M.S.SWAMINATHAN RESEARCH FOUNDATION
3rd Cross Road, Institutional Area, Taramani, Chennai – 600 113, INDIA
Phone: +91-44-2254 2792 (Direct), 2254 1229, 2254 1698, 2254 2698, 2254 2699
Fax: +91-44-2254 1319, E-mail executivedirector@mssrf.res.in

Farming System for Nutrition

MSSRF
Science for Sustainable Development

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Web: www.mssrf.org

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Prepared by MSSRF Team:
Aliza Pradhan
B Jayashree
G Anuradha
G N Hariharan
Israel Oliver King
Priya Rampal
R Rengalakshmi
R Rukmani
R V Bhavani
V Prabavathy

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CONTENTS

FOREWORD

The Indian enigma consists of situations like "grain mountains and hungry millions", agricultural progress coupled with persistence of malnutrition" and "green revolution fame concurrently with farmers suicides". From the days of Independence, several steps have been taken by both the State and Central Governments to abolish hunger and malnutrition. This is because our independence was born in the backdrop of the Bengal Famine. Mahatma Gandhi also said at Noakhali that to the hungry God is Bread and that the God of bread should reside in every home and hut.

A majority of the population of India live in villages with agriculture constituting the major livelihood source. Agriculture is carried out in the form of farming systems comprising crops, farm animals, inland and marine fisheries and forestry and agroforestry. The farm size is small and the marketable surplus also tends to be small. Therefore, our farmers face serious economic problems resulting from the cost – risk and return structure of agriculture. Malnutrition and undernutrition are also high in the rural population. This is why there is a growing understanding of the need to link agriculture, nutrition and health in a mutually reinforcing manner. I therefore designed a Farming System for Nutrition (FSN) programme which will provide agricultural remedies, to the major nutritional deficiencies including micronutrients like zinc, iron, iodine, vitamin A etc. FSN will help to not only improve the yield of crops but also mainstream the nutrition dimension in the choice of crops. In order to enable farmers to identify crops, which can provide specific nutrients like vitamin A, a Genetic Garden of Biofortified Crops is being established as part of FSN. Also, women and men members of the community who are willing to undertake training in nutrition will be helped to attain nutritional literacy. Such members of the local community thus become Community Hunger Fighters.

MSSRF both in its regular programmes and in the UKAid supported project 'Leveraging Agriculture for Nutrition in South Asia (LANSA)' has been promoting FSN in areas where there is a heavy malnutrition burden. The present publication is a description of the FSN approach to farming centred elimination of malnutrition and a summary of the work done so far. I am grateful to Dr V Selvam, Dr R V Bhavani and other colleagues in MSSRF for this timely compilation which should help all interested in integrating agriculture and nutrition.

M S Swaminathan

I. Introduction

Malnutrition is a global problem and the number of people affected is extremely high. For instance, more than 2 billion people suffer a serious lack of vitamins and minerals, and more than 200 million children are stunted or wasted (Ruel et al., 2013). A large proportion of this population live in developing countries where agriculture and allied activities are the main source of livelihood. The United Nations Secretary General Ban Ki-moon launched the Zero Hunger Challenge in 2012 with the target for eliminating hunger, malnutrition and food insecurity. This has been absorbed in the Sustainable Development Goals (SGD) agenda to be achieved by 2030. Food Security encompasses ‘Availability’, ‘Accessibility’ and ‘Utilization’ which includes ‘absorption’ and bioavailability of food making it inclusive of ‘Nutrition Security’ (Rainer et al., 2000). Increasing food production alone cannot address the issue of malnutrition, unless there is a nutrition focus and the poorest have access to sources of diversified and nutritious foods. Beyond staple foods, a healthy diet means a diversified food basket containing balanced foods providing adequate amounts of energy, fat, protein and micronutrients. Agricultural interventions in the development paradigm need to be more nutrition-sensitive, with a greater focus on nutrient-dense foods with high levels of bioavailability, i.e. the proportion of micronutrients capable of being absorbed by the body. The relationship between agricultural production, consumption patterns and nutritional outcomes are not direct but complex, distant and often weak (Alderman, 1987).

Malnutrition is caused by multiple factors; therefore any attempt to address the problem should be holistic and multidimensional. The immediate determinants of nutrition as well as the underlying causes of under nutrition can be addressed by i) focusing on nutrition specific programmes, ii) ensuring an enabling environment of hygiene and sanitation, and iii) nutrition sensitive agricultural or farming systems interventions. The last approach of *leveraging agriculture for nutrition* can be an important approach in countries with large rural populations dependent on agriculture, including India (Das et. al, 2014). Studies across the globe clearly highlight the fact that changes in income alone do not immediately translate into changes in consumption pattern and dietary diversity to improve nutritional status. Policies need to be focused on agricultural production, markets and trade systems, consumer purchasing power and, food transformation and consumer demand. These four aspects of the food system shape the food environment within which people make food choices, which in turn determines the quality of their diet. Diet quality is a measure of good nutrition. A single policy cannot achieve these goals (GloPan, 2014).

Agricultural projects that utilise micronutrient-rich plant varieties have shown high potential for improving nutritional well-being (Kodkany et al., 2013; Leroy et al., 2007). Reviews by Berti et al. (2004) and Masset et al. (2011) found no conclusive evidence of the effects of agricultural interventions on nutritional status in general, but did find positive impacts of selective interventions like home gardening and biofortification. Gulati et al. (2012) found that just improving agricultural performance can have a positive impact on nutritional outcomes. The key pathways between agriculture and nutrition are well known: agriculture provides a source of food and nutrients, a broad-based source of income, has effects on food prices and influences women's time for taking care of very young children, women's nutrition status and their power in decision making (Gillespie and Kadiyala, 2011, Kadiyala et al 2014). Given these links and the fact that it remains the primary activity of half of the region's population (Hazell et al., 2011), agriculture has the potential to be a strong driver of nutrition. The potential is however not being realised. Agriculture growth rates in South Asia are slowing, both absolutely and relative to non-agriculture (Hazell et al., 2011). This is of concern because agricultural growth tends to be more poverty reducing than other forms of growth (Swaminathan, 2010; De Janvry and Sadoulet, 2009). It is doubly worrying for South Asia, because of apparent disconnects between agriculture and nutrition in the region (MSSRF/WFP 2004; Headey, 2011). These slowdowns and disconnects threaten to worsen as farming in the region becomes more prone to the risks and uncertainties driven by South Asia's exposure to climate change (ADB, 2009).

Several reviews concluded that projects having clear effects on improved dietary intake or nutritional status were likely to be those in which either women played a critical role in the intervention or the intervention included a nutrition counselling component (Leroy and Frongillo, 2007; Mullins et al., 1996; World Bank, 2007). A complex interaction of food intake, water quality, care practices, disease burdens, sanitation and health services, as well as the deeper social, economic and political processes that drive these intermediate outcomes impact on nutrition (UNICEF 1990). Overall, however, one finds a sense of urgency and initiative to understand and demonstrate efficacy of pro-nutrition agriculture interventions globally (Bouis, 2000; Miller and Welch, 2013; FAO, 2013; Welch et al., 2013; Wiggins and Keats, 2013).

