Operationalizing the concept of farming system for nutrition through the promotion of nutrition-sensitive agriculture

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Despite impressive gain in agricultural production and greater availability of food, a large population in India is suffering from nutritional imbalance. Improvements in total agricultural production leading to nutritive food would help combat under nutrition. To demonstrate the feasibility of agriculture-based remedy to malnutrition, five villages in Wardha district of Maharashtra were selected for validating the farming system for nutrition (FSN) approach.

On-farm demonstrations of arable crops and women-managed community nutrition gardens (CNGs) of vegetables and fruits were initiated. A wide choice of nutritive vegetables to be grown was promoted to reduce the off-farm transport cost and ensure higher availability of nutritive vegetables to the households. The additional nutritional gain through FSN can be quantified in terms of equivalence and can be calibrated to ensure that the households get the recommended daily intake of nutrition. Accordingly, a FSN approach is evolved to provide nutritional security to every household.

Keywords: Community nutrition garden, farming system for nutrition, nutritional security, nutrition-sensitive agriculture.

AGRICULTURE, nutrition and health have all remained as separate silos for long as they are governed administratively, technically and operationally by different Ministries, both in the states and at the centre. Despite impressive gain in agricultural production and greater availability of food, a large population is suffering from nutritional imbalance[1]. Therefore, improvements in total agricultural production alone may not combat malnutrition if several other mediating factors are not in place. Interventions to improve education, health, sanitation and household infrastructure; care and feeding practices are critical. Innovative strategies that integrate agriculture and nutrition programmes stand a better chance of combating the malnutrition problem[2]. Swaminathan[3] designed a farming system for nutrition, comprising specific steps, including the cultivation of nutrient-rich varieties of millets, sweet potato, etc.

According to 'M.S. Swaminathan, farming system for nutrition can be the answer and he defined it 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'.

There have been several efforts to address the issue of rural employment, food security[4] and poverty by the central and state governments; social organizations and farmers' groups. A critical appraisal to mitigate the agricultural distress in Wardha district, Maharashtra has been made by Rukmani and Manjula[5]. While examining the area and production between 1961 and 2005, they noticed that the area under sorghum declined sharply and the per day per capita food grain production decreased from 532 g in 1961 to a mere 369 g in 2001. Shift from millets to cotton and soybean meant dependency on food grain supply from outside the district. This paradigm shift from millet-based diet had its own impact on the nutrition of the people.

Site selection criteria

Tagade[6] has dealt on the issue of food security and nutritional deficiency in Maharashtra. Farmers committing suicide is also a social issue in this resource-poor semi-arid tract of India. Therefore, Wardha district was selected to reduce the negative footprints of nutrition on the population. After due consideration, a team of scientists scouted 50 km radius around Wardha for appropriate cluster of villages. The cardinal criteria used in site selection were (1) remoteness of the area, (2) predominantly

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Table 1. Demographic profile of the five villages selected in Wardha area for farming system for nutrition evaluation

Block	Panchayat	Village	No. of households	Male population	Female	Male as %	Female as %	Total population
Arvi	Saheli	Saheli		295	276	51.66	48.34	
		Vitpur		126	110	53.39	46.61	
Karanja	Borgaon	Susund		240	245	49.48	50.52	
		Heti		110	82	57.29	42.71	
		Borgaon Gondi		370	334	52.15	47.85	
Total			556	1,141	1,047	52.15	47.85	2,254

