Crop based Demonstrations and Trials under Farming System for Nutrition Study in Koraput (2013-16)

A Report

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About the Report

This Report is a documentation of the crop interventions undertaken as part of the Farming System for Nutrition (FSN) Study under LANSA in Koraput during the period 2013-16.

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1. Introduction

Koraput district is the southernmost district of Odisha and is famous for its rich biodiversity. Tribal communities account for 51 per cent of the district's population and agriculture is the primary occupation of people in the district. More than 70 per cent of the farmers are small and marginal landholders with an average landholding of 1.63 hectare and operational holding of 0.6 hectare (GoO, 2011). The district has high level of poverty at 83 per cent as compared to the state average of 47 per cent. It is also a district with high burden of malnutrition with 49 per cent children under five years of age underweight and 57 per cent stunted (GoO, 2015).

The total cropped area in Koraput is about 3.56 lakh ha out of which 1.53 lakh ha (43% of total cropped area) is irrigated and 2.03 lakh ha (57% of total cropped area) is under rainfed cultivation (Source: Govt of Odisha, Ministry of Water Resources, *www.dowrorissa.gov.in*). Further, more than 60 per cent cultivable land in the district is upland and both small and marginal farmers have a higher percentage of landholdings in uplands vis-à-vis low and medium lands. Agriculture is largely rainfed and kharif is the main cropping season. Paddy is the predominant crop in the region followed by finger millet, which is mostly raised on marginal lands in the upland and hilly regions with few external inputs, either as a pure crop or with a range of pulses, legumes and oilseeds under mixed cropping system. However, the area under finger millet cultivation in the hilly terrain of Koraput district has declined by 55 per cent over 33 years, from 144,480 hectares in 1980 to 65,160 hectares in 2013 (GoO, 2015). This trend is in line with the negative growth seen at all India level (Swaminathan and Bhavani, 2013). Area under finger millet now accounts for 16 per cent of the total gross cropped area and 28 per cent of the total area under cereal crop cultivation in the district (GoO, 2015). The state government has released several millet crop varieties adapted to uplands for improving productivity; but tribal farmers in Koraput largely continue to cultivate local cultivars *viz*., *Telugu mandia, Dasara mandia, San mandia* and *Bada mandia* and follow traditional practices to raise the crops. Due to traditional cultivation practices, the yield is as low as 4 q ha^{-1} under broadcasting method; and even with traditional transplanting methods yield is only 9 q ha^{-1} (Prabhakar, 2014).

Furthermore, irregular and erratic monsoon cycles along with resource degradation have affected productivity of the land and the traditional crop cycles. As rainfall is the main source of water for agriculture in the region, either heavy rainfall or scanty rainfall during this period results in flood or drought and severely affects the livelihood of the people (Govt of Odisha, Annual Report on natural calamities 2012-13). In addition, increasing replacement of climate resilient crops i.e. finger millet, little millet by a cash crop i.e. Eucalyptus, use of decade old seed varieties, improper nutrient management, imbalanced use of fertilizer (application of only urea which is limited to rice fields), absence of crop rotation and crop intensification are some of the emerging agricultural issues found in the region.

The district is one of the locations of the Farming System for Nutrition (FSN) study led by the M.S. Swaminathan Research Foundation (MSSRF) under the research programme on Leveraging Agriculture for Nutrition in South Asia (LANSA). The FSN study potentially seeks evidence on "How agricultural interventions can be pro-nutrition?" The approach involves designing a combination of sustainable agricultural remedies ranging from advanced crop production practices, bio-fortification, promotion of backyard and community nutrition gardens of fruits and vegetables, livestock and poultry development, setting up of small-scale fisheries and regularizing veterinary services as stimulant for rendering consistent output of higher income and better nutrition (Das *et al*. 2014; Nagarajan *et al*. 2014). The main purpose of FSN is to understand the farming systems and improve the same especially the crop components with nutrition point of view.

This report documents the different crop demonstrations and trials undertaken as part of the study in a set of villages in Koraput district, during the period June 2013 to March 2016.

2. FSN study approach

A core set of seven villages (658 households with population of 2845) in Boipariguda block of Koraput district is one of the two locations of the FSN study. The criteria for selecting the villages were based on the, dominance of tribal communities, proximity to watershed area and previous experience of MSSRF with the local community.

Detailed baseline survey and focus group discussions were undertaken from June 2013 to September 2014 to capture information on demographic and socio-economic characteristics, and status of nutritional characteristics of the population in terms of anthropometric indicators, prevalence of clinical signs of nutritional deficiencies and food & nutrient intakes (Annexure 1). Concurrently, a number of crop-based FSN interventions fitting in with local resource factors were undertaken in discussion and with the participation of the farming

community and research institutes, as part of rapport building and understanding prevalent practices versus recommended practices.

Once the baseline survey was completed and data analysed to get a clear understanding of the agriculture nutrition disconnect linkages of the community, the crop based FSN interventions were further intensified in 2015-16 in joint consultation with farm-households and stakeholders.

3. Baseline survey findings

The majority of the population belongs to either Scheduled Tribe (ST) category or Other Backward Castes (OBC) with all of them belonging to Hindu with no other religion being reported in any of the villages. They have road connectivity and electricity. Wells, bore wells and tube wells are the main sources of drinking water. Open defecation is however the predominant practice. There are more females to males in each category of age classification except ≥ 45 years category (Table 1) and majority of the households are having 1-4 members closely followed by households of 5-7 members (Table 2). Other key findings from the baseline survey are discussed below.

Table 1: Distribution of population by age in the study area

Age Classification in years	Number of Male	Number of Female	*Sex Ratio
0 to 5 years	147 (5.2)	186 (6.5)	1265
6 to 11 years	196 (6.9)	219 (7.7)	1117
12 to 17 years	181 (6.4)	198 (7.0)	1094
18 to 44 years	494 (17.4)	579 (20.4)	1172
≥ 45 years	324 (11.1)	321 (11.3)	991
Total	1342 (47.2)	1503 (52.8)	1120

(% figures in parentheses) Source: Baseline Survey 2014

*Sex ratio is calculated by dividing no. of females to no. of males multiplied by 1000 and the value indicates the no. of females to 1000 of males.

Table 2: Distribution of households by family size

Family Size	Households
1 to 4 Members	352 (53.5)
5 to 7 Members	273 (42.5)
>= 8 Members	33 (5.0)
Total	658 (100)

(% figures in parentheses) Source: Baseline Survey 2014

3.1. Occupation of the head of the household and sources of family income

The population of the study villages is predominantly dependent on agriculture. The occupational structure indicates cultivation and agricultural labour are the occupation of majority of households both as primary and secondary occupation in the villages. About 73% of the village households reported either cultivation or agricultural labour as the primary occupation whereas around 68% of the households reported the same as their secondary occupation. Non agricultural wage labour appears to be the next important occupation engaging about 20% of the population both at primary and secondary levels (Table 3).

Table 3: Distribution of households by primary and secondary occupation of head of the household

Occupation	Primary	Secondary
Cultivation	417(63.4)	73(11.1)
Agricultural wage labour	68(10.3)	374(56.8)
Non agricultural wage labour	105(16.0)	96(14.6)
Artisan/independent work	8(1.2)	2(0.3)
Others	60(9.1)	40(6.1)
No Secondary occupation	-	73(11.1)

Total no. of households (N) =658 Source: Baseline Survey 2014
(% figures in parentheses)

3.2. Land and livestock Resources

A majority of the households (530 out of 658) are marginal farmers with less than an acre of land. 109 households (16.6%) are landless (Table 4). The average size of land holding is 0.79 hectares. 360 households reported having home garden. The possession of livestock according to the land classes shows that the largest number of milch cattle and draught animals are with medium sized land holding size of 1 to 2.5 acres. This group also owns most of the small ruminates and poultry in the FSN villages, though the landless are the next important owners of small ruminates and poultry in the FSN villages. Of the households, about 46% possess milch animals such as cows and buffaloes, 39% own small ruminants i.e. goats and sheep and about 40% had poultry.

Table 4: Distribution of households according to the size of the Land holding

Land class	No. of HH and (%)
Land less	109 (16.6)
Marginal (< 1 ha)	530 (80.6)
Small (1 - < 2 ha)	14 (2.1)
Semi-medium (2 - < 4 ha)	5 (0.8)
Total	**658**

(% figures in parentheses). Source: Baseline Survey 2014

3.3. Cropping system

Of the 549 landholding households, the majority (about 98.2%) of households cultivate Kharif season crops. Among Kharif growers, as high as 89% of farmhouseholds cultivate rice. Rice systems occupying bulk portion of land acreage; some households additionally cultivate some portion of upland area with finger millet (7%). 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 per cent 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%). The prevalent cropping system according to the land type in the study region is indicated in Table 5. Percentage of irrigated area as a percentage of gross cropped area is only 17.5% and most of this irrigation is diverted towards cultivation of vegetables followed by ground nut in the rabi season.

Table 5. Prevalent cropping system or crops grown in the study region

Major Cropping Season	Land type				
	Lowland	Medium land	Upland		Jhola land (Land between two mountains)
			Bunded	Unbunded	
Kharif (June-October)	Rice	Medium duration rice	Short duration rice	Finger millet/ Little millet/ Maize/ Niger/ Horse gram	Long duration paddy
*Rabi (November-January)	ǂ Vegetables,	ǂ Vegetables	Fallow	Fallow	Fallow
Pre-summer (February –Mid April/May)	Green gram/ Black gram in un irrigated condition	Ground nut/ Vegetables in irrigated condition	Fallow	Fallow	Fallow

Source: Baseline Survey 2014

*In Koraput, due to very low temperature no field crops are grown during Rabi i.e. November –January and growing of pulses is referred more to as pre-summer crops. However, in the report, we have combined rabi and pre-summer ones and described as rabi interventions.

ǂVegetables are grown commercially wherever water source is available and by a particular community called "Mali community" of village 'Maliguda'.