India also faces the persistent problem of malnutrition in children, women and men. Three types of nutritional deficiencies are observed in India: calorie deficiency due to inadequate consumption of food; protein deficiency due to inadequate consumption of pulses, milk, eggs, etc.; micronutrient deficiency (or hidden hunger) due to inadequacy of iron, iodine, zinc, vitamin A, vitamin B 12 etc. in the diet. In recent times, obesity is also being observed in a section of the population. In 2015-16, 38.4% of India's children, below the age of five, were stunted and 35.7% underweight; one fifth of women in the reproductive age group were estimated to be suffering from chronic energy deficiency while another one fifth were obese. Further, more than 50% of children and women suffer from anaemia (GoI, 2017). A majority of India's population continues to be dependent on agriculture for their livelihoods with close to 60% of the rural households in 2012–13, classified as agricultural households (GoI, 2014). In a context, where a significant section of the population is malnourished and dependent on agriculture, a pathway for addressing food and nutrition security by leveraging agriculture would have great potential.

The pathways through which agriculture can influence nutrition outcomes cover four broad areas: (1) consumption of own production or agriculture as a source of food; (2) income from agriculture; (3) food prices; and (4) aspects related to gender such as the status of women in agriculture and women's nutritional status that directly or indirectly influence food, nutrition and health. Of the different linkages that prevail between agriculture and nutrition, 'cultivation and consumption of own production' is a pathway that can bring about direct changes in food production system enhancing availability and access to food for farming households, in particular the small holders.

Farming System for Nutrition (FSN), as a farmer led strategy is defined by M. S. Swaminathan as:

“The introduction of agricultural remedies to the nutritional maladies prevailing in an area through mainstreaming nutritional criteria in the selection of the components of a farming system involving crops, farm animals and wherever feasible, fish” (Nagarajan et al., 2014).

Underlying the concept of FSN is a principle that household food production contributes positively to the diets of farm families, particularly small holders. In other words, a diversified food production system has the potential to diversify the consumption basket of farm families. The FSN model is a location-specific, inclusive model based on the resource endowments and specific environment, to address the nutritional needs of families. Given that FSN is a flexible model that takes into account the nature of resource endowment, specificities in environment and nutritional problems, ideally a farmer can decide on the possible combinations of different components of FSN depending on his/her location. Nutrition literacy has to be an integral component of the FSN approach, as an understanding and acceptance of the concept is crucial for sustained practice (Rao and Swaminathan, 2017).

Some examples of farming systems are:

1) Crop Husbandry with different nutrient-dense/nutrient rich crop combinations
2) Crop Husbandry + Livestock
3) Crop Husbandry + Livestock + Poultry
4) Crop Husbandry + Horticulture + Sericulture
5) Crop Husbandry (Rice) + Fish culture
6) Crop Husbandry (Rice) + Fish + Mushroom
7) Crop Husbandry + Fishery + Duckery + Poultry

MSSRF has been leading a study since mid 2013 to demonstrate the feasibility of a FSN approach in the states of Odisha and Maharashtra in India, under a research programme on Leveraging Agriculture for Nutrition in South Asia (LANSA)[1]. Section II discusses the design of the FSN approach based on this experience. Section III discusses the concept of Community Hunger Fighters and building capacity at the grassroot level to sustain FSN. Section IV explains the concept of 'Genetic Gardens' that are crucial to generate awareness on what nutrition deficiencies different plants can address and ensure availability of necessary planting material. Section V discusses the importance of an enabling environment and non-food factors for agriculture to effectively impact on nutrition outcomes. Section VI discusses the importance of communication and leveraging partnerships for effective outreach and impact at different levels and Section VII concludes.

[1] www.lansasouthasia.org

II FSN Study under the LANSA Research Programme

The current study is underway in a core set of seven villages (658 households with population of 2,845) in Koraput District of Odisha and five villages (556 households with population of 2,254) in Wardha District in Vidarbha region of Maharashtra. Although agro-ecologically the two study intervention locations are different, both of them are characterized by rain-fed farming and a high burden of malnutrition. In both the field sites, farmers are mainly small and marginal land holders and the average size of the holding is 0.80 ha in Koraput and 1.2 ha in Wardha. In both the study locations, a very low proportion of the area is under irrigation. In Koraput, the farmers belongs to different tribal sub groups such as *Bhumia*, *Paroja* and *Gadaba* while in Vidharba they are socially categorized under backward communities like *Gond, Mahar, Gowari and Gawali*. Farming in their own fields supplemented by wage labour work in other farmer's field is the primary economic activity. Both men and women participate equally in various farming operations with a typical gender division of labour. Some also engage in employment under the MGNREGS[2] that provides wage labour work for an average period of 100 days in a year for one person per household. A detailed baseline study was undertaken in the study villages in 2014, to identify the existing disconnect between agriculture-nutrition linkages. Some key findings from the survey are presented in the sections below.

[2] Mahatma Gandhi National Rural Employment Guarantee Scheme

Nutrition Status

The anthropometric and biochemical measurements in both the field sites (**Fig. 1**) showed that more than 45% of children under age five, reported underweight (weight-for-age *Z*-score (WAZ) at least 2 standard deviations (SD) below the median), 35% stunted (height-for-age *Z*-score (HAZ) at least 2SD below the median) and about 27% wasted (weight-for-height (WHZ) *Z*-score at least 2SD below the median). In Koraput, about 44.8% of school-age children (5–9 years) reported undernourished (Body Mass Index *Z*-score (BMIZ) at least 2SD below the median), in contrast to 30.1% in Wardha. However, in Wardha, about 52% and 57.3% of adolescents (10–14 and 15–17 years) were undernourished (BMIZ at least 2SD below the median) in contrast, to 34.6% and 20.2% in Koraput. In both the locations, percentage of women (47%) with Chronic Energy Deficiency (CED) and Body Mass Index (BMI <18.5) was found to be higher than the men (40%).

The biochemical analysis revealed that, in both locations, about 33% of children under age five had vitamin A deficiency (VAD). About 70% of children under age five in Koraput and 83% in Wardha had anaemia. In Wardha, majority (80.8% and 83.8%) of girls in the age groups of 12–14 and 15–17 years respectively reported anaemia while it was 59.5% and 62.4% respectively in Koraput. The percentage of Non-Pregnant Non-Lactating (NPNL) women having anaemia was 85.9% in Wardha, and 62% in Koraput. In both Wardha and Koraput, about 55–60% of pregnant women and 75% of lactating women were anaemic (See **Fig. 2**).

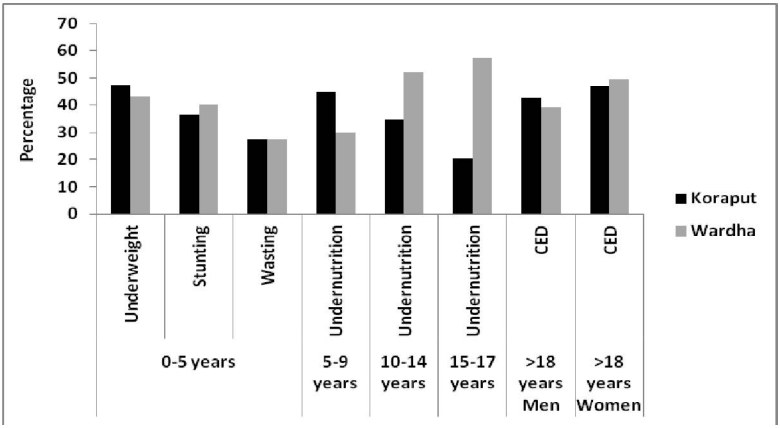

Fig. 1. Status of undernutrition in the study areas (Source: Baseline Survey, 2014)