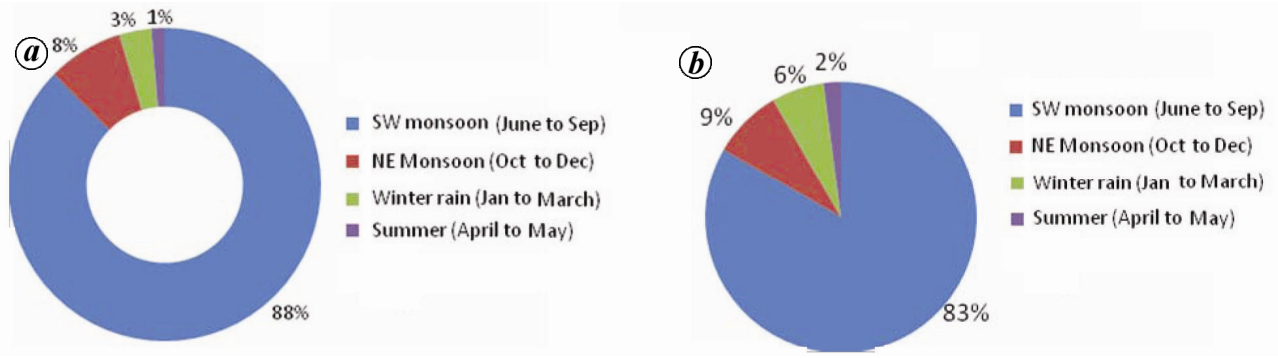

Figure 1. Seasonal rainfall (***a***) and rainy days (***b***) at Wardha.

tribal population with difficult livelihood, (3) possessing some land and cattle, (4) having a reliable water resource, (5) willing to adopt better operational systems and (6) with apparently poor nutritional/diet uptake. On the basis of these criteria, five villages were selected for validating the farming system of nutrition (FSN) approach. The demographic information of these five villages is given in Table 1.

Of the 2,254 people in 556 households inhabiting these villages, 54% belong to the SC and ST communities and the rest are OBC and SBC.

Three youths who are conversant with the local dialect were positioned as 'site guards' and given the necessary training on the project activities to act as local day-to-day action planners.

Climate

Wardha experiences hot and dry weather from mid-April to June, when the maximum temperature for few weeks exceeds 42°C. The farmlands during these months have a parched, semi-arid appearance. By the end of June the monsoon arrives and lasts till early September. And in 40+ days of wet spell ~800 mm of rainfall or about 86.5% of the total annual rainfall occurs. The northeast monsoon in four spells of rainfall provides 9% of the total annual rainfall. The winter rainfall accounts for the remaining 3.5% and summer showers seldom occur (Figure 1).

Land and livestock resources

These villages face a shortage for farmland, grazing area and irrigation needed for a complete crop husbandry. The FSN area has an animal population of 562; of which bullocks alone account for 188, which are used for powering various agriculture operations and transportation. Animal droppings or dung is used as manure or as household fuel. The milch animals that accounted for 45% of the total animal wealth are physically weak and skinny with low productivity.

Social mobilization for FSN intervention

The demography of the FSN villages reveals that 177 households (32%) are landless and 213 households (38%) have less than 5 acres of land. Only the large land holders have diversified their activity covering more than one subsystem. The FSN is an integrated farm-oriented activity with arable farming, vegetable farming, backyard farming and animal farming as various sub-systems within it (Figure 2).

The FSN study seeks to understand whether and how agricultural interventions can generate nutritional impacts in general and specifically explores the scope of improving the nutritional status of malnourished population[7]. The FSN team of this project undertook social engineering activity by discussing this viewpoint with all sections of the village community, mapping the land water resources, establishing communication with the women and understanding their concerns. On this information base, the

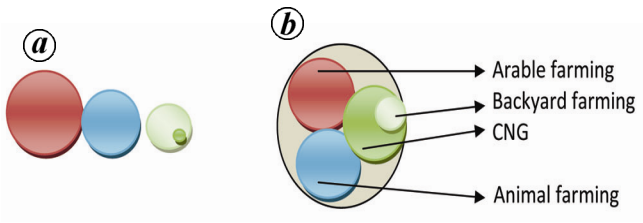

Figure 2. ***a***, Differentiated and unstable agricultural food system currently supplying nutrition in Wardha villages. ***b***, Stable and balanced farming system for nutrition (FSN) that will holistically meet the food-based human nutritional needs.

