Impact of farming systems for nutritional food security to farm families in dry land farming situation in Anantapuramu district, Andhra Pradesh, India

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ABSTRACT

Aims: The present studyvalidates the possibility of Farming Systems for Nutrition based models in dryland farming situation and to address malnutrition among farm families.
Study design: Frontline Demonstrations (Field Demonstrations)
Place and Duration of Study: The field demonstrations were conducted at KVK, Reddipalli instructional farm of Anantapuramu district, Andhra Pradesh during the period from July, 2019 to October, 2021.
Methodology: FSN model was designed for a one-acre area based on the major crop grown in the area and to include all the food group crops (cereals, pulses, fruits and vegetables) that are suitable in the district, and to provide a balanced diet, which is a vital element for a healthy life, by providing right amounts of carbohydrates, healthy proteins, vitamins and minerals. In the Anantapuramu district, as groundnut is the major crop, groundnut-based farming systems are designed by including all the prominent crops to cover all the food groups. This paper thoroughly discusses the farming systems for the nutrition models demonstrated and to meet the annual requirements of all food groups of a Farm household(5-6 members).
Results: The results revealed that, farming systems for the nutrition model provides a total of 35 percent of the cereal requirement which is rich in carbohydrates and can meet the calorie needs of the family, 93 percent of legumes which is rich in protein content and 335 percent of vegetable requirement which meets micronutrient needs and 238 percent of nuts and oilseed requirement, meeting protein and antioxidant requirement of a family.
Conclusion: The results provide evidence regarding feasibility of location specific FSN models to promote sustainable and healthy diets, using locally available plant and animal food resources, to address nutrition deficiencies in farm families. Hence, the approach can be seen as a subset of the larger canvas of agro-ecology and sustainable food systems, with explicit focus on addressing household nutrition security as demonstrated by the study, highlights the need for greater support, research and extension in this important area.

Keywords: Hidden hunger, Household Nutritional security, Millets, Deficiency

1. INTRODUCTION

In India, agriculture is the way of life and a major source of livelihood, and the country is the second-largest producer of food (Poonam et al., 2015). Despite that food security continues to be a matter of great concern for India, as the world's second-largest undernourished population (195.9 million) (Maitra, 2018). Rapid urbanization has led to a decrease in cultivated land, increasing global food requirements, necessitating a need to enhance cropping intensity and productivity (Ankita et al., 2020). Despite efforts to boost agriculture productivity post-independence, a significant portion of the Indian population, particularly malnourished, still suffers from nutritional deficiencies (Das, 2021; Biswas, 2019). Agricultural research and related policies in India have largely focused on building a food environment that can assure staple food production and availability for a growing population

(Eliazer et al., 2019). Consumption of staple foods increases the energy availability (Bayata, 2019). This has led to an important concern, particularly for those in the low-income groups as they are consuming mainly staples, which are high in carbohydrates, but low in micronutrients (Rajendran et al., 2017).

Food quality in rural areas often lacks essential micronutrients, leading to hidden hunger and micronutrient deficiency, as it fails to meet nutrient requirements for growth and development. (Kundu et al., 2017). The problem of hunger is not simply a lack of sufficient quantities of food. The chronic hunger caused by protein and calorie under nutrition is exacerbated by malnutrition (Swaminathan, 2012; Nithya and Bhavani, 2018). The National Family Health Survey (NFHS-5) data in India shows a high prevalence of under-nutrition among under-five children, with 23.4% stunted, 19.7% underweight, and 4% overweight (Das et al., 2021). Unbalanced diets and lack of food are linked to high stunting rates, excessive weight, and death in children under five years old (Suri, S. 2020). In India, 31.4% of pregnant women suffer from anemia, 27% of men and 24.8% of women have high blood sugar levels, and 32.8% of men and 30.9% of women have hypertension (Pattnaik et al., 2023). Food security encompasses ‘Availability’, ‘Accessibility’ and ‘Utilization’ which includes ‘absorption’ and bioavailability of food making it inclusive of ‘Nutrition Security’ (Rainer et al., 2000). This indicates potential for mainstreaming Nutrition- Sensitive agricultural interventions which can be practical, suitable and sustainable ways of alleviating nutritional deficiencies (Shetty, 2015). The focal theme of FAO’s also highlighted in their report on State of Food and Agriculture is ‘Food Systems for Better Nutrition’ (Anonymous, 2013). Gulati et al., (2012) found that improving agricultural performance can have a positive impact on nutritional outcomes. Ruel et al. (2018) reported that agriculture should focus on improving dietary diversity and high-quality diets as a precursor to better nutrition outcomes”. Studies have also shown that recognizing women’s contribution to both agricultural production and domestic reproduction is central to improving nutritional outcomes (Kjeldsberg et al., 2018).