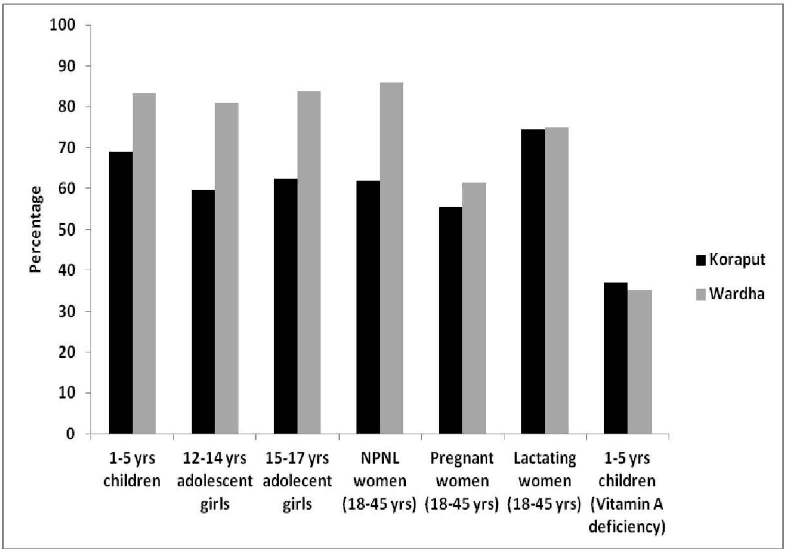

Fig. 2. Status of micronutrient deficiency (Anaemia and vitamin A. deficiency) in the study areas

The existing food consumption pattern and lack of dietary diversity

The diet of people is cereal dominated with consumption of all other food groups being less than the Recommended Dietary Intake (RDI) levels. **Table 1** gives the percentage of households consuming <70% RDI of different food groups. It can be observed that the average intake of cereals and millets ranged from a low 323.1g in Wardha to a high 563.9g in Koraput. The consumption of rice was observed high in Koraput (509.6g) followed by finger millet (77.3g). In Wardha, the consumption of wheat (233.3g) was high followed by rice (113.1g). Consumption of cereals and millets was at >70% of RDI by 78.5% of households in Wardha and 96.6% in Koraput. The average consumption of pulses was 61.1g in Wardha, but only 34.7g in Koraput. The percentage of households consuming pulse-protein <70% of RDI ranged from 75.4% in Koraput and 40.5% in Wardha.

Table 1 Distribution (%) of households according to level of food intake at RDI (<70%) and individual Dietary Diversity Score (DDS)

Categories	Wardha	Koraput
Cereals & millets	21.5	3.4
Pulses and legumes	40.5	75.4
Green leafy vegetables	95.5	90.3
Roots and tubers	98.7	76.3
Other vegetables	97.5	77.4
Milk/milk products	99.4	99.6
Fruits	95.5	94.0
Fats and edible oils	37.0	85.7
Sugars/jiggery	6.2	65.7
DDS	7.8	7.1

Source: Baseline Survey 2014

The average daily consumption of green leafy vegetables and fruits in Wardha and Koraput were well below the suggested level of 100g. Consumption of green leafy vegetables by more than ninety per cent households was <70% of RDI. The average consumption of root and tubers and other vegetables in Wardha and Koraput was well below the recommended level of 200g per capita per day. Consumption of root and tubers and other vegetables by more than 95% households in Wardha was at <70% of RDI in contrast to 76.3% and 77.4% respectively in Koraput.

The average consumption of fish or other sea foods in Wardha and Koraput was 2.2g and 11g respectively. Similar intake pattern was observed for animal products. In Wardha, the majority of the households consumed, meat, egg and poultry, once a week and in Koraput, fish, meat, egg and poultry were consumed once in fifteen days. The average intake of milk and milk products in both the study areas was well below the RDI levels, with more than 99% of households consuming <70% of RDI.

In Wardha, compared with RDI levels, the average consumption of sugar-related products was higher whilst, that of fats and edible oils was comparable. The proportion of households with intake of sugar-related products and fats and edible oils at <70% of RDI was only 6.2% and 37% respectively. In contrast, in Koraput, the average consumption of sugar-related products and fats and edible oils was below the RDI levels with 65.7% and 85.7% of households consuming <70% of RDI respectively of these products.

Relating nutrition status and DDS

In both the study areas, statistically significant association was found to exist only between dietary diversity score (DDS) and body mass index (BMI) of adults (>18 years), indicating that mean BMI significantly (*P*<0.05) decreased, as the DDS decreased from high to medium to low in Wardha and from high to low in Koraput (see **Table 2)**. Only in Koraput, statistically significant relationship (*P*<0.05) was found between DDS and haemoglobin levels of adolescent girls and women aged 12–45 years, implying significantly lower haemoglobin levels (higher prevalence rate of anaemia) in this category, as the DDS decreased from high to low.

From the above analysis it is inferred that under-nutrition, vitamin A deficiency and anaemia are the dominant forms of malnutrition among members in the age group of above 18 years, which is clearly linked to narrow DDS and < 70% RDI.

Table 2 Association between nutrition status and DDS

	Low dietary diversity		Medium dietary diversity			High dietary diversity		
	Mean	±SD	Mean	±SD	*P*	Mean	±SD	*P*
			Wardha					
BMI >=18 years	19.33	3.03	19.39	3.02	0.045*	20.06	2.92	0.01*
Haemoglobin level (12 to 45 years girls & women)	10.77	2.01	10.84	2.088	0.430	11.10	1.54	0.271
			Koraput					
BMI >=18 years	18.80	2.18	19.18	2.22	0.12	19.66	3.12	0.00*
Haemoglobin level (12 to 45 years girls & women)	10.76	1.68	11.40	1.66	0.83	11.34	1.41	0.02*

*Significance at *P<0.05*

The common cropping system in Koraput is lowland - paddy - Fallow and upland - fallow or perennial tree crops where the Cropping Intensity is around 100 in many of the farmers' fields. Rice is the predominant crop in medium and lowlands (June/July-Sept/October) and mixed cropping of maize with vegetables in uplands in *kharif* season. Increasingly, the upland area is put in to perennial tree based land use which has further reduced the cultivation area under millets and pulses. Further, farmers growing pulse (green gram/black gram) in pre-summer[3] have very low production due to moisture stress during the crop growth period which in turn leads to their low pulse consumption.

Of the 549 landholding households in Koraput, the majority (about 98.2%) of households cultivate Kharif season crops. Among *Kharif* growers, as high as 89% of farm households cultivate rice with an average productivity of 3–4 t ha^{-1}. Rice systems occupying bulk portion of land acreage; some households additionally cultivate some portion of upland area with finger millet (7%) with a productivity of 400–900 kg ha^{-1}. A very small percentage of farm-households (3%) cultivate sole or mixture of horse gram, black gram, ground nut, finger millet or little millet. Of the 98.2% of *Kharif* growers, only 38.1% households (i.e. 31.7% of total households) cultivate *Rabi* season crops. *Rabi* land acreage is predominately occupied with ground nut (28.6%), green gram (13%), onion (9.1%), maize (1.8%), finger millet (4.6%) and black gram (1.2%). Percentage of irrigated area is only 17.5% and most of this irrigation is

[3] Pre summer (late January/ February to April/May) is the second cropping season in Koraput as it is difficult to grow in rabi due to intense low temperature.

diverted towards cultivation of vegetables followed by ground nut in the *rabi* season which are largely cultivated for market.

In Wardha, among *Kharif* growers, 24% of farm households practice intercropping of cotton with pigeon pea. Typically, cotton + pigeon pea occupies bulk portion of land area and these cultivators also use some proportion of cotton + pigeon pea land area to cultivate either soybean (21% of households) or sorghum (15% of households) and sometimes both (15%). The variety used in cotton is Bt cotton hybrid. Very few households practice sole cropping i.e. soybean (5%) or sorghum (1%). Only 15% of the *kharif* season cultivator households go for rabi season crops i.e. wheat, Bengal gram.