FSN team catalysed the formation and promotion of volunteer forces or clubs for a given activity. Leader farmers were identified through dialogue and several farmers agreed to experiment with (a) arable crop interventions (ACIs) and (b) women-managed community nutritive gardens (CNGs). For this, multisite (at least half an acre at each site) ACI trials were conducted covering cotton, soybean, pigeon pea, QPM maize, sorghum, micronutrient dense pearl millet, strip cropping, multiple cropping, etc. during the *kharif* of 2013. These trials had the objective of increasing crop yield, reduce cost of cultivation and thereby provide higher farm income from a unit area. The additional income through gain in crop productivity may eventually assist in procuring nutritive food. Thus the FSN approach is sound and robust and is designed to provide a locally harvested nutritious diet to the households, and enhance the farm income to enable a need-based procurement of food items.

CNGs managed by women farmer groups were established at sites close to the dwelling area, both to ward off wild animal attacks and also enable the women to give more time for management of the garden. The CNGs were centrally located on Panchayat land or on the land taken on lease, with provision for watering the gardens. Keeping the needs of the member households in mind, a field of 25 × 15 m size was earmarked for this activity. Quality planting materials as seed/sapling, fertilizers and manure, etc. were made available to the CNG club. The club members drew their own work schedule and time-sharing details. Accordingly, the vegetable harvest was shared among them. The overriding ethical principle was that the club members will not leave the CNG activities midway in the season. In short, the FSN–CNG was framed as 'an overarching decentralized, people-inclusive, women-empowered, collective action programme for a better nutrition household'.

Outcome and benefits

Community vegetable gardens

Affordability apart, one of the reasons for the low consumption of vegetables in Wardha is that a greater share of the vegetables comes from outside. The choice of vegetables, supply, demand and price are beyond their control. The FSN attempts to rectify this anomaly by promoting a wider choice of nutritive vegetables to be grown within the same village. Also, the objective is to reduce the associated transport cost and ensure greater availability of farm-fresh, nutritive vegetables to the households. This stand-by route for fresh supply of vegetables is more pragmatic than supplying as fortified food, etc.

In the five villages CNG was popularized as a sub-system under the FSN; 10–12 women households organized themselves as a club, did all the day-to-day operations and shared the produce. The womenfolk was given a choice of 16 different vegetables and 5 condiments and spices (taste-makers) for cultivation. Leafy vegetables such as the amaranth and spinach yielded maximum in comparison to tomato, cucumber, okra (bhendi), etc. that were plagued by viral diseases and pests. The micronutrient content of most of the vegetables cultivated in the CNGs is given elsewhere[8]. This information served as the baseline to calculate the nutrition equivalence of the vegetables accruing to households from the CNGs.

Of the five villages, Vitpur CNG supplied maximum amount of nutrients and vitamins to the households. Although Heti and Borgaon Gondi grew a variety of vegetables, the nutrients supplied to the diet of the household were less. Hence, keeping in view the objective of the CNGs, it is important to choose the proper vegetables for cultivation and the size of the plot that they should occupy. As the area covered by a given vegetable in CNGs varied with location, the nutrition harvested to supplement the diet of a household varied. The vegetables that were shared by the club members in Saheli village were converted to nutrition equivalence in terms of iron (Fe), zinc (Zn), calcium (Ca), pro vitamin A and ascorbic acid (vitamin C; Table 2).

The CNGs harvested radish, but the tender leaves of radish, beetroot and mustard that were also used as vegetable were not accounted while calculating the nutrition equivalence. Examination of the nutrition equivalence reveals that more than 50% of the supply of Fe, Ca, Zn and pro vitamin A and vitamin C was from the leafy vegetables. Yet, the decision to cultivate a vegetable in CNGs was not driven by the felt nutrient deficiency in the diet of the household. Household preference was for the taste-makers and for vegetables like brinjal, tomato, etc. that are not endowed with important minerals and vitamins. Also, unlike the green leafy vegetables, here, only a part of their biomass is edible. Leafy vegetables such as spinach are amenable to multiple cuts/harvest. Amaranth is more fibrous than spinach and tends to become less palatable as the plant matures. Harmonizing the CNGs with other production sub-systems such as backyard farming, arable farming, and animal production systems may holistically remedy the issue of nutritional malady of the people.