3.4. Anthropometric and biochemical measurement findings

The prevalence rates of chronic energy deficiency, underweight, stunting and wasting were calculated based on the cut off limits given by World Health Organization standards (http://www.who.int/nutgrowthdb/about/introduction/en/index5.html). In the study locations, forty seven per cent of children under age five reported underweight (low weight for age), thirty seven per cent stunted (low height for age) and about twenty seven percent wasted (low weight for height). Further, about 45 % of school-age children (5-9 years) and about 35% and 20% of adolescents (10-14 and 15-17 years) were undernourished. Also the percentage of women (47%) with CED (BMI<18.5) was found higher than the men (43%) (Fig.1).

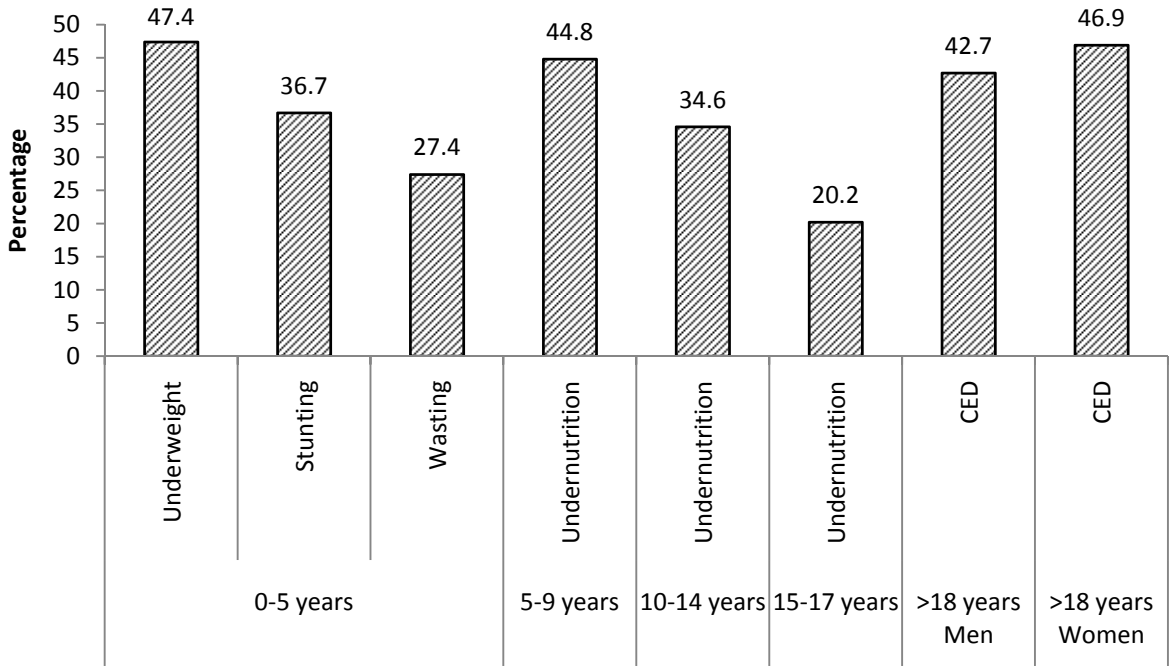

Fig. 1. Status of Undernutrition in the study area (Source: Baseline Survey 2014)

(Total no. (N) under different age groups are: (1-5 yrs: 272); (5-9 yrs: 335); (10-14 yrs: 295);(15-17 yrs: 158); (>18 yrs Men:734) & (>18 yrs Women: 809).

The biochemical analysis indicated that about 69% of children under age five and around 60 % of girls in the age groups of 12-14 and 15-17 years were reported to be anaemic. The percentage of non-pregnant non-lactating women having anaemia was 62%. Further, about 55 per cent of pregnant women and 75 per cent of lactating women were reported to be suffering from anaemia. It was also found that about 37% of children under age five were having vitamin A deficiency (VAD) (Fig 2).

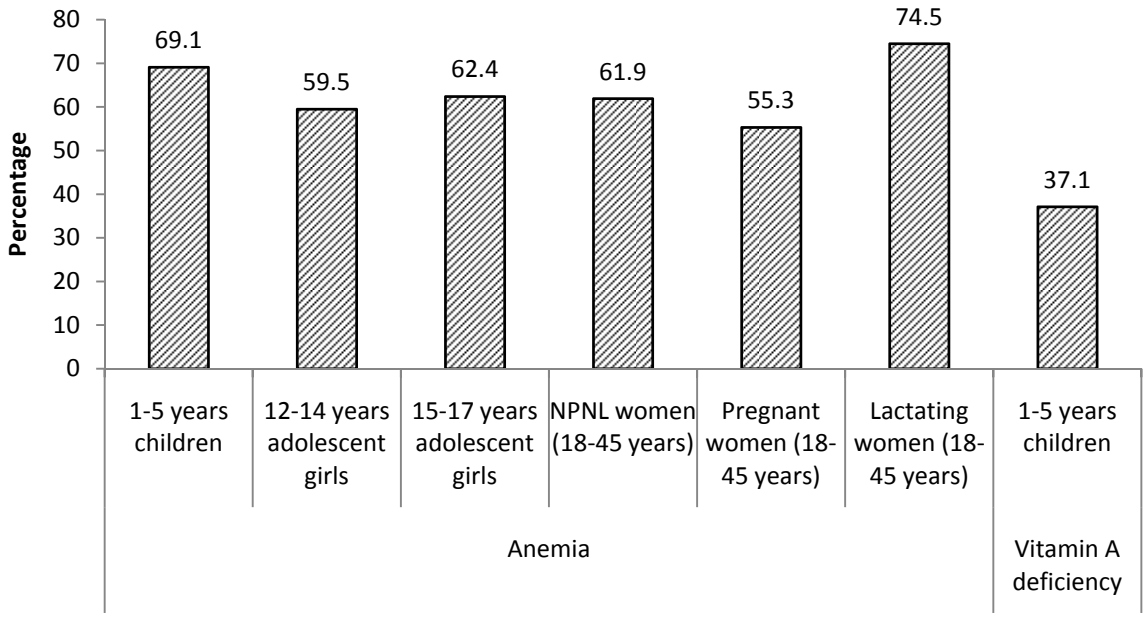

Fig. 2. Status of micronutrient deficiency (Anaemia and Vit A. deficiency) in the study area

(Source: Baseline Survey 2014); (Total no. (N) under different age groups are: (1-5 yrs: 272); (12-14 yrs adolescent girls: 121); (15-17 yrs adolescent girls: 77);(NPNL: 483); (Pregnant women:38) & (Lactating Women: 47).

3.5. Food consumption pattern and dietary diversity

The diet was found to be largely cereal dominated with consumption of all other food groups being less than the recommended levels (Table 6). Only about 2.7 per cent of the households were found to be consuming cereals & millets in quantities <70 per cent of the Recommended Daily Intake (RDI). The average consumption of pulses at 39.4 g per capita per day was less than the recommended RDI of 75 g/day; the percentage of households consuming pulse < 70% of RDI was reported to be 68.6 per cent. The average daily consumption of green leafy vegetables and fruits was well below the suggested level of 100g/day. Around ninety per cent households consume green leafy vegetables <70 % of RDI (Table 6). The average consumption of root and tubers and other vegetables was well below the recommended level of 200g. More than 78% households consume root and tubers and other vegetables <70 % of RDI. The average consumption of fish or other sea foods as well as meat and poultry was around 7.0g. The average intake of milk and milk products was well below the RDI levels, with almost all the households consuming <50 % of RDI.

Table 6. Average intake of food groups (g/CU/day) and their frequencies (%) as per levels of their consumption (% RDI)

FOOD GROUPS	FSN villages (N: 150)		RDI*	Frequency distribution (%) as per levels of consumption (% RDI)		
	Mean	±SD		<50	50-70	>70
Cereals & Millets	563.9	190.5	375	2.0	0.7	97.3
Cereals	518.1	172.3				
Millets	46.4	38.1				
Pulses & Legumes	39.4	27.3	75	53.3	15.3	31.4
Green Leafy Vegetables	15.8	43.8	100	89.3	2.0	8.7
Roots & Tubers	103.1	68.4	200	55.3	22.7	22.0
Other Vegetables	67.6	81.3	200	74.7	10.7	14.6
Fruits	2.3	28.0	100	99.3	0.0	0.7
Fish & other Sea Foods	7.6	31.2	-			
Meat &Poultry	7.1	21.4	-			
Milk & Milk Products	4.1	19.3	300	99.3	0.7	0.0
Fats & Edible Oils	12.7	9.7	25	60.0	24.0	16.0
Sugar & Jaggery	12.5	10.0	20	41.3	16.7	42.0

Source: Baseline Survey 2014; * Recommended Dietary Intakes as per Dietary Guidelines for Indians, ICMR, 2011 (As there is no RDI for meat and fish, the frequency of consumption was not calculated)

3.6. Sources of food

With respect to food source, about 36% of households consume home-grown rice, 45% sourced from the PDS and the remaining (19%) from market (Table 7). Millets were consumed daily and the source for millet was reported as mainly market (71%) and the remaining home-grown (27%) which clearly indicates an existing demand-supply gap that needs to be addressed. The market also served as major source of non cereal foods such as pulses, fruits and vegetables for majority of the households in the area.