It was inferred from the baseline analysis that the existing cropping system at both the study locations have very less area under nutrient rich crops and low production with narrow on-farm crop diversity especially of millets and pulses. The latter is evident from the prevailing food sourcing pattern in the region, about 76% of the households in Wardha reportedly sourced wheat and rice from the market and the remaining 24% from the public distribution system (PDS). In Koraput, about 43% of households consumed home-grown rice, 43% sourced from the PDS and the remaining (14%) from market. The source for finger millet was reported as mainly market (70%) and the balance 30% was home-grown. In both the study areas, majority of the households reported market as a major source of benefitting pulses and vegetable groups. This subsequently results in reduced dietary diversity and consumption of lower level of RDI of certain food products. This coupled with poor socioeconomic conditions and lack of awareness may be seen to be reflecting in the higher prevalence of undernutrition and micronutrient deficiency (anaemia) among the age group of more than 18 years. The high prevalence of anaemia (>60 per cent) and vitamin A deficiency among children in both the study areas was related to cereal dominated consumption pattern with very low consumption of vegetables and fruits coupled with low socio-economic condition and lack of awareness on nutrition.

The existing farming system practices and outputs in both the field sites reveals disconnect between agriculture and nutrition. Against this backdrop, the study investigated how to design location-specific farming system for nutrition (FSN) interventions to improve household diet diversity and nutrition outcomes. Here considering the prevailing cultural and social practices and food consumption behaviour, crop based interventions were the main focus rather than other allied enterprises like livestock, agro forestry etc. in the farming system.

FSN Strategies

The strategies to fine-tune the Farming System to address nutritional concerns were:

1. Increase the availability of cereals and pulses for household food requirement by enhancing production at the farm level

2. Widen the on-farm crop diversity to improve the dietary diversity

3. Promoting vegetable cultivation through household and community level gardens with naturally biofortified fruits and vegetables species and nutrient-dense varieties

especially green leafy vegetables to address micronutrient malnutrition

Methods and Approaches

Fig. 3 shows the broad steps followed while improving the nutritional dimension in the existing farming system in both the study areas.

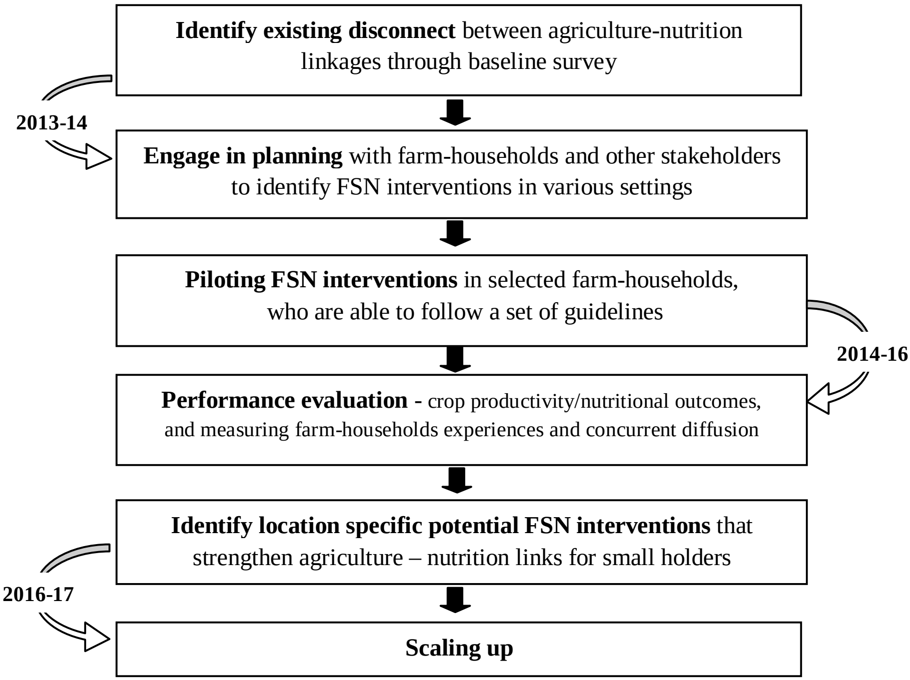

Fig 3. Steps in designing FSN

As mentioned in **Fig. 3** and also discussed earlier, a detailed baseline analysis was carried out to understand the constraints in the crop production and existing farming systems linkages through quantitative surveys and qualitative methods like participatory appraisal, participant observation, focus group discussion and interaction with related stakeholders. With reference to nutritional status assessment, standard protocols for anthropometric and biochemical analysis, were followed.

The height and weight of all the household members in both the study areas were measured using standard equipment (Seco weight balance, stadiometer and infantometer). The prevalence rates of chronic energy deficiency, underweight, stunting and wasting were calculated based on the cut off limits given by World Health Organization (WHO) standards: (http://www.who.int/nutgrowthdb/about/introduction/en/index5.html). For biochemical analysis, the blood samples were collected using filter paper technique to estimate the haemoglobin levels by cyanmethaemoglobin method (Drabkin's method) and blood vitamin A levels by dried blood spot technique using High Performance Liquid Chromatography (HPLC). The collected samples were analysed at the National Institute of Nutrition (NIN), Hyderabad. The WHO cut off levels were used to diagnose the extent and degree of iron-deficiency anaemia. Discussions were held with research institutions and experts on strengthening the cropping system to improve the productivity and production especially identifying suitable varieties. At the field level, men and women farmers were mobilized during the appraisal phase on the proposed interventions and on-farm demonstrations was used as a method to test the suitable practices and the protocol of Participatory Varietal Selection was adopted to select locally suitable varieties. During the process, men and women farmers were involved in the design, implementation and assessment stages; the process itself served as a sensitization and training phase for them. Standard methods to record the biometric parameters of the crop were followed to collect the data and compared with control or existing practices. Further, the cost of cultivation was calculated by taking input costs such as seed and fertiliser, whereas total return was calculated by multiplying yield with the average market price of the respective crop. The net return was calculated by subtracting the total cost of cultivation from the total return.

Results and discussion

The nutritional security component of the interventions was addressed through two approaches - enhancing productivity and production through varietal substitution, and diversification through crop intensification. While introducing new varieties, the primary nutrient content of the varieties was considered as biofortified crops/varieties.

As mentioned earlier, in Koraput, in both in low and medium land paddy ecosystems, interventions were promoted to increase the cropping intensity to 200% by introducing rice fallow crops such as green gram/black gram/finger millet by creating access to irrigation or relay cropping etc. Similarly, in upland, finger millet, maize pulse intercropping, vegetables and orange fleshed sweet potato (OFSP) are promoted instead of leaving as fallow or shifting towards perennial tree cropping. In Wardha, both sole cropping and intercropping of pulses i.e. pigeon pea and green gram, as well as cultivation of sorghum were encouraged instead of sole cotton /cotton+soybean/ sole soybean cultivation. Besides, suitable varieties of Bengal gram and wheat were promoted to bring more area under cultivation in *rabi*. Household level increased food crop production was encouraged in this manner, besides increasing productivity through new varieties, use of quality seeds and crop intensification through intercrops. While demonstrating the improved practices, recommended package of practices for cultivation was adopted especially in maintaining the plant population (spacing), nutrient and pest management. The interventions are discussed in detail here.

