. Mean Hb increased by 0.93 g/dL, from 10.59 to 11.51 g/dL, and 91.3% of women recorded an increase, with no participant showing a decline. The accompanying shift in anemia severity was consistent with this pattern: moderate anemia declined substantially, severe anemia was no longer observed at follow-up, and more than one-third of women moved to a less severe anemia category.

These biological changes occurred in the same study population in which stronger household food production and substantially higher dietary diversity were observed. Although MDD-W does not directly measure iron intake or bioavailability, the higher dietary diversity observed among intervention women provides a plausible nutritional context for the concurrent improvement in Hb and anemia severity. The study design, however, does not allow the contribution of dietary change to be isolated from other influences on Hb.

The findings from this study in Wardha is noteworthy because biological outcomes are less consistently demonstrated in nutrition-sensitive agriculture studies than changes in production or dietary behaviour. Previous evidence has shown that improvements in dietary diversity may occur without corresponding changes in measured nutritional status (Sharma *et al.* 2021; Prost *et al.* 2022). The concurrent improvement in Hb concentration and anemia severity in the present study therefore adds an important biological dimension to the observed agricultural and dietary changes.

Interpretation of the Hb findings should nevertheless remain cautious. Hemoglobin is influenced by multiple nutritional and non-nutritional factors, including reproductive, infectious and clinical conditions, and these were not all captured in the present study. In addition, paired earlier and follow-up Hb measurements were not available for comparison participants. The observed improvement should therefore be understood as occurring in the context of Programme exposure and the accompanying dietary and agricultural changes, rather than as a definitive estimate of the Programme's causal effect on Hb.

Overall, the observed improvement in Hb and anemia severity was accompanied by stronger household food production and dietary diversity among intervention women, a pattern consistent with the Programme's proposed nutrition pathway. The alignment of agricultural, dietary and biological findings strengthens the coherence of this interpretation, while the study design does not permit causal attribution.

5.4 Women's agency, community delivery and complementary WASH pathways

The agricultural and dietary changes observed in Wardha occurred within a wider process of community participation and behaviour-change learning. Qualitative analysis indicates that some women described changes in how they participated within their households and communities.

One group leader described the change in locally expressed terms:

"मी आधी घराबाहेर फारशी पडत नव्हते. आता मी बाहेर जाते, लोकांसोबत काम करते, महिलांना कार्यक्रमातील माहिती समजावून सांगते आणि लोक माझं म्हणणं ऐकतात."

(Earlier I rarely stepped outside the home. Now I go out, work with people, explain Programme-related information to other women, and people listen to what I say).

Another woman expressed the value of being recognised and heard in the community:

"लोक ओळखतात आणि आपलं बोलणं ऐकतात, तेव्हा चांगलं वाटतं."

(It feels good when people recognise you and listen to what you say).

Source: Author



Figure 23. Group discussion with women during the field enquiry in an intervention village, Wardha district, Maharashtra.

Other field responses referred to increased confidence in public speaking, participation in meetings and greater visibility through group-leader roles. These responses indicate that Programme participation was accompanied, for some women, by changes in confidence, social participation and perceived recognition within the community.

Women's responses also suggested that these changes extended, in some cases, into household decision-making. One participant described being heard more on food-related decisions at home:

"आता घरी खाण्यापिण्याच्या गोष्टींबाबत माझं मत ऐकतात—काय बनवायचं, कोणते पदार्थ खायचे याबद्दल मीही सांगते."

(Now my views are heard at home regarding food —what should be prepared and what foods should be eaten.)

These responses do not constitute a formal measure of women's agency, but they provide qualitative evidence that the knowledge acquired through the Programme was, for some women, accompanied by greater confidence in expressing views and influencing everyday food-related decisions.

The role of community facilitators was also formally recognised at the completion of the Programme, when group leaders, ASHA workers and Anganwadi workers received certificates acknowledging their participation and contribution. This recognition was relevant because several women linked their Programme role with increased confidence, visibility and acknowledgement within their communities. For some group leaders, being recognised publicly and invited to participate on stage appeared to reinforce a sense of achievement and legitimacy in their community-facing role.