Table 7. Percent households according to major source of the commodity commonly consumed under different food groups

Food Groups	Percent households according to major source of commodity, averaged over three seasons (n=658)			
	Home Grown	Purchased from PDS	Purchased from Open Market	Other Sources
Cereals & Millets	32.9	28.2	37.9	1.0
Cereals (Rice)	35.7	44.5	19.2	0.6
Millets (Finger millet)	27.0	0.0	71.4	1.5
Pulses & Legumes	4.1	0.0	94.5	1.4
Green Leafy Vegetables	16.2	0.0	74.1	9.7
Roots & Tubers	6.5	0.0	88.7	4.9
Other Vegetables	17.5	0.0	76.6	5.9
Nuts & Oil Seeds	7.0	0.0	86.7	6.4
Condiments & spices	7.1	0.0	80.1	12.9
Milk & Milk Products	13.3	0.0	79.8	6.8
Fruits	9.7	0.0	77.4	12.9
Fish & Other Sea Foods	0.5	0.0	66.3	35.8
Meat & Flesh Foods	0.8	0.0	93.9	5.4
Fats & Oils	0.2	0.0	99.8	0.0
Sugar & Jaggery	0.0	0.0	99.7	0.3

Source: Baseline Survey 2014

4. Existing disconnect between Agriculture and Nutrition

Based on the baseline surveys conducted, following few agriculture nutrition disconnect linkages were found out (Table 8) and accordingly appropriate technologies/approaches in order to address these issues were laid out in discussion with technical experts and villagers.

Table 8. Existing Agriculture Nutrition disconnect linkages in study villages of Koraput

Agriculture	Nutrition	Approach
• Less productivity of Finger millet	• Gap between demand and supply	• Improve productivity and area under finger millet
• No major kharif pulse crop • Less productivity of rabi pulses	• Pulse consumption way below the RDI	• Option for introducing a kharif pulse crop • Improve the productivity and area under rabi pulse
• Less area under tuber cultivation	• Less consumption • Vitamin A deficiency in (1-5) yr children	• Nutrition awareness • Option for introducing bio-fortified tuber crops (Orange flesh sweet potato; rich in Pro-vitamin A)
• Cultivation of vegetables limiting to some groups	• Consumption below RDI • Prevalence of anaemia	• Nutrition awareness • Introduction of nutrition garden (cultivation of different groups of vegetables)
• Livestock used for either cultivation or source of money or for rituals	• Consumption of animal protein below RDI	• Scope for introducing fishery as an alternative for animal protein source; where water bodies is available (either individual or community level)

5. Crop-based FSN interventions

Based on the above agriculture and nutrition disconnect linkages, different crop-based FSN interventions based on following technologies were taken into consideration (Details in Annexure I).

- Increase cropping intensity;
- Introduce nutrient dense crops for crop diversity;
- Improved agriculture practices; and
- Increase land use efficiency

Following strategies were adopted to implement the FSN interventions.

On-farm Demonstrations (OFD): The technologies and practices identified for the FSN interventions were developed and tested by OUAT as part of the state agriculture development programme. Hence it was decided to demonstrate and fine-tune the different

interventions to the local context. In this back drop, OFD was chosen as a potential strategy to implement the FSN interventions. As the baseline survey was underway, 2013-14 and 2014-15 OFDs were mainly to build rapport with the farmer households whereas OFDs during 2015-16 were designed based on:

- ✓ *Baseline survey result*
- ✓ *Existing farming system of the study area*
- ✓ *Nutrition status of the population*
- ✓ *Input from researchers*
- ✓ *Discussion with the villagers to finalize the intervention*

In OFD, each farmer was considered as a replicate. For example, OFD allotted land area was split into known portions to fit farmers's method against recommended agronomic practice. This approach was highly relevant as in Koraput the size of the landholding is small. Increasing the treatment or replications within a given land is less feasible. Moreover, the importance of OFD is to mostly follow a comparative approach where farmers can witness the superiority of the crop field and yield performance under proposed production practices under their direct involvement and in their own farm environment. Nevertheless, the involvement of researchers helped to collect some agronomic data (e.g. plant population, plant height, 1000 grain weights) for comparative assessment. Quadrat method was mostly followed with variable replications based on attempted assessment. As the OFDs were mainly considered as entry point activities initially, improved cropping method and/ or varietal trials were feasible only with few participating farmers which further limited the scope of proper statistical analysis. However, average plot yield recorded from the OFDs provided farmers the most crucial criteria to judge and take up the suggested interventions with a nutrition-sensitive focus in future. Additionally, it also suggested that the increased yield if any, will serve as increased availability of nutrient rich food per household. The nutrition composition of different crops being promoted under FSN is given in Annexure II. The economics of production under OFDs included total cost of cultivation, gross return, and net return. The cost of cultivation (A1) included expenses (both for inputs and labor) incurred during land preparation/ sowing/ nutrient application/ weeding/ harvest while gross return was calculated by multiplying the total return with their market price. Net return was calculated by subtracting total cost of cultivation from gross return.

In this study, OFD followed both single component (e.g. demonstrating high yields from improved varieties) and package (e.g. demonstrating combined effects of irrigation and

fertilizers on improved varieties) technologies (Farrington & Martin 1988; Amanor 1990). Single component technologies are simple and need little flexibility in existing operational plans whilst, package technologies aimed at demonstrating the superiority of package of practice with not extremely complex interacting components (Farrington & Martin 1988; Amanor 1990).

5.1. Rainfall and climate

The study site is characterized by hot summer, cold winters and rainy seasons. The summer season commences from March and continues till middle of June. The mean daily maximum temperature is around 40^{o}C while the mean daily minimum temperature is around 14^{o}C. It is observed that about 80% of the total annual rainfall takes place due to south-west monsoon between the middle of June and mid-October. The average rainfall varies between 1320-1520 mm. The month-wise rainfall pattern in the area during the study period of 2013-15 is shown in Fig. 3.

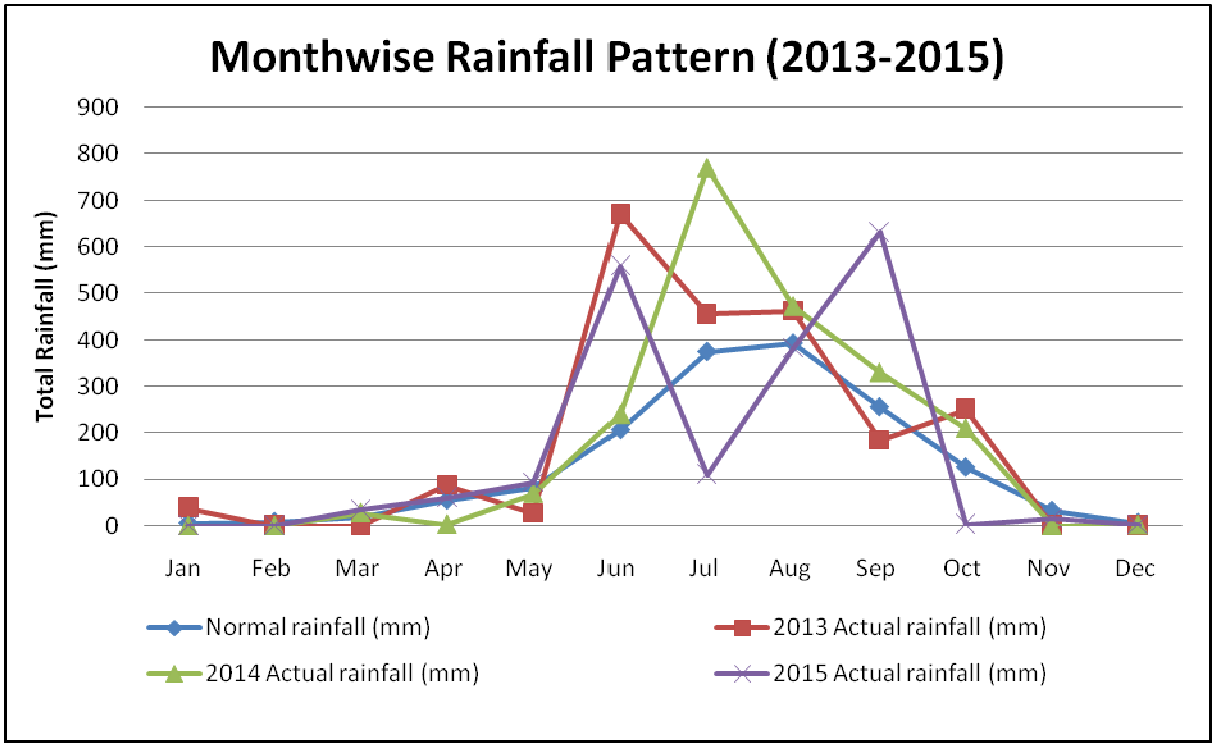

Fig. 3. Month-wise rainfall pattern in the study sites (2013-15)

5.2. Soil characteristics

Major soil type found in the area is matured red lateritic soil (Alfisols), mixed grey soil (Inceptisols) and unaltered soils with coarse parent materials (Entisols). Alfisols include red loamy and red sandy soils and are generally light textured with a pH ranging from 6.5 to 7.3.

These soils have average to good fertility status whereas Ultisols are slightly acidic soils with a pH ranging from 4.5 to 6.0. The prevailing soil texture in the area is mostly sandy loam.

5.3. Year-wise on farm demonstrations (OFD) under FSN

5.3.1. 2013 OFD

As the baseline surveys were underway, the objective of OFDs during 2013 was mainly to build rapport with the farmer households and start orienting them on the need for a nutrition focus in agriculture. The OFDs were undertaken keeping in view the existing cropping pattern and farming practices, to examine results with different varieties of the same crop and better cultivation practices.

5.3.1.1. Kharif-2013 OFD

The OFDs in kharif-2013 were:

i) Improving fertilizer-use efficiency in paddy cultivation with Urea Super Granules
ii) Mixed Cropping and
iii) Sweet potato cultivation

Study 1: Improving fertilizer-use efficiency through Urea Super Granules (USG) in rice

Objective: To demonstrate improved fertilizer-use efficiency through fertilizer deep placement with Urea Super Granules (USG) vis-à-vis prilled urea.