I. Introduction of new varieties in the existing cropping system

I.1. Performance of improved varieties of finger millet (*Elusine coracana*) in uplands of Koraput: A study was conducted to assess the performance of improved variety of finger millet GPU-67 against farmers' local varieties (e.g. *Telenga mandia, Dasara mandia*) under both traditional and recommended agronomic practices in Koraput. The traditional varieties are long duration and sensitive to photoperiods and hence sowing at the right time is crucial. Instead, GPU-67, a short duration and photo insensitive variety, was identified as suitable varieties under the earlier varietal testing programme through participatory varietal selection. Further, the recommended agronomic practices mainly included seed treatment, line transplanting and timely intercultural operations. In contrast, traditional farming practice followed broadcasting and no seed treatment along with limited intercultural operations. The grain yield and net return with GPU-67 was 31% and 62% higher than that of farmer's varieties under traditional agronomic practices (1579 kg ha^{-1} and 8200 Rs ha^{-1}, respectively). The crop being rich in micronutrient content, especially calcium, iron and folic acid, increased grain yield of finger millet under improved variety with improved package of practices will provide larger quantity of nutrient rich food to farmer households.

I.2. Performance of improved varieties of green gram (*Vigna radiata*) and black gram (*Vigna mungo*) in Rice fallows of Koraput: Rice fallows offer a huge potential niche for legume production. The rice fallows in Koraput generally remain fallow during *rabi* (winter) season due to extreme cold conditions and farmers having low or medium land cultivate green gram and black gram during pre summer i.e. February to mid April/May. Addressing these constraints through introduction of suitable short duration improved varieties with timely crop management practices was identified to increase pulse production.

A comparison study of two improved high yielding varieties of green gram *viz.*, SML-668 and NVL-585, with farmers' varieties indicated that SML-668 gave 12 and 14 per cent higher seed yield than NVL-585 (435 kg ha^{-1}) and farmers' varieties (425 kg ha^{-1}), respectively. As green gram is highly protein-dense, nutrient equivalent conversion indicates that SML-668 yields an additional 13 and 15 kg ha^{-1} protein than NVL-585 and farmers' varieties, respectively. In case of black gram, a comparative study between TK94-2, and NUL-7, reportedly a high yielding variety, that TK94-2 (351 kg ha^{-1}) gave 17% superior seed yield than NVL-7 (300 kg ha^{-1}). As black gram is highly protein-dense, nutrient equivalent conversion indicated an additional 12 kg ha^{-1} protein from TK94-2 than NVL-7.

Farmer amidst Finger millet crop, Koraput

Farmer inspecting pheromone trap in his field with Bengal gram crop, Wardha

I.3. Introduction of biofortified nutrient-dense varieties: Introduction of biofortified nutrient-dense varieties as well as improved high yielding varieties of nutrient-dense crops play a major role in increased availability of the nutrient-rich food per household.

I.3.1. Cultivation of Orange fleshed sweet potato (OFSP): Tuber crops especially sweet potato (*Ipomoea batatas*) find an important place in the dietary habits of small and marginal farmers especially among tribal population of India. However, the white flesh traditional varieties contain no pro-vitamin A whereas orange fleshed sweet potato varieties have emerged as the most promising plant sources of β-carotene (Harvestplus, 2012) with 100-g serving (about half a cup) of boiled roots supplying about 50% of the daily vitamin A requirement of a young child. In order to include the orange fleshed sweet potatoes in cultivation practices as well as in the food systems of tribals, a study was carried out as a component of FSN through introduction of OFSP varieties both at field and nutrition gardens. The initial planting material of OFSP (varieties ST-13, ST-14, Kamala Sundari), was multiplied and made available for growing in fields and/or nutrition gardens. In Koraput, areas under sweet potato cultivation by households varied from 122 to 2254 m^2 with an average of 490 m^2. In Wardha, the cultivation of OFSP was a part of promotion of nutrient sensitive agriculture, therefore was mainly confined to nutrition gardens (Pradhan et al., 2016).

OFSP cultivation

I.3.2. Performance of nutrient dense wheat (*Triticum aestivum*) varieties in Wardha: An on-farm demonstration was undertaken to evaluate the field and yield performance of zinc and iron rich (bio-fortified) wheat varieties namely AKAW-4627 and NIAW-1415 under irrigated conditions in Wardha. The package of practices was consistent, irrespective of the varieties tested. The grain yield for AKAW-4627 and NIAW-1415 were 3239kg ha^{-1} and 3594kg ha^{-1}, respectively while the mean grain yield of local varieties (Narmada Sagar and Lok-1) was of 1375kg ha^{-1} ensuring both food and nutritional security.

Harvesting of wheat, Wardha

II. Diversification through crop intensification

Crop intensification achieved either by intercropping or by sequential cropping like double cropping.

II.1. Performance of maize pigeon pea intercropping: Intercropping of improved maize (*Zea mays*) variety (NHM-51) and pigeon pea (*Cajanus cajan*) variety (NTL 724) in a 1:1 row ratio instead of usual sole cropping of local varieties of maize resulted in 4585 $kgha^{-1}$ of tender maize, 341 $kgha^{-1}$ of maize grains, and 4128 $kgha^{-1}$ of green fodder along with 349 $kgha^{-1}$ of pigeon pea tender pods and 356 $kgha^{-1}$ of pigeon pea seeds. Intercropping of maize and pigeon pea not only increased profitability of the dry land cropping system, but also maintained soil fertility through biological nitrogen fixation. As an added advantage, farmers were able to harvest two crops viz., maize and pigeon pea ***(a cereals-pulses combination)*** from the same piece of land.

Maize pigeon pea intercropping (1:1)

Pigeon pea harvest for dal

II. 2. Performance of sole pigeon pea/sole green gram/cotton green gram intercropping along with cotton pigeon pea intercropping: Pulses, especially pigeon pea, is generally grown as an intercrop with cotton in the region; however, considering pulses as a nutrient dense climate resilient nitrogen fixing crop, sole crop cultivation was encouraged. In *kharif*, pigeon pea varieties PKV-Tara and Durga PDKV, were grown both by intercropping with cotton in 2: 6 ratio as well as sole cropping. The results indicated that the yields of Durga and PKV-Tara were 2077 and 1544 kg ha^{-1}, respectively with 22 % higher yield in Durga than regular farmer's varieties (1696 kg ha^{-1}). Further, due to early maturity of Durga and PKV-Tara, the surplus amount could catch early market with good economic returns. The tender pods are consumed as vegetable and also fetch good price in market. As per feedback from farmers, the cooking quality and market acceptability of the variety is also equivalent to other popular varieties. Green gram is normally not cultivated as an intercrop; however, the crop diversification under FSN included trials of sole cropping as well as intercropping of green gram of improved variety Naval with cotton in 2: 6 ratios. A seed yield of 505 kg ha^{-1} was recorded which was 32% higher than local varieties (383 kg ha^{-1}).

Pigeon pea sole cropping

Drying of pigeon pea for Dal

Green gram with cotton intercropping (2:6)

Green gram harvest

<u>II. 3. Introduction of short duration finger millet in Rabi season:</u>
A short duration variety of finger millet '*Bhairabi*' was cultivated in rice fallows by the households having no suitable

Farmers' exposure visit to *rabi* finger millet fields, Koraput

area for growing the crop in *kharif* under irrigated conditions. The average yield was reported to be 1527 kg ha^{-1}. Millets were consumed daily and the source for millet was reported as mainly market (71%). This intervention of converting fallow lands for finger millet growing helped meet household food and nutritional requirements.