MS Swaminathan Research Foundation (MSSRF), Chennai has been promoting the Farming Systems for Nutrition (FSN) model. Farming System for Nutrition is a location-specific, inclusive approach based on resource endowments and a specific environment, to address the nutritional needs of households. It is a flexible approach that considers the nature of resource endowments available, specificities in environment and nutrition problems, because of which farmers can decide on possible combinations of different components of FSN. The potential of the approach to influence and improve intermediate outcomes such as dietary diversity and the consumption of nutrient-rich foods irrespective of agro-ecological differences as demonstrated by the study, highlight need for greater support and research in this important area.

FSN model envisages the introduction of location-specific agricultural remedies for nutritional maladies by mainstreaming nutritional criteria in the selection of farming system components involving crops, animals and wherever feasible fish (Das et al., 2014; Nagarajan, 2014). FSN is a sustainable intervention promoting small and marginal farmers to implement mixed farming on 1 acre, focusing on advanced crop production, bio-fortification, nutrition gardens, livestock development, and small-scale fisheries, addressing nutritional deficiencies (Swaminathan, 2014). Pradhan et al. (2021) provided evidence regarding feasibility of location specific FSN models to promote sustainable and healthy diets, using locally available plant and animal food resources, to address nutrition deficiencies in farm families. The FSN model has resulted in improvement in nutrition status through an improved agricultural production system, dietary diversification (Nitya and Swaminathan, 2017), income enhancement, greater nutrition awareness and changed behavior patterns (Das et al., 2014). The baseline survey findings of the FSN study have been discussed by Vijaya et al. (2017), Nithya et al. (2018) and Nithya et al. (2021) provide a basis for structuring integrated agriculture-nutrition programmes or a FSN approach to diversifying household food and diets, for improving nutrition and health in India. Overall, however, one finds a sense of urgency and initiative to understand and demonstrate efficacy of pro-nutrition agriculture interventions (Miller and Welch, 2013). Recognizing the significance of the FSN model, demonstrations were conducted to validate the possibility of an agriculture-based remedy to malnutrition by including locally available millets at Krishi Vigyan Kendra, Reddipalli, Anantapuramu district, Andhra Pradesh.

2. MATERIAL AND METHODS

The field demonstrations were conducted at KVK, Reddipalli instructional farm of Anantapuramu district, Andhra Pradesh during the period from July, 2019 to October, 2021. FSN model was designed for a one-acre area based on the major crop grown in the area and to include all the food group crops (cereals, pulses, fruits and vegetables) that are suitable in the districtto provide a balanced diet, which is a vital element for a healthy life, by providing right amounts of carbohydrates, healthy proteins, vitamins and minerals. In the Anantapuramu district, as groundnut is the major crop, groundnut-based farming systems are designed by including all the prominent crops to cover all the food groups (Table 1).

Table 1: FSN model demonstrated at KVK Instructional Farm

Crop	Area
Groundnut+Redgram along with mixed pulses	1500 m^2
Pearl millet+redgram (1:5) & foxtail millet+redgram (1:5)	1200m^2
Vegetable block	700m^2
Millet block	300 m^2
Orchard block	300 m^2
Total area	4000 m^2
Sheep	5 no.
Poultry	15 no.