**The USG were made available by the International Fertiliser Development Corporation under an MoU with them. The USG helps in greater fertilizer use efficiency via reducing the rate of mineralization due to its bigger size which in turn helps in less loss of nitrogen.*

Materials and methods: On farm study was undertaken in 3 selected farmers' fields, covering a total land area of 3 acres covering one acre each of upland, medium land and low land types. Orissa University of Agriculture and Technology (OUAT) released high yielding varieties *viz.*, Jyotirmayee (103 days) for upland and Hiranmayee (135 days) for both medium and low land, were selected for on farm demonstrations. The allotted area under each land type was split into two equals halves in order to allot the treatments; T_1: improved agronomic practices + USG and T_2: improved agronomic practices + prilled urea. Improved agronomic practices broadly covered seedlings treatments, line sowing / line transplanting @ 20 x 10 cm with 1-2 seedlings $hill^{-1}$ and 3-4 cm planting depth and with recommended intercultural operations. Seeds were treated with Chlopyriphus 20 EC @ 2ml lit^{-1} before sowing.

The main field was ploughed thrice and FYM was applied @ 12 t ha^{-1} during last ploughing in all land types. For upland, dry seeds were sown through two row seeder whereas in medium land, pre-germinated seeds were sown through drum seeder. In addition, line transplanting of seedlings was done in case of lowlands. The recommended fertilizer dose of 60:30:30 NPK kg/ha for Jyotirmayee and 80:40:40 NPK kg/ha for Hiranmyee was adopted. For prilled urea plots, 50 per cent of N, 100 per cent P and 50 per cent K was applied at the time of direct seeding/transplanting as basal dose. The remaining 50 per cent N and 50 per cent K was applied in two equal split doses during tillering and at booting stage. For USG plots, 100 per cent P and 50 per cent K was applied at the time of direct seeding / transplanting. The remaining 50 per cent K was applied in two equal split doses during tillering and at booting stage. USG was applied as a single dose by reducing 25 per cent of the recommended N, (22.5kg for Jyotirmayee and 30kg for Hiranmayee) at 10 days after transplanting or after 25 days of direct seeding. Furthermore, zinc sulphate was applied @ 20kg ha^{-1} during the tillering stage in order to supplement the zinc requirement by the crop. In addition, application of Chloropyriphos 20EC @ 3ml lit^{-1}, Triazophos @ 3ml lit^{-1}, Carbendazim + Mancozeb @ 1.5gm lit^{-1} and Streptocycline @ 0.6gm lit^{-1} was carried out towards controlling blast, stem borer and stem rot.

Results:

Different yield associated parameters such as plant height, tiller numbers $hill^{-1}$ and number of panicles $hill^{-1}$ were observed at different crop growth stages. It was observed that rice varieties under USG had higher yield contributing parameters and thereby recorded (14-28) % higher grain yields than that under prilled urea, irrespective of varieties. Further analysis of economics of crop production revealed that the net return also followed the same pattern as that of grain yield. Net return under USG application increased by 78% for Jyotirmayee and 49% and 53% for Hiranmayee under direct and transplantation respectively as compared to their cultivation under prilled urea. Table 9 gives the details.

Table 9. Comparison of yield parameters, yield* and economics of production under USG *vs.* prilled urea

Variety	USG / prilled urea	Plant height (cm)	No. of tillers hill^{-1}	No. of panicles hill^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})
Jyotirmayee (upland)	Prilled Urea	91.3	14	13	4.7	5.1	35590	55960	20370
	USG	99.4	20	18	6.0	6.6	34580	71020	36440
Hiranmayee (medium land)	Prilled Urea	118	8	7	5.7	6.2	43344	68200	24856
	USG	131	13	12	6.5	8.7	41802	78777	36975
Hiranmayee (low land)	Prilled Urea	107	7	6	5.7	7.4	42680	68750	26070
	USG	132	10	9	6.6	9.6	40174	80180	40006

**Mean value reported*

Study 2: Demonstrations on mixed cropping

Objective: To assess to assess performance of new varieties under the existing mixed cropping systems.

Materials and methods: On farm study was undertaken in 4 farmers' fields covering a total land area of 1.5 acres to assess performance of new varieties under the existing mixed cropping systems. The existing mixed cropping systems included different combinations of rice, finger millet (FM), black gram (BG), pigeon pea (PP) and maize. In case of finger millet, as GPU-67 and GPU-45 had been selected earlier through a participatory varietal selection (PVS) programme in Kundra block of Koraput district, under IDRC-NUS programme led by MSSRF; and was identified as suitable varieties in terms of grain yield, agronomic parameters related to local agro-environmental conditions and also culinary properties; the same was selected for this study. For maize, both composite and high quality protein maize (HQPM) varieties were adopted. Recommended dose and standard practice of fertilizer application was followed for each crop under different mixed cropping demonstrations.

Results:

Grain yields of finger millet variety GPU-67 was found to be 30% higher than GPU-45 (7.1 q ha^{-1}) (Table 10). The seed yield of black gram ranged from 5.35 to 7.25 q ha^{-1}. The mean seed yield of pigeon pea was 19.6 q ha^{-1}. The yield of HQPM was found to be twice that of composite variety. The mean grain yield of rice under mixed cropping was reported to be around 8.6 q ha^{-1}.

Table 10. Details of mixed cropping demonstrations trials in Kharif 2013

Demonstration	Crop	Variety name	Spacing (cm)	Total area (ac)	Area under each crop (ac)	Yield (q ha^{-1})
Demo.1 FM:BG:PS (4:1.6:1)	Finger millet	GPU-67	20 x 10	0.4	0.24	7.10
	Black gram	Nirmal No.7	30 x15		0.10	7.25
	Pop Sorghum	Traditional	50 x 20		0.06	
Demo.2 FM:BG:PS (4:1.6:1)	Finger millet	GPU-45	20 x 10	0.4	0.24	9.20
	Black gram	Nirmal No.7	30 x 15		0.10	6.25
	Pop Sorghum	Traditional	50 x 20		0.06	
Demo.3 Rice: Maize :PP (2:2:1)	Rice	Jyotirmayee	15 x 10	0.35	0.14	10.90
	Maize	HQPM-1	60 x 25		0.14	42.50
	Pigeon Pea	Durga-30	45 x 20		0.07	19.60
Demo.4 Rice: Maize :BG (2:2:1)	Rice	Jyotirmayee	15 x 10	0.35	0.14	6.25
	Maize	Pusa Composite-4	60 x 25		0.14	23.00
	Black gram	Nirmal No.7	30 x 15		0.07	5.35

*no yield data due to lack of proper management (as finger millet and black gram were already harvested, farmers did not give proper attention to the pop sorghum and the crop damaged due to unmanaged grazing.

Study 3: Demonstration on sweet potato cultivation

Objective: To demonstrate cultivation of orange flesh sweet potato (rich in vitamin A)

Materials and methods: Orange-fleshed sweet potato (OFSP) is a biofortified crop rich in β-carotene and could be a critical nutrition intervention to increase vitamin A intake among resource poor households. In general, tuber cultivation is an indigenous practice of tribal people but there was no prior record of growing OFSP in the area. Therefore an on farm demonstration of OFSP was undertaken in one selected farmers' fields covering a total land area of 0.1 acres in order to make them aware about the variety, its cultivation as well as the benefits of including it in their diet. Planting materials were accessed from the Regional Centre of Central Tuber Crop Research Institute (CTCRI), Bhubaneswar. Agronomic package of practices was followed as recommended by CTCRI. Study details are given in Table 11.

Results:

The demonstration was mainly intended for initial introduction along with production of planting materials for subsequent seasons (mainly for homestead gardening). Therefore, the total produce from the allotted area was recorded and accordingly, the economics was calculated to provide necessary information to farmers. One hundred and eight farmers from seven villages visited the demonstration plots, during the field day organized on 23.10.2013.

Table 11. Details of sweet potato demonstration, Kharif 2013

Varieties suggested by CTCRI	Type	Spacing	Area (acre)	Total tuber yield (kg)	Tuber yield (t ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})
ST-14	Orange flesh	60 cm X 20 cm	0.1	*210	5.3	25,375	79,500	54,125
Kamala Sundari	Orange flesh							
CIP-440127	Orange flesh							
Kishan	Normal							

Local market price of sweet potato was Rs. 15 kg^{-1} (2013-14).
*around same yield was obtained for all the varieties.

5.3.1.2. Rabi-2013 OFD

In Rabi 2013, demonstration on yield enhancement of rice with and without USG, and intercropping of different cereal pulse combinations *viz.,* finger millet + black gram; maize + cowpea were undertaken. However, the trials undertaken were affected by low temperature (7-9)^{o}C and water scarcity. A short duration rice variety (Jyotirmayee) was taken for demonstration on 1 acre of land using urea deep placement on half acre and modified practices on the other half; about 20 per cent higher yield was observed with urea deep placement. Intercropping of cow pea with winter maize in 1:2 ratio was undertaken as demonstration of a cereal-pulses combination on 0.5 acre of a farmer's field. Three quintals of maize and 0.6 quintals of cow pea were harvested from the plot. Intercropping finger millet with black gram (4:2) was undertaken on 0.3 acres of land. Due to cool climatic conditions, very poor yield was observed in black gram (15kg) and finger millet (60 kg) from the plot.

5.3.2. 2014 OFD

5.3.2.1.Kharif-2014 OFD

The OFDs in kharif 2014 were:

i) fertiliser deep placement with USG undertaken both on farmers' fields and at the MSSRF site office; and
ii) improved production practices of pulse-finger millet intercropping

Study 1: Fertilizer Deep Placement in Rice with USG on campus

Objective: To study the performance of rice under deep placement of USG

Materials and methods: Field demonstration was conducted at the MSSRF, Regional Centre, Jeypore, from 03 July 2014 to 30 November 2014 covering a total area of 0.8ha (0.4 ha of medium land and 0.4 ha of low land). OUAT released high yielding variety Mandakini (105 days) for medium land and Pratikshya (140 days) for low land were selected.