Table 2. Nutrient equivalence made available to each CNG women-member household, village Saheli during *rabi* 2013–14

Nutrient	Spinach	Amaranth	Coriander	Carrot	Radish	Chilli	Tomato	Brinjal	Bhendi	Ridge gourd	Total
Iron (mg)	66.84	26.18	0.73	1.03	0.4	20	3.2	3.0	2.0	1.5	106.85
Zinc (mg)	18.0	2.02	0.16	–	–	–	2.0	3.0	–	1.0	26.2
Calcium (mg)	4,380	2978	199	80	35	30	240	130	20	60	8,152
Pro vitamin A (μg)	56.64	6.26	0.24	0.65	–	0.3	0.3	–	–	–	64.39
Vitamin C (μg)	1,680	742.5	70	1.5	21	300	135	90	–	20	3052.8

Spillover benefits: Surveys have shown that the diet of school-going children is deficient in calorie, protein, vitamins and minerals[9]. Following the success of the midday meal scheme of school-going children, a nation-wide scheme was launched. The midday meal programme benefits the young school-going children[10]. In Saheli village, the members gave the school 3 kg of spinach as gratis for the midday meal and in Susund, 10 kg of spinach and 1.5 kg of beetroot were given to the village school. In addition, the CNG club members also sold 16 kg of spinach and 2 kg brinjal to other households in the villages.

Interventions in farming arable crops

Farming system intervention under crops has two broad objectives: (1) to increase the productivity and profitability of crops that are of commercial value, to enable the purchase of nutritive food, and (2) promote pulses and demonstrate bio-fortified crops like iron-fortified pearl millet and sorghum to address protein and micronutrient deficiencies.

Arable farming: In the villages of Wardha field crops such as cotton, pigeon pea, soybean, maize and other major millets are cultivated during the *kharif* season. *Rabi* or low-temperature months are more suited to wheat, mustard, chickpea (Bengal gram), mung bean, black gram and safflower. Grain-cum-fodder maize, sorghum also cultivated in some area. Commercial crops, namely cotton and soybean drew the attention and care of the farmers as their priority was financial security. The crop interventions done as part of FSN are given in Table 3. The interventions increased the crop yield, reduced the cost of cultivation and resulted in higher income from the farm. Farmers were encouraged to sell the plant biomass and not burn it.

During the 2013–14 *rabi* season farmers cultivated some area under wheat, chickpea, sorghum, mustard, linseed and maize. It was evident that farmers were growing old varieties like Lok-1, Narmada Sagar and Vijay (private company varieties), implying that the genetic gain made by way of new varieties had not reached them. Therefore, seeds of recent varieties of wheat and chickpea having good protein content were made available as part of the FSN intervention.

Wardha area seems better suited for the production of pulses – pigeon pea during *kharif* and chickpea during *rabi* yielded stability. The chickpea genotype JNKVV 9218 is a small-seeded desi or land race-type and yields more; while the other type is large-seeded kabuli type that yields less, but fetches higher price in the market. Through the increased harvest of pulses, protein, iron, carotene and other nutrients in their diet can be augmented. In general, harvest index is 0.6 for wheat, indicating that for every kilogram of biomass harvested, 0.4 kg is grain and 0.6 kg is straw. While the grain goes for the household, the crop residue is used as cattle feed. Following threshing, the broken grain is collected and used as poultry feed. Thus, hardly any part of the biomass is wasted and everything is recycled through different routes to produce nutritive food.

In 2014, at Saheli, the non-FSN plots of 0.2 ha size recorded an average yield (mean of two demonstrations) of 275 kg of wheat grain harvested, while in the FSN fields of similar size the harvest was 648 kg of grain. Similarly, from 0.2 ha of non-FSN field, 155 kg of Bengal gram was harvested and by growing superior genotypes as FSN intervention the yield increased to 293 kg. This additional harvest of 373 kg of wheat and 138 kg of Bengal gram per household FSN demonstration was converted to nutrition equivalence. The extent of additional nutrition gained by harvesting nutrition-dense modern varieties is quite substantial (Table 3). What this means in terms of mitigating the nutrient deficiency syndrome is to be examined further.