Further detailed description of each component was explained in Table 2

Table 2: The details of the crops with varieties and special characteristics

Crop	Area	Crop/Variety	Special Characteristics
Groundnut+Redgram	1500 m^2	Groundnut –	High-yielding, pest and disease

along with mixed pulses		Harithandra	resistance
		Redgram-LRG-52	Medium duration, high yielding, early maturity
		Horsegram-PHG-2	High yielding
		Greengram WGG-42	Short duration, high yielding, YMV tolerant
		Cowpea-TPTC-29	High yielding
Bajra+redgram (5:1) & foxtail millet+ redgram(5:1)	$400m^2$	Bajra-ABV-04	Bio-fortified with iron (70 ppm) and zinc 63ppm,82-90 days crop, fodder yield 5500-6000 kg/ha
	$400m^2$	Korra-SiA 3156	High iron content, It is nonlodging early duration, Maturity:70-75 days Average yield
Millet & fodder block 400 m^2			
Little millet	100 m^2	Local Variety	Fiber-rich, a good source of copper, iron, B-vitamins
Brown top millet	100 m^2	Local Variety	High fiber, gluten-free, rich in essential nutrients
Barnyard millet	100 m^2	Local Variety	Good source of digestible protein, dietary fiber, iron-rich
Fodder block	100 m^2	Super Napier	Multi-high protein fodder variety
Vegetable block	$700m^2$	Field bean, cowpea, cluster bean, chili, tomato, long yard	Quality protein, rich in, fiber, vitamins and minerals

		beans, brinjal	
Poultry	5	Kadaknath birds	Low cholesterol
	5	Rajashri birds	High egg-laying breed 160-170 eggs/yr
	5	Local birds	Local adaptability with disease resistance.
Sheep	4+1	Nellore brown	Fast-growing& locally adaptable
Nutri-Garden	$80m^2$	Green leafy vegetables & vegetables	vitamins and minerals, vit-A, iron, dietary fiber

2.1 Groundnut+redgram along with mixed pulses

In the Anantapuram district, prevalent intercropping pattern of groundnut and redgram is 7:1. The existing intercropping system with the innovative practice of mixing redgram alongside of other pulses like cowpea, greengram and horsegram as intercrop was demonstrated to provide dietary diversity in pulses, which are rich in protein, fiber and other important nutrients.

2.2. Pearl millet+redgram (1:5) & foxtail millet+redgram (1:5)

Millets were selected for intercropping with redgram to promote diversified dietary habits for improving nutritional status. Foxtail millet and pearl millet are the most suitable millet crops for the farming situations inAnantapuramdistrict. Keeping this in view the biofortified Bajra variety ABV-04 was selected whichcontains higher amount in iron (70ppm and zinc (63ppm). In this direction, the experiment was designed and demonstrated in the KVK instructional farm.

2.3. Millet & fodder block

Apart from foxtail millet and pearl millet, other millets like brown top millet, little millet and barnyard millet were demonstrated in a 100 m2 area to create awareness among the farmers on different millet crop varieties and their nutritional importance, browntop millet, little millet and barnyard millet are rich in fiber, a good source of copper, iron, B-vitamins, rich in essential nutrients, good source digestible protein. The perennial fodder crop, Thailand super Napier was also maintained in 100m2 as part of demonstration and as a feed for the sheep.

2.4. Vegetable block

Vegetables which are the main sources of micronutrients and fiber were planned in the model and demonstrated. Vegetables that were commonly consumed like Field bean, cowpea, cluster bean, chili, tomato, long yard beans, and brinjal were selected, the varieties that are high yielding and have additional nutritional benefits.

2.5. Poultry & sheep

Poultry units with different breeds i.e., Rajasri birds, Kadaknath birds and local birds were maintained (each breed 5). Rajasri birds are egg layers that have the capacity of laying 120–140 birds this can provide quality protein to the family, kadaknath birds that have medicinal properties and low cholesterol were selected along with the local birds to fulfill the objective to provide quality protein and improve the nutritional security among the households.