The selected medium/ low land area was divided in to four equal portions i.e. 0.1 ha to include four treatments *viz*., (i) Improved agronomic practices + application of USG, (ii) Improved agronomic practices + application of prilled urea, (iii) Farmers practices + application of USG and (iv) Farmers practices + application of prilled urea. Improved agronomic practices mainly included seedlings treatments, line transplanting @ 20 x 10 cm with 1-2 seedlings $hill^{-1}$ and deep planting at (3-4) cm, and recommended intercultural operations. In contrast, traditional farming practices included random transplanting with variable spacing, no seedling treatment and with limited intercultural operation. However, fertilizer recommendation was consistent irrespective of treatments.

Dry seedbeds were prepared 25-30 days before transplanting where seeds were sown @ 50kg ha^{-1} in close lines and covered with a thin layer of soil + cow dung mixture. Seedlings were treated with Chloropyriphous 20 EC @ 2ml lit^{-1} before transplanting. The main field was prepared 3 weeks before transplanting by three times ploughing followed by submergence with 5-10cm of standing water. FYM was applied @ 5t ha^{-1} and incorporated during last ploughing. OUAT fertilizer recommendation of 60:30:30 NPK kg ha^{-1} for Mandakini and 80:40:40 NPK kg ha^{-1} for Pratikshya was followed.

For prilled urea plots, 50 percent of N, 100 percent P and 50 percent K was applied at the time of transplanting as basal dose. The remaining 50 percent N and 50 percent K was applied in two equal split doses during tillering and at booting stage. For USG plots, 100 percent P and 50 percent K was applied at the time of transplanting. The remaining 50 percent K was applied in two equal split doses during tillering and at booting stage. USG was applied as a single dose by reducing 25 percent of the recommended N, (45 kg for Mandakini and 60 kg for Pratikshya) at 10 days after transplanting. Irrespective of the trial plots, zinc sulphate was applied @ 20kg ha^{-1} during tillering stage. Besides Chloropyriphos 20EC @ 3000ml ha^{-1} and Phorate 10G @ 10kg ha^{-1} was applied to control stem borer.

Results:

It was observed that under the given soil and weather condition, deep placement of USG produced higher number of tillers and grain yield as compared with prilled urea, irrespective

of varieties. Application of USG increased grain yield of Mandakini by 9% while Pratikshya showed 11-18% higher yield as compared to prilled urea under both improved and farmer's traditional agronomic package of practices (Table 12).

Table 12. Comparison of yield parameters and grain yield* under USG vs. prilled urea

Variety	Method	Form of Urea	Plant height (cm)	No. of tillers hill^{-1}	No. of panicles hill^{-1}	1000 grain weight (g)	Grain yield (kg ha^{-1})
Mandakini (105 days)	Line transplanting	USG	106	11	9	25.3	3436
		Prilled Urea	108	6	4	25.2	3149
	Normal transplanting	USG	123	11	10	25.1	3696
		Prilled Urea	108	8	7	24.9	3410
Pratikshya (140 days)	Line transplanting	USG	97	11	8	20.5	5058
		Prilled Urea	91	10	9	20.4	4547
	Normal transplanting	USG	95	11	10	20.9	5004
		Prilled Urea	96	9	7	20.6	4241

***Mean value reported*

The yield of rice was severely affected by extremely severe cyclonic storm called 'Hud-Hud' at flowering stage.

Study 2: Fertilizer Deep Placement in Rice with USG in farmers' fields

Objective: To study the performance of rice under deep placement of urea super granules (USG) in farmers' fields

Materials and methods: Yield enhancement of rice through deep Placement of Urea Super Granules (USG) was undertaken by 15 farmers from June to November 2014, covering a total land area of 6 ha.

Six high yielding varieties *viz*., Udaygiri (100 days), Mandakini (105 days), Jyotirmayee (110 days), Hiranmayee (135 days), Puja (140days) and Pratikshya (140 days) were selected by farmers for this study. Out of these 6 varieties, the first 3 varieties were reportedly short duration and traditionally transplanted in medium land while, the later 3 varieties were of medium duration and generally line transplanted in low land.

The selected land area was divided into two parts to accommodate two treatments which included (i) application of USG and (ii) application of prilled urea. OUAT recommended 60:30:30 NPK kg ha^{-1} for short duration varieties and 80:40:40 NPK kg ha^{-1} for medium duration varieties was followed.

For prilled urea plots, 50 percent of N, 100 percent P and 50 percent K was applied at the time of transplanting as basal dose. The remaining 50 percent N and 50 percent K was applied in two equal split doses during tillering and at booting stage. For USG plots, 100 percent P and 50 percent K was applied at the time of transplanting. The remaining 50

percent K was applied in two equal split doses during tillering and at booting stage. USG was applied as a single dose by reducing 25 percent of the recommended N, (45 kg for short duration varieties and 60 kg for medium duration varieties) 10 days after transplanting. Chloropyriphos 20Ec @ 3000ml/ha and Phorate 10G @ 10kg/ha was applied to control stem borer.

Results:

Compared to prilled urea plots, plant height, number of tillers and panicles hill^{-1} was found to be higher under USG plots. Among all the varieties, grain yield under USG was 4 to11% higher as compared to prilled urea (Table 13).

Table 13: Comparison of yield parameters and grain yield* under USG vs. prilled urea

Variety	Method	Form of Urea	Plant height (cm)	No. of tillers hill^{-1}	No. of panicles hill^{-1}	1000 grain weight (g)	Grain yield (kg/ha)
Udayagiri (100 days)	Traditional transplanting	USG	83	14	10	25.10	2625
		Prilled Urea	78	11	8	24.00	2417
Mandakini (105 days)	Traditional transplanting	USG	119	6	5	26.24	3041
		Prilled Urea	111	5	4	25.52	2935
Jyotirmayee (110 days)	Traditional transplanting	USG	79	14	11	21.20	3801
		Prilled Urea	71	9	8	21.00	3551
Hiranmayee (135 days)	Line transplanting	USG	104	8	7	19.54	5021
		Prilled Urea	94	7	6	18.72	4543
Puja (140 days)	Line transplanting	USG	111	9	8	19.60	4717
		Prilled Urea	102	7	6	18.85	4282
Pratikshaya (140 days)	Line transplanting	USG	97	9	7	24.32	3992
		Prilled Urea	85	7	6	23.34	3640

***Mean value reported*

The yield of rice was severely affected by extremely severe cyclonic storm called 'Hud-Hud' at flowering stage.

Study 3: Improved production practices of pulse-finger millet intercropping

Objective: To assess the performance of finger millet intercropped with black gram under traditional and recommended agronomic practices.

Materials and methods: The demonstration was undertaken in 10 selected farmers' fields from 02 July to 03 November 2014 covering a total area of 3 ha. The selected land area was

divided into two equal portions to accommodate two different treatments *viz*., (i) black gram (var. TK94-2) and finger millet (var. *GPU-67*) intercropped in a ratio 2:6 and (ii) mixed broadcasting of black gram (var. TK94-2) and finger millet (var. *GPU-67*).

Improved agronomic practices included seed treatment, line sowing @ 20 x 10cm for finger millet, 30x10cm for black gram and recommended intercultural operations. In contrast, traditional farming practice included broadcasting with variable spacing and without seed treatment and with limited intercultural operations. Fertilizer recommendation was consistent irrespective of agronomic practices.

Seeds of finger millet were treated with Carbendazim 50WP @ 2g kg^{-1} seed; seeds of black gram were treated with Rhizobium culture @ 100g kg^{-1} six hour before sowing. Fertilizer recommendation for finger millet was 40:20:20 NPK kg ha^{-1} and for black gram 20:40:20 NPK kg ha^{-1} but considering the intercropping practice, only 50% of fertilizer recommendation dose for both the crops was applied taken into consideration. Accordingly, blanket recommendation of 30:30:20 NPK kg ha^{-1} was followed for the trial. Full P and K and 50% N were applied 20-25 days after sowing. The remaining 50 percent of N was applied 35-40 days after sowing. Further, Triazophos 40EC @ 2ml lit^{-1} was applied to control blast and leaf eating caterpillar.

Results:

It was observed that intercropping black gram (168 kg ha^{-1}) with finger millet (1196 kg ha^{-1}) in a ratio 2:6 showed superior yield performance, as compared with mixed broadcasting of black gram (96 kg ha^{-1}) and finger millet (610 kg ha^{-1}) (Table 14).

Table 14. Comparison of grain yield under different combinations of black gram and pigeon pea

Treatment	Grain yield of black gram (Kg ha^{-1})	Grain yield of finger millet (Kg ha^{-1})
Black gram + Finger millet (2:6)	168	1196
Mixed broadcasting of black gram and finger millet	96	610

5.3.2.2.Rabi-2014 OFD

The OFDs in rabi 2014 were:

i) improved production practices of green gram; and

ii) improved production practices of black gram.

Study 1: Improved production practices of green gram

Objective: To evaluate the performance of green gram varieties *viz*., SML-668 and NVL-585 against farmers' local varieties under recommended agronomic practices.

Materials and methods: On farm demonstration was undertaken from 25 February 2015 to 25 May 2015 in 20 selected farmers' fields covering a total land area of 5 ha. The selected land area was split into three equal portions to accommodate SML-668, NVL-585 and farmers' varieties. Variety SML-668 recommended by Government of Odisha, is reportedly a high yielding and also more suitable to the local soil and weather conditions whereas variety NVL-585 is highly tolerant to powdery mildew and yellow mosaic virus, that are often problematic in green gram. Seeds were treated with Rhizobium culture @ 10g per kg seed for 6 hours before sowing @ 20kg ha^{-1}. Land preparation was started on 25 February 2015 and seeds from different varieties were broadcasted within 15 March 2015. Quinalphos (0.05%) @ 2ml lit^{-1} was applied to control hairy caterpillar, and for managing *Cercospora* leaf spot, Carbendazim (0.05%) @ 2gm lit^{-1} was applied. The pesticide applications were done within 10 to 20 April 2015. The final harvest was completed within the third week of May 2015.