II.4. Vegetable and fruit based interventions through nutrition garden: The approach aims to promote greater diversity, better nutrition and additional income from sale of surplus produce. **Box 1** highlights the experience gained by MSSRF in promoting home gardens of fruits and vegetables under an earlier project on Alleviating Poverty and Malnutrition in Agro-biodiversity Hotspots[4]. The selection of fruit species and vegetables for nutrition garden is inclusive of the three groups of green leafy vegetables, roots and tubers and other vegetables with particular

[4]http://59.160.153.185/library/sites/default/files/Revised%20Final%20Technical%20Report%20of%20the%20APM%20Project%206%20November%202014.pdf

Box 1

'Nutrition Garden' in the farming system to improve dietary diversity, especially consumption of different vegetable groups

A total of 1412 kitchen gardens were promoted between 2011-2015 in three different tribal farming systems, 398 in Kolli Hills in Tamil Nadu among Malayali tribes; 387 in Koraput, Odisha among *Bhumia, Paroja* and *Gadaba*; and 627 in Wayanad, Kerala with *Kurichiya*, *Kuruma and Paniya* tribal communities. Households reported that the nutrition garden initiative helped in increasing the availability of vegetables at the household level and in improving their dietary diversity.

This initiative made it possible for people to consume a variety of self-grown, pesticide-free and fresh vegetables. The availability of vegetables per family per annum increased from 56 kg to 135 kg in Jeypore; from 48 kg to 90 kg in Kolli Hills; and from 26 kg to 96 kg in Wayanad (Siddick et al., 2014). This was more than double the quantity of vegetables that families were previously buying from local markets. Households that maintained nutrition gardens were found to have access to more nutritious and diverse food and reduced their reliance on local markets and shared more food with others than non participating households. Across the three sites, more than 50% of households consumed all produce generated from the nutrition gardens. The interventions were found to have increased women's control over foods consumed in the household, increased their self-efficacy for nutritional garden management, decreased reliance on the market to obtain food, and promoted knowledge of positive health outcomes associated with home grown vegetables (Rengalakshmi et al., 2017). An attempt was made to understand and address the challenges faced by the local community in establishing nutrition gardens, awareness created about the importance of vegetable gardening and investment made in strengthening their capacity in vegetable cultivation, pest and disease management, seed selection and storage, and good cooking practices with minimum loss of nutrients. Apart from ensuring dietary diversity, this established processes and practices to ensure sustainability of vegetable gardening even in the absence of promoting agencies through reviving local seeds system (Girigan et al., 2016).

attention to addressing micronutrient deficiencies, particularly anaemia and vitamin A. The objectives were to add vegetables and fruits in household food basket and to create awareness regarding importance of consuming different groups of fruits and vegetables to address malnutrition as well as to introduce nutrient rich plants / vegetables and fruits to overcome specific deficiencies and enhance dietary diversity.

The nutrition garden interventions were designed in discussion with the community at two levels *viz.*, (i) Household level managed by individuals and (ii) Common area in the village managed by a group of members in the community (basically to meet the space constraint in certain households to cultivate such crops in backyard/fields).

Household nutrition garden: Households with backyard area and with incidence of anaemia and Vitamin A deficiency among members were particularly targeted for cultivating nutrient-rich vegetables and fruits (206 in Koraput and 246 in Wardha). The average area of backyard land available is low, ranging from 6.3 to 15.9 sqm. Many households preferred to cultivate vegetables on a patch in the field itself and were encouraged to do so. A seasonal calendar of locally available vegetables was prepared and seeds were distributed accordingly. Besides, saplings of naturally fortified plants *viz.*, moringa, mango, guava, sapota, pomegranate, lemon, papaya were also distributed to the households. The produce mainly goes for own consumption with the surplus being distributed to neighbours.

Household nutrition garden, Wardha

Household nutrition garden, Koraput

Community nutrition garden: Community nutrition gardens on common or land leased without rental have been operating in about 0.1 acre each in Saheli, Heti, and Borgaon Gondi since late 2013 in Wardha. Leafy vegetables such as spinach, amaranth (*rajgira* and *chavalai*), fenugreek, coriander, and cabbage; roots and tubers such as carrot, radish, beetroot, and garlic; and other vegetables such as chillies, tomato, brinjal, lady's finger, cauliflower, cucumber, and ridge gourd; and cereals such as maize were planted. They are maintained by a group of women in each village and the produce shared by them. Surplus produce is given to neighbours, relatives or to the village school for inclusion in the midday meal. The community initiative is an effort to create greater awareness on the importance of cultivating and consuming vegetables.


Community nutrition garden

Taking Stock

The FSN interventions focused on improving production diversity and thereby dietary diversity through increased production and consumption of nutrient rich foods.

The interventions clearly demonstrated that through the introduction of improved varieties and crops in the existing cropping systems, and improved agronomic practices and nutrition gardens, the cropping intensity and food production at the farm level can be increased in both the study areas at the field level. The introduction of short duration and improved varieties also helped to diversify the household food production into cereals, pulses, vegetables etc. The increased food grain availability and diversity may help the household change their food consumption pattern, largely to move towards meeting the daily RDI. This is especially in the food groups of cereals, pulses and vegetables which have potential to influence the main malnutrition issue of under-nutrition and micronutrient deficiencies especially anaemia. An endline survey is currently underway in this regard. Nutrition awareness to instil this understanding is an integral component of the approach and is discussed in Section III

The sharing of experience by participating farm men and women at capacity building and stakeholder engagement programs indicate the impact of FSN interventions. Some of their insights are given here.

Dadarao Kamble, Heti village, Wardha: I have 5 acres of land in which I used to grow cotton and soybean earlier. Through FSN, I got trainings on seed treatment, improved package of practices, and I cultivated two improved biofortified varieties of wheat i.e. Nethravathi (NIAW1415) and Sardar (AKAW1445) in half acre of land under each variety during rabi and obtained 2200 kgs from that one acre and also supplied seed materials to neighbouring farmers when compared to 1000 kgs earlier in the same area. Earlier I used to experience wilting in my Bengal gram field but replacing the traditional variety to Jaki 9218 and through seed treatment and IPM strategies, I got a yield of 1200 kgs when compared to 500 kgs per acre in the past. Now I am not only able to fulfil my family's food requirements for wheat and pulses but also able to get additional income via providing seeds to others neighbouring farmers.

-Shared during block level FSN consultation in Karanja, Wardha, 9th May 2017

Ghenu Khillo, Farmer, Atalguda village, Koraput: I am actively involved in backyard kitchen garden where I am growing papaya, moringa as well as other seasonal vegetables and climbers in addition to newly introduced orange fleshed sweet potato. Specially, my children love to eat OFSP due to the colour but I am aware that eating vegetables having orange colour flesh is good for eye sight. Earlier, I did not have any idea on importance of consuming carrot and coriander. Now through FSN awareness programs, we all have started consuming carrot and coriander. I am also practicing intercropping of maize and pigeon pea under FSN intervention and getting two crops from the same field.

-Shared during block level FSN consultation in Boipariguda, Koraput, 27th April 2017

Ms. Ushatai Kourati from Borgaon village, Wardha: I got to know the importance of vegetable consumption. Since I as well as some other households had no or very small backyard area, we approached Gram Panchayat (GP) to get the common land in the village, but as the space was not available with GP, we approached to forestry department and from them we got the space of 25m X 15m in the village for establishment of community nutrition garden (CNG). Now we are eleven members in the group including me and all of them had given their time and efforts for the cultural operations like sowing, weeding, harvesting etc. From this CNG, two to three times in a week we are harvesting the produce and equally distribute among all of us. Sometimes we also share the surplus with the local school for their Mid Day Meal. We all are now getting most of vegetables from the CNG and are no longer dependent on market. We have also planted some fruit trees *viz.*, lemon, sapota, mango, guava, moringa etc. which will also provide them fruits in coming days. Also during awareness activities, we have learnt some recipes to be prepared from newly introduced leafy and root vegetables such as OFSP, bottle squash, coriander etc. My daughter in law is consuming a lot of vegetables in the diet during her pregnancy. During these eight months she has not been troubled by any kind of illness.