In sheep, Nellore brown breed 4+1 was demonstrated which has fast growth and is an additional income source to the farmers in dryland areas like Anantapuramu district, Agriculture-sheep rearing is the best suitable farming system model in the district. Sheep rearing not only provides quality protein it gives additional income to the farmers and the feed can be maintained by the haulms of various crops from FSN model.

2.6. Nutri-garden

Apart from the demonstration in one acre, model Nutri-Garden was maintained in 80 m2 and showcased all the 6–7 types of leafy vegetables, biofortified varieties like Arka Arunima were bought from IIHR, Bengaluru having high calcium and iron content. 5 to 6 varieties of vegetables and cucurbits like ridge gourd, bitter gourd and bottle gourd were raised and planned in such a way that it provides yearlong availability of vegetables, cucurbits and leafy vegetables, which can provide vitamins, minerals, dietary fiber and plant-based proteins to the families meeting the RDA, the vitamin c enhancers like lime was planned on the borders along with curry leaf, papaya, moringa which are having both medicinal and nutritional properties.

A total of three demonstrations were conducted for 3 years i.e., from July, 2019 to October, 2021 at KVK instructional farm, with the above components and the data was collected, compiled and subjected to statistical analysis to draw valid conclusions.

3. RESULTS AND DISCUSSION

The demonstrations were conducted for 3 years in KVK instructional farm, and the component-wise cost and output details were collected and analyzed using statistical tools. The detailed results and discussions are given below in Table 3. Nutri-cereals, which were planned in 500m2 with an investment of Rs.1082/- as cost of cultivation (COC) yielded 192 kg of different types of millets with gross returns of Rs. 4369/-. Regarding legumes and pulses in 1000m2, with cost of cultivation of Rs. 1705/- recorded 173 kg yield with mean gross returns of Rs.13319/- in the specified area. Groundnut is the major crop in Anantapuramu district, hence in the layout, major portion of 1500 m2 area was allotted to the groundnut crop with COC of Rs.4575/- yielded 183 kg with gross returns of 11730/-. Locally grown vegetables like field beans, cowpea, cluster beans, chili, tomato, and brinjal were promoted in 700 m2 area to meet the requirement for vegetables and to gain additional income for the family. Vegetable yields were 2541 kg with COC of Rs. 2510 and gross returns of Rs.6998/-. Apart from growing various crops in one acre as per the layout, A well-structured nutria-garden was designed and implemented to meet the vegetable and green leafy vegetable requirement of the family in 300 m2 area where 398 kg yield was received with COC of Rs. 870/- and gross returns of Rs.1505/-.

As per the National Institute of Nutrition (NIN), Hyderabad standards, a family requirement of food for one year was mentioned *vis-à-vis* Recommended Dietary Allowance (RDA) along with the percent fulfillment from the FSN demonstration plot from the Kharif season given in the Table 4.
A balanced 2000 calorie diet for Indians as per the Indian Council of Medical Research (ICMR), 2024 guidelines include 250 grams of cereals/Nutri cereals, 85 grams of pulses and legumes, 400 grams of vegetables, 100 grams of fruits, 35 grams of nuts and seeds, and 27 grams of fats and oils (ICMR, 2024). This balanced 2000 calorie diet is represented in the model form of food pyramid in Figure 1. Dietary guidelines for Indians indicate that, to meet the requirements of a family for one year with six members should meet a minimum of 2000 k. cal per day per individual. Concerning the food group of cereals from Table 4, it is evident that 192 kg of yield was achieved where 35% of the family requirement can be met by adopting this model. Redgram Dal is the major pulse consumed by the people in Anantapuram district which comprises lesser protein content than the other three pulse crops that were chosen for demonstration. A mixed pulses system also provides dietary diversity in pulses, rich in protein, fiber and other important nutrients. Apart from nutritional benefits cowpea as intercrop alone reduces the runoff to a greater extent as the crop acts as a vegetative barrier (Khokhar et al., 2021). This practice does not involve any additional expenditure and in addition, this system increases the total net returns of the farmer, reduces runoff, soil erosion, and dietary diversity in pulses with nutritional benefits. In the case of vegetables from the vegetable block and Nutri-Garden, a total yield of 2939 kg was achieved by growing vegetables, roots, tubers and green leafy vegetables, a family requires 876 kg per year, after meeting the requirement surplus vegetables can be sold for additional income. Consuming vegetables and green leafy vegetables can reduce vitamin and mineral deficiency (Hemalatha 2024, Chowdhury and Ray, 2024).