Seed yield was estimated by hand harvest (destruction method) from an area of $100m^2$ for each variety and from 20 farmers' field. The harvested seeds were sun dried for 36 hours, and cleaned to record the yield.

Results:

It was observed that SML-668 gave 12 and 14% 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.

Study 2: Improved production practices of black gram

Objective: To study the suitability of black gram varieties namely TK94-2 and NVL-7 under recommended agronomic practices.

Materials and methods: On farm demonstration was undertaken in 35 selected farmers' fields from 25 February to 20 May 2015 covering a total area of 3ha. MSSRF investigation under India-Morocco Food Legumes Initiative Project study in Boipariguda Block of Koraput district, Odisha, during the year 2013-14 had identified TK94-2 as the best variety in terms of seed yield and other agronomic attributes, related to local growing conditions under

participatory varietal selection (PVS). Another variety, NUL-7, is reportedly a high yielding variety, with compact plant type and determinate growth habit.

The selected land area was split into two equal portions to accommodate TK94-2 and NVL-7. Seeds were treated with Rhizobium culture @ 100g kg^{-1} for 6 hours before sowing @ 20kg ha^{-1}. Land preparation was started on 25 February 2015 and seeds from different varieties were broadcasted within 10 March 2015. Quinalphos (0.05%) @ 2ml lit^{-1} was applied to control the pressure of hairy caterpillar and for managing Cercospora leaf spot Carbendazim (0.05%) @ 2gm lit^{-1} was applied. The pesticide applications were done within 3 to 9 of April 2015. The final harvest was completed within the third week of May 2015. Seed yield was assessed on plot basis for each variety and from 35 farmers' field. The harvested seeds were sun dried for 36 hours, and cleaned to record the yield.

Results:

It was observed 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.

5.3.3 2015 OFD

Building on the learnings from the OFD trials in 2013 and 2014 and with the baseline information regarding the nutrition status of the community in hand, detailed discussions were held with community members, to plan the crop trials in kharif and rabi 2015.

5.3.3.1 Kharif-2015 OFD

The following trials were undertaken in Kharif:

i. Improved production practices of finger millet
ii. Improved production practices of pulse-finger millet intercropping
iii. Pulse-maize intercropping with improved agronomic practices and
iv. Introduction of shorter duration rice varieties
v. Cultivation of orange flesh sweet potato

Study 1: Improved production practices of finger millet

Objective: 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.

Materials and methods: On farm demonstration was undertaken from 24 June 2015 to 28 October 2015 covering a total area of 0.5ha to study the performance of improved variety GPU-67 against farmers' local varieties. The selected land area was divided into four equal portions to include treatments *viz*.,

T_1: GPU-67 + recommended agronomic practices,

T_2: farmers' variety + recommended agronomic practices,

T_3: GPU-67 + traditional farming practice, and

T_4: farmers' variety + traditional farming practice.

Suggested agronomic practices mainly included seed treatment, line transplanting @ 20 x 10cm and planting depth of 2cm; and recommended intercultural operations. In contrast, traditional farming practice followed random transplanting with variable spacing and no seed treatment along with limited intercultural operations. Fertilizer recommendation was consistent irrespective of variety and agronomic practices.

Seeds were treated with Carbendazim 50WP @ 2g kg^{-1} seed before 24 hours of sowing in the nursery. Seedlings were grown in raised bed @ 5 kg ha^{-1}. Seedlings of 3-4 weeks old were transplanted in the main field with one to two seedlings per hill. Blanket recommendation of 40:20:20 NPK kg ha^{-1} was followed. 50 percent N and 100 percent P and K was applied at the time of transplanting. The remaining 50 percent of N was applied at 25 days after transplanting. As part of precautionary measures, Carbendazim 50WP @ 1g lit^{-1} and Chloropyriphos 20EC @ 2000ml ha^{-1} was applied to control blast and stem borer, respectively. Grain yield and yield contributing parameters such as number of productive fingers per hill, finger length and grain weights per hill as well as grain yield were recorded under each treatment.

Results:

It was observed that under improved agronomic practices for both GPU-67 and farmer's varieties (1832 kg ha^{-1}), GPU-67 (2067 kg ha^{-1}) had 13 per cent higher grain yield (Table 15). GPU-67 under improved agronomic practices produced 31% higher yield than that of farmer's varieties under traditional agronomic practices (1579 kg ha^{-1}). Further, the net return was highest for GPU-67 with improved agronomic practices with an increase of 62% than farmers' variety with traditional practices (8200 Rs ha^{-1}). Though the benefit to cost ratio of GPU-67 under both improved (T_1) and traditional agronomic practices (T_3) were almost similar i.e. 1.6, increased grain yield of finger millet under T_1 will provide larger quantity of nutrient rich food to farmer households, the crop being rich in micronutrient content, especially calcium, iron and folic acid.

Table 15. Comparison of yield contributing parameters, grain yield and economics of production among treatments

Treatments	No. of productive fingers plant $^{-1}$	Finger length (cm)	Grain yield (kg ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross return	Net return	B:C ratio
T_1: GPU-67 + recommended agronomic practices	4.4	7.4	2067	20,800	34,110	13,310	1.64
T_2: Farmers' variety + recommended agronomic practices	4.4	6.6	1832	20,670	30,236	9,566	1.46
T_3: GPU-67 + traditional farming practices	4.3	6.6	1740	17,980	28,712	10,732	1.60
T_4: Farmers' variety + traditional farming practices	4	6.5	1579	17,850	26,050	8,200	1.46

Market price of finger millet @16.50 Rs kg^{-1}

Study 2: Improved production practices of pulse-finger millet intercropping

Objective: To study the suitability of finger millet intercropped either with black gram or pigeon pea under traditional and recommended agronomic practices.

Materials and methods: On farm demonstration was undertaken from 30 June 2015 to 15 November 2015 covering a total area of 0.9ha in 10 farmers' fields.

Firstly, the selected land area was divided into two known portions. Each known portion was further divided into two equal halves to accommodate different intercropping treatments *viz*., T_1: black gram (var. NUL-7) and finger millet (var. Bhairabi) intercropped in a 2:6 ratio; T_2: farmer's mixed broadcasting of black gram and finger millet; T_3: pigeon pea (var. NTL-724) and finger millet (var. Bhairabi) intercropped in a 2:6 ratio and T_4: farmer's mixed broadcasting of pigeon pea and finger Millet.

Recommended agronomic practices mainly included seed treatment, line sowing @ 20x10cm for finger millet; 30x10cm for black gram and 45x30cm for pigeon pea with intercultural operations. In contrast, traditional farming practice followed broadcasting and no seed treatment along with limited intercultural operations. Fertilizer recommendation was consistent irrespective of treatments.

Seeds of finger millet were treated with Carbendazim 50WP @ 2g kg^{-1} seed whereas seeds of black gram and pigeon pea were treated with Rhizobium culture @ 100g kg^{-1} for 6 hours before sowing. Fertilizer recommendation for finger millet (40:20:20) NPK kg ha^{-1} and for black gram and pigeon pea (20:40:20) NPK kg ha^{-1}. Due to intercropping nature of the trail, as a thumb rule, 50% of the fertilizer recommendation for finger millet and 50% of the black gram and pigeon pea were taken into consideration. Accordingly, blanket recommendation of

30:30:20 NPK kg ha^{-1} was adopted. Full P and K and 50% N were applied 20-25 days after sowing. The remaining 50% N was applied 35-40 days after sowing. As part of precautionary measures, Carbendazim 50WP @ 1g lit^{-1} and Triazophos 40EC @ 2ml lit^{-1} was applied to control blast and leaf eating caterpillar, respectively. Finger millet yield and yield associated parameters such as plant height, number of productive fingers per hill, finger length and grain weights per hill was recorded. The grains/seeds of finger millet, black gram and pigeon pea were sun dried for 36 hours, cleaned and recorded for yield data.

Results:

It was observed that black gram + finger millet and pigeon pea + finger millet in 2:6 ratio and under recommended agronomic practices had higher crop yield in comparison to mixed broadcasting (Table 16). Similar trend was observed in net return and B: C ratio.

Table 16. Comparison of yield parameters, yield and economics of crop production among the treatments

Treatments	No. of productive fingers (n)	Finger length (cm)	Finger millet yield (kg ha^{-1})	Black gram yield	Pigeon pea yield	Total crop yield (kg ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T_1: BG +FM (2:6)	4	6.9	1147	75	-	1357	14,530	22,349	7,819	1.53
T_2: FM +BG (mixed broadcasting)	3	6.8	949	58	-	1112	14,110	18,341	4,231	1.29
T_3: PP+FM (2:6)	44	6.7	1125	-	66	1310	14,350	21,615	7,265	1.51
T_4: PP +BG (mixed broadcasting)		6.4	995	-	18	1045	13,930	17,184	3,254	1.23

Market price of finger millet (FM), black gram (BG) and pigeon pea (PP) were 16.50, 46.25 and 46.25 Rs. kg^{-1}, respectively.

Total crop yield (kg ha^{-1}) = Finger millet yield (kg ha^{-1}) + finger millet equivalent yield (kg ha^{-1})

Finger millet equivalent yield (kg ha^{-1}) = other crop yield x price of other crop (Rs kg^{-1}) / price of finger millet (Rs kg^{-1})

Study 3: Pulse-maize intercropping with improved agronomic practices

Objective: To study the performance of nutrient-dense maize (var. NHM-51) intercropped with pigeon pea (var. NTL-724) in a 1:1 ratio under improved agronomic practices.

Materials and methods: On farm demonstration was undertaken in 13 selected farmers' fields from 27 June 2015 to 23 November 2015 covering a total area of 0.7ha to study the performance of nutrient-dense maize (var. NHM-51) intercropped with pigeon pea (var. NTL-724) in a 1:1 ratio under improved agronomic practices.