The performance of mustard in three different villages during *rabi* 2014 was impressive. Mustard leaf is one of the richest sources of Fe and carotene. Apart from mustard oil, the household also used the tender mustard leaf as green vegetable, but this was not quantified. In short, additional yield of pigeon pea, chickpea, wheat, mustard, etc. harvested by cultivating new varieties as intervention under FSN substantially added to the nutrition basket of the households. The extent of benefit gained from *rabi* sorghum, fodder crops and other grain legumes, if quantified, then a guestimate of the real benefit from FSN can be made.

Increasing the productivity of crops such as cotton and soybean enhanced the farm income and thereby promoted the purchase of food items to meet the out-of-season food shortage. These two distinct pathways, one providing

Table 3. Additional nutrition harvested by the intervention farmers located in Saheli through wheat and Bengal gram crops of 2013–14

Additional gain	Protein (kg)	Ca (g)	Fe (g)	Zn (g)	Carotenes (g)	Vitamin C (g)
Wheat (373 kg)	44.014	153.0	19.83	10.1	108.0	nil
Bengal gram (135 kg)	23.085	272.7	6.21	5.80	0.255	4.05
Total	67.099	425.7	26.04	15.9	108.25	4.05

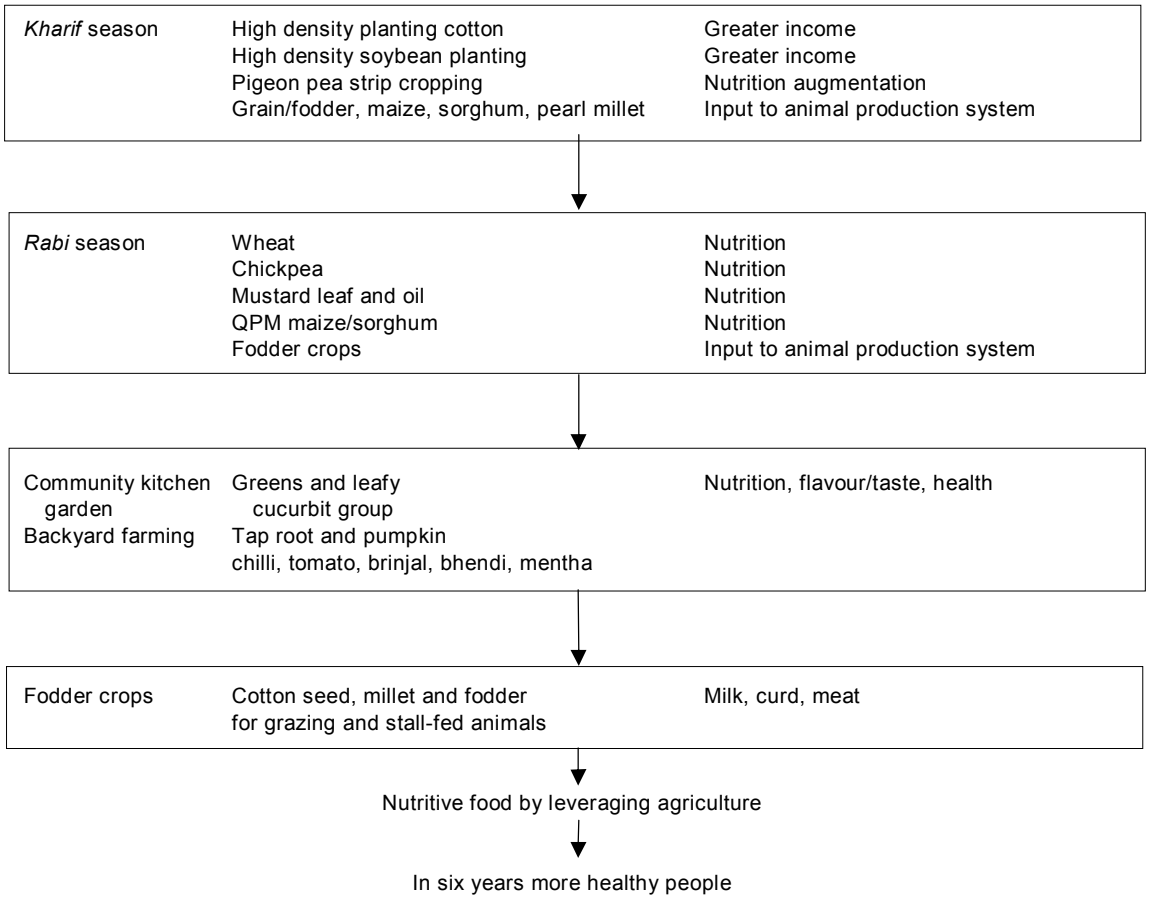

Figure 3. The farming system for nutrition agriculture package finalized and recommended for adoption by the villagers in Wardha, Maharashtra.

additional nutrition through FSN and the other additional income by FSN would ensure household food and nutrition security.

Nutrient shrub and fruit tree garden (community kitchen garden and backyard farming): In the homestead gardens of Kerala[11] and states in the North East, backyard gardens are so designed to intercept sunlight with great efficiency to maximize biomass production and yield. These multi-layer crops mature at different periods of time; the vegetation with varying root system harnesses the soil moisture from different profiles and provides ideal microclimate for productive backyard farming. Though the weather conditions at Saheli are different from those in Kerala, the CNGs and backyard gardens are planned to include shade-providing fruit trees and shrubs that supplement the vegetable cultivation. This multi-layer vegetation system will provide a comprehensive nutrition supply year around to the households.

Farm biomass, fodder, and animal and aquatic production systems

Fodder shortage in this tract is acute and is evident from the poor health of the cattle. Biomass of the winter cereals, fodder sorghum and maize stover can be used as animal feed, to improve the cattle health. We are still involved with the animal and aquatic production systems as part of FSN and the effect of complete FSN on the nutrition of the Wardha households will be reported elsewhere.