-Shared during district level nutrition garden and nutrition awareness to address malnutrition in Wardha, 23rd May 2017

III. Community Hunger Fighters - Champions at the Village Level

Nutrition knowledge that is required for integrating agriculture and nutrition varies across different sections. Farmers need an understanding and relevant information on alternatives available for integrating nutrition in their farming systems; agricultural scientists would have to see the importance of focusing their research on the nutritive properties of crops; households need to be made aware of the missing components of their diets and the decision-makers appreciate the potential to incorporate nutrition elements in various government programmes. The FSN approach also has to be backed by an enabling environment including clean drinking water, environmental hygiene and sanitation.

MSSRF initiated a community centred approach to address malnutrition related issues, through training a cadre of grass root level community volunteers, designated as Community Hunger Fighters (CHF) to be champions at the community level. In spite of a plethora of programmes implemented across the lifecycle by both the Central and State governments to enhance health, income and nutritional status of the people, there has not been a significant reduction in the levels of malnutrition in the country. It was felt that for hunger and malnutrition to decrease, people themselves need to act to change their practices, actively demand, seek and utilize entitlements and urge for good governance. The idea of the Community Hunger Fighters was conceived with this objective in mind. The programme was taken up as an action education model. It involves capacity building of at minimum three and up to five persons selected by the village community and representing different social groups and including both men and women, from each village / hamlet.

The process - of how to engage with the community, to facilitate collective critical thinking and subsequent action to move towards nutrition security, such that they are self sustaining - was discussed extensively within the institution. It was agreed that facilitation had to be continuous, to help people to reflect, decide, initiate, and move in a sustained manner towards desired ends. This could be attempted through a continuous process of action and reflection by community representatives consisting of men and women, identified as Community Hunger Fighters (CHFs). These men and women selected by the community would be the trailblazers in leading themselves and their communities towards freedom from hunger and undernutrition.

Facilitation is achieved through a sense of identity with the community, in not so much as being one of them, but to empathise with their lives, struggles and hopes and to provide them with the needed technical and advisory support and guidance at each phase of their progress towards addressing hunger and undernutrition. There is no formal structure of the CHFs since it is felt that the participants as well as the larger community in their endeavours in moving towards nutrition security, should have the opportunity for exploring various possibilities of engaging amongst themselves, with the implementers and with others outside of the villages during the course of intervention, based on which they could take a decision. They can use existing structures and the need for a structure, if any should be endogenous in origin and not one promoted by the facilitator.

In trying to empower communities to move towards the goals of nutrition security and freedom from hunger and undernutrition, the initiative envisages that stimulating critical reflection on the part of a group of people consisting of men and women belonging to different castes would lead to an enhanced consciousness on the part of the participants leading to collective action towards the goals of nutrition security.

Community members in the FSN study locations in Wardha and Koraput have been capacitated on the lines outlined above through residential participatory workshops and follow-up trainings to address needs identified by the trainees. The process is ongoing and is being monitored.

IV. Genetic Garden

Genetic gardens of nutrient dense plants (both natural like moringa and biofortified through plant breeding) are a potential means of creating awareness and provide necessary planting material for ensuring the sustainability of the FSN approach. The naturally nutrient dense plants and biofortified crops and landraces varieties found in small farms are often unique and have been passed from generation to generation, neighbour to neighbour, undergoing human selection and natural drift on their journey through time. Further, there is no germplasm collection in the form of a genetic garden which has chronicled all the available varieties of all species of vegetables, fruits, spices that are unique in its nutritional contents on a regional basis.

The establishment of a grid of **regional Genetic Gardens** of such naturally nutrient dense as well as biofortified plants and crop landraces will serve as a base to strengthen the protection of plant varieties and farmers' rights and with the collection of germplasm, this garden will also serve as a **Conservation Centre.** A permanent facility is an effective way to accelerate and scale up our efforts to understand and conserve and increase their cultivation area. The facility will also serve as an **Awareness Creation Centre** on the nutritive value of the different plants being conserved and the nutrient deficiency that they can help address: horticultural and agricultural remedy for nutritional maladies. The genetic garden is expected to evolve as a centre of dynamic adaptive management of a rich variety of nutritionally dense plant species and varieties. The biofortified plants will be actively selected with the participation of progressive farmers and managed in ways that allow them to evolve in changing circumstances.

The components of the Genetic Garden are:

A well landscaped garden with specific theme plots for key nutrients: Collection plots nested with subplots designated for key nutrients with fruits, vegetable, legumes etc. containing varieties of plants and their landraces;

A nursery of biofortified crop landraces for their multiplication and making planting material available to enhance the area of cultivation by farm families;

A seed bank for *ex situ* conservation with separate species specific storage facility. Species that requires vegetative propagation will be conserved using on-farm practices;

A poly house and shade net facility to grow plants with specific microclimate requirement;

A special conservation section for rare and rapidly disappearing and highly seasonal nutrient dense species;

An Interpretation centre on biofortified plants for specific nutrient deficiencies, passport data on unique nutritionally rich plant species and crop landraces, their cultivation methods for enriching subsistence farming systems, crop calendar, culinary preparations to maintain their nutritive value etc.

V. Non food factors

The FSN approach also has to be backed by an enabling environment. "...non-food factors influencing nutrition security like clean drinking water, environmental hygiene and sanitation should get concurrent attention through ensuring convergence in the delivery of health and other infrastructure and services" (Rao and Swaminathan, 2017). However, in as much as malnutrition is related to inequality of resources, poverty and social discrimination, the FSN design has to take these fundamental aspects into consideration.

Water, sanitation, and hygiene can have a profound effect on health and nutrition. While open defecation has declined only very slowly in India, other countries have experienced faster improvements in WASH, which has sometimes contributed to improvements in child nutrition (Spears and Haddad, 2015).

Most of the literature on child underweight in India concentrates on childcare by women, health aspects of women and children, and education of women (Black et al., 2008). The level of sanitation and availability of safe water have also received attention in explaining child undernutrition (Spears and Haddad, 2015). Given a predominantly agricultural setting, and that undernutrition rates are more persistent in rural areas, the study by Vepa et al. (2016) examined the impact of agricultural land productivity in explaining child underweight rates in India. Alongside this, the study also focused on public provisioning of amenities like water, sanitation, and health care facilities as well as the policy of provisioning food grains through PDS. It is observed that the variations in access and the quality of services depend primarily on governance and efficiency of the administrative system. The major contribution of this study is in establishing the child-nutrition-to-agriculture linkage in the case of India, which was suspected to be very weak. It shows that an increase of 1% in agricultural land productivity with its spillover effects could result in 0.08% improvement in child nutrition, after controlling for factors related to public provisioning, women's health and children's health, and women's education. Agriculture has an indirect effect largely coming from improvements in net agricultural income or agricultural wages and allied activities due to improved productivity. The results emphasise the points that creation of public awareness in terms of full dose of vaccinations, oral rehydration in emergencies, etc., contribute to better child nutrition. Public health facilities situated within the villages can go a long way in improving child nutrition in the district. Public provisioning of food, health, water, and sanitation services along with land productivity could bring about substantial improvements in child nutrition, since these variables impact marginal groups with less income and poor health status. The results of the study demonstrate the possibility of big gains in child nutrition, where agricultural development efforts converge with public provisioning efforts.