Improved agronomic practices mainly included line sowing @ 60x30 cm for maize and 60x60 cm for pigeon pea and with recommended intercultural operation. Fertilizer recommendation for maize was 80:40:40 NPK kg ha^{-1} and for pigeon pea 20:40:20 NPK kg

ha^{-1}. Being an intercropping trial, 50% of the fertilizer recommended for maize and 50% of the pigeon pea were taken into consideration. As a result, a blanket recommendation of 50:40:30 NPK kg ha^{-1} was applied. 25 percent N and full P and K was applied at the time of sowing. The remaining 50 percent N was applied at first hoeing and earthing up, and the other 25 percent of N was applied at second hoeing and earthing up. Top dressing of fertilizers was coincided with hoeing/earthing up operations for better incorporation of the applied nutrients into the soil for greater availability. Weeding was performed twice. The first weeding was 15-20 days after sowing (or before the first hoeing) by hand weeder. The second weeding was 40-45 days after sowing (or before the second hoeing). Chloropyriphos 20 EC @ 5 ml lit^{-1} was applied to control the attack of termites in maize and Triazophos 40 EC @ 2ml lit^{-1} was applied to control the pressure of leaf eating caterpillar in pigeon pea.

Results:

From the study trials, 4585 kg/ha of tender maize, 341 kg/ha of grains, and 4128 kg/ha of green fodder along with 349 kg/ha of pigeon pea tender pods and 356 kg/ha of pigeon pea seeds were harvested. The economics and the benefit to cost ratio is given in Table 17.

Table 17. Economics of crop production (per ha)

Total cost of cultivation	Rs.27,600		
Total Production	kg	Price (Rs.) /kg	Total
Maize (Tender)	4585	10.00 (Local)	Rs.45,850.00
Maize (Grain)	341	13.25 (MSP)	Rs.4,518.00
Pigeon Pea (Tender pods)	349	30.00 (Local)	Rs.10,470.00
Pigeon Pea (Grain yield from mature pod)	356	46.25 (MSP)	Rs.16,465.00
Gross return (Rs.)			Rs.77,303.00
Net return (Rs.)			Rs.49,703.00
B:C			2.8

Study 4: Introduction of shorter duration rice varieties

Objective: Introduction of short duration rice varieties in order to promote pulses like green gram and black gram cultivation in rice fallows of the area.

Materials and methods: Typically, rice cultivation dominates Kharif crop season. However, after harvest, most often than not the land is kept fallow. In this context, four short duration rice varieties *viz*., MTU-1010 (110 days), Khandagiri (90 days), Mandakini (105 days) and Jyotirmayee (110 days) were studied with 31 farmers' covering an area of 7.3ha from 05 June

2015 to 20 November 2015 to promote pulses like green gram and black gram by utilizing residual moisture after rice harvest.

The selected land area was divided into known portions to accommodate above recommended short duration varieties and existing popular varieties of the area. Irrespective of the varieties tested, the package of practice was consistent. Prior to this study, green manure *Dhanicha (Sesbania cannabina)* was grown in the farm fields.

Usually, fertilizer dose of 60:30:30 NPK kg ha^{-1} is followed as a blanket recommendation. However, as the previous cropping was *Dhanicha,* N input was reduced substantially, and 30:30:30 NPK kg ha^{-1} was adopted. Full P and 50 percent K were applied at the time of transplanting as basal dose. The remaining 50 percent of K and full dose of N was applied in two equal split doses i.e. during tillering and at booting stage As a precautionary measure, Triazophos 40EC @ 1.5ml lit^{-1} was applied to control stem borer.

Results:

It was observed that under the given soil and weather condition, tested short duration varieties showed superior yield performance, as compared to most of the existing popular varieties in the area (Table 18).

Table 18. Comparison of grain yield* between introduced short duration and existing popular rice varieties in the study area

No. of farmers	Recommended varieties	Yield (kg/ha) in introduced varieties	Existing popular varieties	Yield (kg/ha) in farmers varieties
5	MTU-1010	3716	Khandagiri	1581
8	MTU-1010	3978	Arize Gold, Kranti, Kaberi	3334
5	MTU-1010	2074	Kranti, Naveen, Lalat	2523
2	Khandagiri	2707	Arize Gold, Kranti,	3664
5	Mandakini	5513	MTU-1010, Khandagiri	3792
3	Mandakini	4917	MTU-1001	4356
3	Jyotirmayee	4595	Puja, MTU-1001	4356

***Mean value reported*

Due to intense winter, farmers however waited till January to go for sowing of black gram and green gram. Therefore, the entire objective of utilisation of residual soil moisture by pulses through introduction of shorter duration rice varieties did not work out in the study site.

Study 5: Cultivation of orange flesh sweet potato in fields

Objective: to enable rural families to grow orange flesh sweet potato in their fields as well as in their back yard nutri-garden.

Materials and methods: As discussed in Study 3 under Kharif-2013 (5.3.1.1), the planting materials collected from the Central Tuber Crops Research Institute (CTCRI), were multiplied and, made available for growing in field, household and community nutrition gardens (Table 19).

Table 19. Details of planting material (cuttings) of sweet potato

SN	Crop	Variety/species	No. of cuttings received for multi-plication in 2013 and 2014	No. of cuttings made available for distribution
1	Sweet potato	*ST-13	250	1200
		*ST-14	200	1000
		Kishan	130	2000
		*Kamala Sundari	150	2000

*Orange-fleshed sweet potato varieties; Planting Material (cuttings of roots and stems/stumps) were obtained from Regional Centre, CTCRI, Bhubaneswar

Results:

Area under sweet potato cultivation by households varied from 122 to 2254 m^2 with an average of 490 m^2 (Table 20). Both the area and production of white and orange fleshed sweet potatoes were reported to be same but the amount of additional nutrients harvested in terms of β carotene and vitamin C accounted from 143-540 mg and 1035-1487 mg per 100g of the raw produce, respectively. It was observed that households sold the entire harvest of normal sweet potato but preserved 10 per cent of the OFSP produce for home consumption. The market price of both varieties was the same @Rs.7/- per kg. As the households preferred the orange fleshed ones for consumption, it maybe surmised that it will help in alleviating their vitamin A deficiency to some extent. Also the additional income from selling the produce will increase the household income.

Table 20. Details of area, production and consumption of sweet potato intervention

No. of farmers/ households	22	
Minimum area	122 m^2	
Maximum area (m^2)	2452 m^2	
Average area (m^2)	490 m^2	
	White fleshed	Orange-fleshed
Significant attribute	-	Rich in pro-vitamin A (β carotene)
Varieties	Kishan	ST-14, Kamala Sundari
Area	5387 (m^2)	5387 (m^2)
Total production	5550 (kg)	5546 (kg)
*Additional nutrients harvested	-	β carotene: 143 – 540 mg / 100g Vitamin C: 1035-1487 mg /100g
Consumption	-	10% of the total production per household
Sale @ Rs. 7 kg^{-1}	100%	90%

*additional nutrients i.e. β carotene and vitamin C content of orange-fleshed sweetpotatoes of these varieties were calculated as per Mitra, 2012 (β carotene: 2.58-9.74 mg /100g and vitamin C: 18.66 to 26.82 mg/ 100g

5.3.3.2 Rabi-2015 OFD

The OFDs during rabi 2015 were as follows:

i) improving the production and productivity of finger millet;
ii) enhancing pulse production through intercropping of Dolichos bean and French bean with maize;
iii) improved production practices of green gram; and
iv) improved production practices of black gram

Study 1: Demonstration on improving the production and productivity of finger millet

Objective: To study the performance of improved variety (Bhairabi*)* under improved agronomic practices.

Materials and Methods: The demonstration was undertaken in 20 selected farmers' fields of Boipariguda block in Koraput, Odisha during Rabi 2015 (November 2015 to March 2016) covering a total area of 1.15 ha under irrigated condition. The soil texture was sandy loam. The average air temperature and seasonal precipitation during the cropping period was 22^oC and 34mm over 4 rainy days.

Previous MSSRF investigation in the trial of finger millet as a sole crop and through intercropping with black gram and pigeon pea in *Kharif* 2015, identified GPU-67 is best variety followed by Bhairabi in terms grain yield and other agronomic attributes related to local agro-environmental situations and culinary properties. Although the trial was undertaken in irrigated condition during *Rabi* season but there was a risk of water scarcity

during flowering time. Therefore Bhairabi variety was selected for this trial due to its shorter duration in comparison to GPU-67.

The selected land area was divided into two equal portions to accommodate two treatments *viz.*

T_1: Bhairabi + improved agronomic practices;

T_2: farmers' variety + improved agronomic practices.

Improved agronomic practices included seed treatment, line transplanting @ 20 x 10cm, planting depth of 2cm and recommended intercultural operations. Irrespective of variety fertilizer recommendation was consistent. Seeds were treated with Carbendazim 50WP @ 2g per kg seed for 24 hours before nursery. Seedlings were grown in raised bed @ 5 kg ha^{-1}. Seedlings almost 3-4 weeks age were transplanted with one to two seedlings per hill. Blanket recommendation of 40:20:20 NPK kg ha^{-1} was adopted. 50 percent N and 100 percent P and K was applied at the time of transplanting as a basal dose. The remaining 50 percent of N was applied 25 days after transplanting. Carbendazim 50WP @ 1g lt^{-1} and Chloropyriphos 20EC @ 2000ml ha^{-1} was applied to control the pressure of blast disease and stem borer pest.

Morphological data (e.g. plant heights, number of productive fingers/hill, finger length) was observed. The grain yield was reported after sun-drying the harvest for 36hrs.

Results:

It was observed that under improved agronomic practices, the grain yield of Bhairabi was only 8 per cent higher than farmer's variety (1414 kg ha^{-1}) (Table 21).

Table 21. Economics of crop production of finger millet

	T1	**T2**
Total cost of cultivation (Rs. ha^{-1})	17,200	16,900
Total Production (Kg. ha^{-1})	1521	1414
MSP /kg (Rs.)	16.50	16.50
Gross Return (Rs. ha^{-1})	25,097	23,331
Net Return (Rs. ha^{-1})	7,897	6,431
B:C	1.46	1.38

Study 2: Enhancing pulse production through intercropping of Dolichos bean and French bean with maize

Objective: To study the performance of Dolichos bean and French bean intercrop with maize to enhance the pulse production in rabi season.