This social dimension was reinforced by the Programme's community-based delivery structure. LANN+ PLA and Farmer Field School activities were facilitated through community resource persons, women's group leaders, ASHA workers, Anganwadi workers and lead farmers, with repeated meetings, demonstrations and household-level follow-up. Rather than functioning only as recipients of Programme information, these local facilitators helped communicate and reinforce Programme learning within their villages. Such locally embedded delivery created opportunities for nutrition and agricultural messages to be discussed in relation to everyday household circumstances. This is consistent with evidence that women's participation and repeated community engagement can support the translation of agricultural and nutrition knowledge into practice, while participation alone should not be interpreted as a comprehensive measure of agency (Gupta *et al.* 2019; Prost *et al.* 2022).

Participatory learning tools also appear to have contributed to the recall and interpretation of Programme messages. *Manjari*'s Story was used within LANN+ PLA as a participatory learning narrative to explain how agricultural practices, household food availability and women's nutrition can intersect over the life course. The story begins with *Manjari* growing up in a household where diversified production, a nutrition garden and locally produced foods contributed to the availability of a wider range of foods for household consumption. After marrying at a young age, she moved to a household whose agricultural production was more strongly oriented towards cash crops and where food for household consumption was more dependent on market purchase. The story described a more limited availability of diverse foods, including leafy vegetables, within this household setting. During the subsequent period of pregnancy, *Manjari* experienced poor maternal nutrition and anemia, followed by an adverse pregnancy outcome. The narrative was used to open discussion not only on diet, but also on the wider circumstances surrounding women's nutrition, including early marriage, maternal nutritional needs, access to healthcare, hygiene, girls' education, household food production and women's participation in decisions. Rather than presenting any one of these factors as the sole cause of *Manjari*'s experience, the story brought them together within a single household narrative to show how agricultural, dietary, health and social conditions may interact across a woman's life and potentially extend to the next generation. Several women recalled *Manjari*'s Story during the Wardha field enquiry when discussing learning related to nutrition, child marriage, education, hygiene and health.

WASH constituted a complementary household-health pathway within the Programme. Drinking water in intervention villages was supplied through the Gram Panchayat system to household taps after treatment, while Programme learning also addressed household water handling, sanitation and hygiene. A locally specific example concerned the storage of drinking water in earthen pots (*matka/ghada*), which were often kept at floor level. Women recalled guidance to place these pots on an elevated surface to reduce exposure to dust and dirt during household cleaning. This illust-

rates how WASH messages were translated into practical household behaviours. These practices are best understood as part of the wider health environment in which dietary and agricultural changes occurred.

Translation of Programme learning into practice was not uniform. Field identified response constraints including limited space for nutrition gardens, rainfall-related disruption to production, seasonal availability of foods and continued reliance on markets when household-produced foods were unavailable. Some women also remained hesitant despite participating in Programme activities. These findings suggest that Programme exposure created opportunities for behavioural and agricultural change, but adoption remained shaped by household resources, seasonality, infrastructure and individual circumstances.

Overall, women's participation, community-based facilitation and practical WASH learning appear to have functioned as enabling and complementary features around the main agriculture–diet pathway. They help explain how Programme learning could move from community sessions into household practice, while also showing why the extent of adoption varied across women and households.

Source: Payal Thakur



Figure 24. Women demonstrating WASH learning on safe water storage and handwashing during the field enquiry in an intervention village, Wardha district, Maharashtra.

Source: Author



Figure 25. The first author speaking on nutrition-sensitive agriculture during the CRP Learning Exchange Workshop in Wardha.

5.5 Strengths, limitations and scope

- **Strengths.** The study combined repeated Hb measurements with dietary diversity, household food production, food sourcing, agricultural-practice adoption and qualitative field evidence, allowing Hb changes to be interpreted within a broader agriculture–nutrition context.
- **Limitations.** The study was non-randomized, the comparison group was small, and paired Hb measurements were available only for intervention participants. Dietary diversity was based on a single 24-hour recall; for some participants, the field enquiry coincided with fasting, which limited the completeness or representativeness of dietary intake reported for that day. Reproductive, clinical and other factors that may influence Hb were not comprehensively measured, and qualitative evidence was based on field notes rather than verbatim transcripts.
- **Scope.** Future evaluations would benefit from prospective Hb measurements in both intervention and comparison groups, repeated dietary assessments that account for fasting or atypical intake days, and more systematic documentation of clinical and reproductive factors.

6 CONCLUSION

This study presents findings from research conducted across 12 intervention villages and two comparison villages in Wardha, Maharashtra, within the LANN+ PLA Programme, assessing changes in hemoglobin and anemia severity among women of reproductive age alongside nutrition-sensitive agriculture, household food production, dietary diversity and community-based behaviour change. Among intervention participants with repeated measurements, Hb improved substantially and anemia severity shifted towards less severe categories. These biological changes occurred in the same setting in which nutrition gardens, diversified household production and adoption of nutrition-sensitive agricultural practices were widely reported, while women in intervention villages had substantially higher dietary diversity than those in comparison villages.