Farm-level diversity and FSN

In the last three decades in Wardha area, there has been a narrowing down of plant species under cultivation. Area under several millets, grain legumes, mixed cropping with native cotton (*Arborium* types) has changed to cotton (upland types), soybean, and fodder millet during *kharif* and a variety of crops during *rabi* in response to market and household needs. Barring a few patches growing commercial vegetables, the backyard serves as the main supplier of fresh vegetables. Often, this supply may be inadequate and purchasing them in the weekly bazaar (market) is a normal practice. The CNG popularized under the FSN intervention has diversified the food base. The FSN approach promotes the cultivation of an array of plants, aquatic life and farm animals to sustain a nutrition-rich diet to the farm families. In the process, the food base is also widened and greater diversity is retained at farm level.

Together with the above, a nutrition awareness drive at all levels – household, community and institutional – covering aspects of balanced diet, hygiene and sanitation, infant and young children feeding practices will have to be undertaken for internalization of the benefits and to sustain the impact. Access to extant entitlements for food and nutrition will also be facilitated.

Technology and stakeholder platforms of research institutes, government departments and local NGOs and farmer groups in the area have been formed to leverage the power of knowledge and intervention partnerships.

Empirical model on the flow of operations in FSN interventions

On the basis of experience of designing FSN for Saheli, a sequence of decision-making is advocated. The Wardha tract being semi-arid, aquaculture is not a dominant occupancy for the households, whereas animal farming is a dominant occupancy. The sequence of decision-making, depicted in Figure 3, is likely to provide nutritional security at household level.

Conclusion

The underlying unifying approach of FSN is to promote a science-based nutritive farming – food production technology, to enhance the nutritive value of the agricultural harvests and enable the rural households meet their daily diet requirements from their own local resources coupled with greater nutrition awareness. The FSN approach that is area-specific has been designed for the Wardha region which offers an opportunity to mitigate nutrition deficiency and the related maladies.

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