VI. Networking & Communication Approaches for Better Nutrition Outcomes

A combination of communication and advocacy approaches are integral to development interventions. In the area of nutrition this is particularly so, for effective nutrition literacy, knowledge management and advocacy. For a nutrition-sensitive response, the importance of communication processes and the need to work on Knowledge, Attitude, Practice and Behaviour has been frequently emphasized. Some of the following approaches undertaken by MSSRF have supported and complemented ongoing efforts towards Zero Hunger:

Inter-Personal Communication: The Community Hunger Fighters Initiative, described in detail in Section III, describes how women and men from within the community take the lead in enhancing the nutrition status of their peers. It involves providing solutions with a scientific understanding, but the communicators are members from the peer group. This community empowerment and peer-led communication is an important pathway for greater nutrition outcomes.

Participatory Communication Approaches adopted under the research study led by MSSRF on 'Alleviating Poverty and Malnutrition in Biodiversity Hotspots' during 2011--14, helped increase collaboration and communication between scientists and farmers to share knowledge and adopt proven practices related to agriculture and nutrition. The concept of 'Village Knowledge Centres' helped facilitate intensive communication and information sharing among community members. The study found that a partnership of community-based institutions and scientists helps scale up nutrition security initiatives. The knowledge empowerment was in the domain of integrated agriculture, conservation, nutrition, health and entitlements which had forward linkages to and adoption of practices such as inter-cropping, seed management, soil health management, nutrition gardens, inland fisheries, health, sanitation, credit linkages and functional literacy, to bridge the knowledge divide. The nutrition volunteers and village knowledge disseminators helped in increasing the nutrition related awareness at the household level. As an outcome it increased the adoption of nutrition-friendly practices in the project locations.

Knowledge Management plays an important role in facilitating and supporting development interventions. The World Food Programme (WFP) notes that not all data need be generated through primary research – many gaps can be filled through improved Knowledge Management (KM). Studies have shown that improved knowledge on nutrition is an important factor to enhance the nutrition levels of the community. Also, KM is essentially about people – how they create, share and use knowledge (Servin, 2005). The 'Tamil Nadu Nutrition' portal, facilitated by MSSRF, an online platform with research, policy documents, reports, communication tools, facilitates a one-stop point for nutrition knowledge. These would support stakeholders on work related to nutrition for the state of Tamil Nadu. In due course it aims to propose a model for the country and region.

Networking for Impact: MSSRF has engaged with multiple stakeholders and institutions and its two major nutrition initiatives have been multi-country research consortia. A number of interventions by implementers focus on enhancing nutrition levels. However, this is dependent on knowledge, skills and capacities of the personnel engaged. The 12th Five Year Plan for Tamil Nadu suggested that capacity building of personnel in nutrition efforts could help them be effective 'change agents'. It also suggests greater convergence with allied Departments and Institutions to widen the reach of services and increase overall impact of programme interventions. The 'Tamil Nadu Nutrition Alliance' an MSSRF-UNICEF facilitated initiative has representatives from Government, Non-Governmental organizations, farm families, community based organizations, educational and research institutions and experts working on nutrition outcomes. It aims to facilitate greater convergence, build capacities and share best practices, resources and tools for better impact.

Technology and Stakeholder Platforms have been important forums of stakeholder engagement in the FSN study under LANSA to leverage support, acceptance and advocacy for wider impact. The 'Technology Platform' has representatives from research institutions, agricultural and veterinary university and the private sector as 'knowledge partners' who support and guide the initiative. The 'Stakeholder Platform' comprises members from the district administration, banks (district lead bank, NABARD), farmers' associations, NGOs, civil society, and farm men and women as 'intervention partners' to partner with us at the field level in on-farm demonstrations and provide support services.

Communication Demand Pull Strategies: Demand or consumption for better nutrition is another important aspect of communication. In order to drive a demand pull for millets considered Climate and Nutrition Smart, 'Smart Food' an innovative communication strategy by ICRISAT in partnership with the Indian Institute of Millets Research and MSSRF, was awarded an international 'Launch Food' Innovation award in 2017. This strategy aims to increase consumption of millets, also referred to as 'nutri-cereals' for their nutritive properties. It involves various innovative communication approaches and by making them more lucrative and sought after, encourage farmers to grow more nutritious crops.

Advocacy for Nutrition: India is the first country to adopt a Food Security Act in 2013 as an act of Parliament to ensure every citizen the 'Right to Food'. The Act promises availability and access to food in adequate quantities and at affordable prices and provides for inclusion of millets in government food distribution programmes including the Public Distribution System. Prof M S Swaminathan, Founder MSSRF has for long been an active advocate of this measure. The effective implementation of this provision has significant potential to change consumption patterns and the nutrition scenario of the country.

These experiences indicate the importance of integrating a specific or a combination of communication approaches for greater nutrition impact.

VII. Conclusion and Going Forward

The foregoing sections discussed the relevance and potential of leveraging agriculture for nutrition, the need for nutrition sensitive agriculture and the experience of designing a crop based FSN model under the LANSA research programme; the supporting components necessary for the success of the FSN approach, viz. building understanding, capacity and ownership at the community level, the need for a grid of genetic gardens of both naturally fortified and bio-fortified plants, the importance of non-food factors and networking and communication have also been discussed. These components together make for a holistic approach to address the problem of malnutrition.

Long ago, Hippocrates advocated “let food be thy medicine”. Going forward, the opportunity for adopting this principle is now great with a large number of biofortified crops such as vitamin A rich sweet potato and multiple micronutrient rich *moringa* etc. being available. MSSRF is therefore planning to take forward the concept of FSN. This project will consist of the following components implemented in an integrated manner.

1. Eliminating under-nutrition or calorie deprivation through the effective implementation of the provisions of the National Food Security Act. Besides wheat and rice, the Act provides for making available nutri-millets like ragi at a very low cost.
2. Including pulses in the PDS in order to ensure that protein hunger is eliminated.
3. Designing location specific FSN models based on the resources available to address prevailing nutrition deficiencies
4. Overcoming hidden hunger caused by the deficiency in the diet of micronutrients such as vitamin A, iron, iodine, zinc, vitamin B12 etc., can be now done by integrating agriculture and nutrition through biofortified plants. Genetic gardens of biofortified plants which can provide the specific missing micronutrients in the diet can be organised in every block. *Krishi Vigyan Kendras* should take this knowledge to the field and also help to train a cadre of 'Community Hunger Fighters', well-versed with information on the missing micronutrients and the crops that can provide them.
5. Effective steps will be taken to avoid food losses and to ensure food safety, particularly with reference to aflatoxins in food. This will require the safe storage of grains under low moisture conditions.
6. Finally, the programme will include attention to the provision of clean drinking water, sanitation,

nutritional literacy and primary health care including immunisation.

7. For all the above to be sustainable, it is essential that the social engineering aspects of programme design and implementation, are given attention. The foremost among them is the need for mainstreaming the gender dimension, but recognising differences in needs and opportunities of men and women within local communities. There is also need to set up a suitable community-based and driven organisation to support and monitor this process. Such an organisation could be the guiding force behind the 'community hunger fighters'.

All the above steps need to be initiated in a mutually reinforcing manner. For achieving the above, particularly integrated action, there will be a need for a suitable management and coordination structure at the district level. A project implementation committee consisting of representatives of Indian Council for Medical Research (ICMR), Indian Council of Agricultural Research (ICAR) and local district-level agencies needs to be set up. Monitoring and evaluation will be done in order to assess the nutritional impact of the intervention. Suitable methods of monitoring and evaluation will have to be developed and introduced. Well-trained community hunger fighters, can contribute to make this process more effective.

With the right direction, appropriate action and effective co-ordination, the FSN approach can enable the country reach the goal of Zero Hunger by 2030.

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