An important finding of the study is the distinction between participation in agriculture and the nutritional relevance of agricultural production. Farming was present in both intervention and comparison villages, but the orientation of production differed. Intervention households more frequently incorporated nutrition gardens and a wider range of foods relevant to household diets, whereas comparison households with farm access were more commonly oriented towards field and cash crops, particularly cotton and soybean. This suggests that agricultural participation alone does not necessarily translate into greater dietary diversity; the types of foods incorporated into household production and their relevance to household consumption are also important.

The dietary findings strengthen this interpretation. Women in intervention villages had markedly higher MDD-W scores and were more likely to consume pulses, dairy, vitamin A-rich fruits and vegetables, other vegetables and other fruits. Food-source information further showed that nutrition gardens, livestock and household farms contributed substantially to foods consumed by intervention participants, while markets remained relevant for foods that were seasonal, unavailable through household production or not locally produced. The findings therefore point to a setting in which diversified household production was associated with greater access to nutritionally relevant foods without removing the continuing role of markets in household food access.

The agricultural and dietary changes were also situated within a broader process of behaviour-change learning and community participation. Programme delivery through community resource persons, women's group leaders, ASHA workers, Anganwadi workers and lead farmers created locally embedded opportunities for nutrition, agriculture and WASH messages to be discussed and applied within everyday household circumstances. Qualitative responses of increased confidence, greater participation in community activities, recognition within villages and, in some cases, a stronger voice in household food-related decisions provide additional context for understanding how Programme learning was experienced beyond the adoption of specific agricultural practices.

Overall, the findings indicate that nutrition-sensitive agriculture is most relevant when agricultural production, household food access and nutrition-related behaviour are considered together. In Wardha, the observed improvement in Hb and anemia severity occurred alongside diversified household production, substantially higher dietary diversity and widespread adoption of nutrition-sensitive practices. The consistency of these findings supports further investigation of the relationships observed in this setting.



Figure 26. Drumstick (*Moringa oleifera*) grown within household food production in an intervention village, Wardha district, Maharashtra.

The study design does not permit the Hb improvement to be attributed solely to the Programme, particularly because paired Hb measurements were unavailable for comparison participants and other clinical and reproductive influences on hemoglobin were not comprehensively measured. These limitations define the level of interpretation that the present evidence can support, while still allowing the biological findings to be considered meaningfully alongside the agricultural and dietary changes.

The wider significance of the Wardha study lies in its relevance to agricultural settings where commercially oriented production coexists with persistent nutritional challenges. Future evaluations should assess these relationships prospectively through standardized Hb measurement in both intervention and comparison populations, repeated dietary assessment and longer-term follow-up. This would help determine whether integrating diversified food production, nutrition learning and community-based delivery within established agricultural systems can contribute to sustained improvements in women's dietary and nutritional outcomes across different rural contexts.

Women of reproductive age play a pivotal role in shaping the health, growth, and development of future generations. However, the coexistence of obesity and anaemia among women belonging to middle- and high-income households highlights the dual burden of malnutrition and underscores the complexity of nutritional challenges. This phenomenon indicates that nutritional well-being is influenced not only by economic resources but also by factors such as dietary practices, nutrition knowledge, food choices, healthcare access, and women's autonomy.

The findings of this study emphasize the need for a multidimensional approach to addressing malnutrition. Nutrition education, promotion of safe and nutritious food production for household consumption and strengthening of women's empowerment could be integrated into government initiatives related to agriculture, livelihood enhancement, and income-generation programs. Incorporating these components into existing development schemes may improve the effectiveness of interventions and contribute significantly to achieving the national goal of a malnutrition-free India.



Figure 27. A woman showing her household farm during the field enquiry in an intervention village, Wardha district, Maharashtra.

7

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IMPACT OF DIVERSIFIED AGRICULTURE AND NUTRITION BEHAVIOUR CHANGE ON WOMEN IN REPRODUCTIVE AGE GROUP IN WARDHA, MAHARASHTRA

Photo Credit: Payal Thakur

Photo (caption): ASHA worker showing the nutrition garden at her home in an intervention village, Wardha district, Maharashtra.

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