Table 3: Component-wise cost and output details

Food groups	Crops	Area (4000 m^2)	Yield (kg) 2019	2020	2021	Mean	COC (ha) (Rs/ha)	Cost of cultivation (Rs/m^2 area) 2019	2020	2021	Mean	Gross Returns (Rs/m^2 area) 2019	2020	2021	Mean
Nutri-Cereals	Bajra	100	78	45	80	68	12500	185	200	240	192.5	2340	1350	2400	1845
	Setaria	100	58	75	125	86	12000	200	210	280	205	1450	1875	3125	1663
	Little millet	100	10.5	6	12	10	11500	200	230	300	215	263	150	300	238
	Brown top millet	100	21.2	12.5	16.8	19	11500	200	250	300	225	530	313	420	422
	Barnyard millet	100	8.5	5.6	10	9	12000	220	270	320	245	213	140	250	201
Total		**-**	**176.2**	**144.1**	**243.8**	**192**	**59500**	**1005**	**1160**	**1440**	**1082.5**	**4796**	**3828**	**6495**	**4369**
Pulses, legumes &	Redgram	600	204	46	90	147	18000	1080	1120	1150	1100	18360	4140	8100	11250
	Greengram	200	12.5	09	15	14	16500	330	350	410	340	1250	900	1500	1217
	Horsegram	200	11.5	10	15	12	12500	250	280	320	265	805	700	1050	852
Total		**-**	**228**	**65**	**120**	**173**	**47000**	**1660**	**1750**	**1880**	**1705**	**20415**	**5740**	**10650**	**13319**
Nuts & oilseeds	Groundnut	1500	215	182	150	183	30000	4500	4650	4720	4575	11750	11710	8100	11730
Total		**-**	**215**	**182**	**150**	**183**	**30000**	**4500**	**4650**	**4720**	**4575**	**11750**	**11710**	**8100**	**11730**
Vegetables	Vegetable block	700	2600	2750	2275	2438	35000	2450	2570	2650	2510	6870	7250	7125	6998
Nutri-Garden	Nutri-garden	300	420	445	375	398	28000	840	900	970	870	1450	1650	1560	1505

Total	**-**	**3020**	**3195**	**2650**	**2836**	**63000**	**3290**	**3470**	**3620**	**3380**	**8320**	**8900**	**8685**	**8503**

Table 4: Approximate yearly requirement of various food groups for one family with six members & fulfillment from FSN plot

Food Group	Daily Requirement for a 2000 K cal diet (g)	Total requirement $Year^{-1}$ $family^{-1}$ (kg)	Yield from FSN plot (kg)	% Fulfilment of RDA from FSN plot
Cereals & Millets	250	548	192	35
Legumes & Pulses	85	186	173	93
Vegetables (including green leafy vegetables & tubers)	400	876	2939	335
Nuts & seeds	35	77	183	238

Figure 1: Food pyramid for a balanced diet for 2000 k cal

4. CONCLUSION

Farming System for Nutrition is a location-specific, inclusive approach based on resource endowments and a specific environment, to address the nutritional needs of households. The results revealed that, farming systems for the nutrition model provides a total of 35 percent of the cereal requirement which is rich in carbohydrates and can meet the calorie needs of the family, 93 percent of legumes which is rich in protein content and 335 percent of vegetable requirement which meets micronutrient needs and 238 percent of nuts and oilseed requirement, meeting protein and antioxidant requirement of a family. These results provide evidence regarding feasibility of location specific FSN models to promote sustainable and healthy diets, using locally available plant and animal food resources, to address nutrition deficiencies in farm families.

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1.

2.

3.

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