Materials and Methods: The demonstration was undertaken in 19 selected farmers' fields of Boipariguda block in Koraput, Odisha during Rabi 2015 (i.e. December 2015 to March 2016) covering a total area of 0.5 ha under irrigated condition. The soil texture was sandy loam. The average air temperature and seasonal precipitation during the cropping period was 22^0C and 34mm over 4 rainy days. This is a new cropping system for the area. Varieties used in the trial were: Maize (*NHM-51*), Dolichos bean (*Konkan Bhusan*) and French bean (*Suman*) from Nirmal Seeds Pvt. Ltd.,

The selected land area was divided into two equal portions to accommodate two treatments *viz.,* T_1: Maize + Dolichos bean (2:6); and T_2: Maize + French bean (2:6). Improved agronomic practices included seed treatment, line sowing and maintaining recommended spacing, recommended dose of fertilizer application and timely intercultural operations.

Results:

All the three crops were harvested at green stage such as green cob in case of Maize and green tender pod in case of Dolichos bean and French bean. It was observed that from T_1: 2496 kg of tender maize and 1196 kg of tender pod of Dolichos bean per ha, respectively; and from T_2: 2418 kg of tender maize and 1012 kg of tender pod of French bean per ha was harvested. Though the yield was not satisfactory due to adverse weather condition but, both the beans fulfilled the household requirement of regular protein rich vegetables for a period of one month. As the crops were harvested daily in small quantities, therefore 100 per cent of the produce was utilized as home consumption.

Study 3: Improved production practices of green gram

Objective: To study the performance of improved variety of green gram under improved agronomic practices.

Materials and Methods: The demonstration was undertaken in 48 selected farmers' fields of Boipariguda block in Koraput, Odisha during last week of February to May 2016 covering a total area of 9.75 ha. The soil texture was ranging from sandy to heavy loam. The average air temperature and seasonal rainfall during the cropping period was 27.8^oC and 190 mm over 15 rainy days.

Out of the 48 farmers, 15 farmers were selected for the comparison of the performance of the three selected varieties covering a total area of 3.6 ha. The selected land area was divided into three equal portions to accommodate three different varieties viz; SML-668, NVL-585 and Nayagarh Local. High yielding SML-668 was a recommended variety for this area by the Government of Odisha whereas NVL-585 was a new variety introduced through FSN intervention due to its high tolerance to PM (Powdery Mildew) and YMV (Yellow Mosaic Virus) disease, and Nayagarh Local is another variety which was widely cultivated in the area for its good yield and cooking quality.

All the three varieties were broadcasted after 3 ploughing. Seeds were treated with Rhizobium culture @ 100g/kg 6 hour before sowing @ 20 kg/ha. Quinalphos (0.05%) @ 2ml/lit was applied to control the pressure of hairy caterpillar and for managing *Cercospora* leaf spot Carbendazim (0.05%) @ 2gm/lit was applied.

Results:

Grain yield was recorded by taking yield cut from 100 m^2 areas from each of the 3 varieties of 15 selected farmers' fields. The yield was reported after sun-drying for 36hrs.

It was observed that SML-668 was superior in compared to NVL-585 and Nayagarh Local. SML-668 (495 kg ha^{-1}) gave 17 per cent superior yield than NVL-585 (412 kg ha^{-1}) and 7 per cent superior yield than Nayagarh local (458 kg ha^{-1}).

Study 4: Improved production practices of black gram

Objective: To study the performance improved variety of black gram under improved agronomic practices.

Materials and Methods: The demonstration was undertaken in 16 selected farmers' fields of Boipariguda block in Koraput, Odisha during last week of February to May 2016 covering a total area of 3.6 ha. The soil texture was ranging from sandy to heavy loam. The average air temperature and seasonal rainfall during the cropping period was 27.8^{o}C and 190 mm over 15 rainy days.

The selected land area was divided into two equal portions to accommodate two different varieties viz; TK94-2 and NUL-7. Previous MSSRF investigation through India-Morocco Pulses Project in Boipariguda Block of Koraput district, Odisha, during the year 2013-2014 under participatory varietal selection, identified TK94-2 as a suitable variety for the area in terms of grain yield and other agronomic attributes. On the other hand, NUL-7- was a new variety introduced by FSN intervention due to its high potential yield, compact plant type, and determinate growth habit.

Seeds were treated with Rhizobium culture @ 100g/kg prior to 6 hrs of sowing and broadcasted @ 20 kg/ha. Quinalphos (0.05%) @ 2ml/lit was applied to control the pressure of hairy caterpillar and for managing *Cercospora* leaf spot Carbendazim (0.05%) @ 2gm/lit was applied.

Results:

Grain yield was recorded by taking the plot yield for each of the 2 varieties from 16 farmers' fields. The yield was reported after sun-drying for 36hrs (Table 2). It was observed that TK94-2 was superior in compared to NUL-7. TK94-2 (368 kg ha^{-1}) gave 15 per cent superior yield than NUL-7 (312 kg ha^{-1}).

5.4. Overall Assessment

From the attempted OFD and trials, it is evident that just altering the existing practice (for e.g. line sowing in place of broadcasting), showed convincing improvement in crop productivity. In addition, introduction of improved varieties and production technology including cost-effective intercultural operations almost doubled the crop yields in most piloted OFD, compared with existing package of practices.

Direct increase in crop yields, indirectly improves nutrient output per unit area. As hypothesized, attempted OFD served dual purpose in terms of income (through sales) and most importantly increased availability of nutrient-dense crops for furthering household food security.

6. Issues and challenges

The major challenges in the process have been ensuring timely seed availability and coping with erratic rainfall. Rabi interventions failed in 2013-14, due to very low temperature during winter (See section: 5.3.1.2). The yield of rice demonstration in Kharif 2014 was not satisfactory as the crop was severely affected by extremely severe cyclonic storm called *Hud-Hud* at flowering stage (See section 5.3.2.1). The yield of shorter duration rice in Kharif 2015 demonstration was severely damaged at maturity and grand growth stage due to severe rain /flash flood. Heavy weed infestation in Kharif upland crop is also another challenge for crop production. Pest build-up due to continuous cloudy weather in Kharif season and loss of nutrients due to leaching, posed serious risks. Besides this, it was found that the farmers are not aware of even improved varieties of seeds released by the agricultural research system and the different government entitlements for improving their agriculture.

The rice trials with fertiliser deep placement in 2013-14 and 2014-15 showed positive results; paddy being the main crop, these trials enhanced the process of rapport building with the farmers. With the use of neem coated urea being made compulsory by the Indian government, it was decided not to do any further demonstration with USG. The evidence generated could be taken forward with other suitable funding, if desired.

A major learning from the different trials has been that just improving cropping practices and introduction of improved seed varieties can bring about significant change in crop yield. Increase in crop yield of nutrient dense crops means increased nutrient harvest. Farmers have to be made aware of the entitlements under extant government schemes, in order to access and improve their agriculture. Increasing the area under improved crop varieties also requires establishment of sustainable seed systems to ensure regular supply of the improved seeds and efforts.

7. Way forward

Based on the experience of the three years and discussion with farmers, increasing the area and availability of nutrient dense crops, *viz;* finger millet and pulses have been identified as the crop interventions to focus on under FSN.

The replacement of local landraces with improved variety along with improved agronomic practices supported higher crop yield; further the surplus created demand among farmers through barter/exchange system as well as provided opportunity for giving to relatives. Along with increased availability of nutrient rich food per household, this in turn will create the channel for spreading the message to nearby villages and untouched areas through the daily and weekly local markets. The OFDs enabled gaining the confidence of the farmers, sensitize them on the need for a nutrition focus and helped identify improved varieties of millets and pulses for promotion and greater uptake. This process has commenced from 2016-17. For example, the impact of the finger millet OFD with 10 farmers from four villages in 2015-16, generated demand from 312 farmers from 21 villages (including the farmers from the initial four villages) for improved variety of finger millet seed for Kharif 2016-17. Seeing the benefits in terms of increased yield and returns, farmers are willing to share or even bear the input costs, which is crucial for long-term sustainability. Measures for ensuring seed availability through community managed seed banks are being initiated.

References

1. Amanor K. (1990). Abstracts on farmer participatory research. ODI Agric. Admin. Unit Paper No. 10. Regent College, England: Overseas Development Institute.
2. Das PK, Bhavani, RV & Swaminathan MS. (2014). A farming system model to leverage agriculture for nutritional outcomes. *Agricultural Research,* 3(3), 193-203.
3. Farrington J & Martin A. (1988). Farmer participation in agricultural research: a review of concepts and practices. ODI Agric. Admin. Unit Paper No. 9. Regent College, England: Overseas Development Institute.
4. Government of Odisha - GoO (2011) District Statistical Hand book of Koraput, Directorate of Economics and Statistics, Bhubaneswar.
5. Government of Odisha - GoO (2015) Odisha Agriculture Statistics (2013-2014), Director of Agriculture and Food Production, Bhubaneswar.
6. Masset, E., Haddad, L., Cornelius, A., & Isaza-Castro, J. (2011). A systematic review of agricultural interventions that aim to improve nutritional status of children. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.
7. Mitra, S. (2012). Nutritional Status of Orange-Fleshed Sweet Potatoes in Alleviating Vitamin A Malnutrition through a Food-Based Approach. *Journal of Nutrition and Food Sciences* 2(8): 160. doi:10.4172/2155-9600.1000160.
8. Nagarajan S, Bhavani RV & Swaminathan MS (2014). Operationalizing the concept of farming system for nutrition through the promotion of nutrition-sensitive agriculture, *Current Science,* 107 (6), 959-964.
9. Prabhakar A (2014), Pragati, Koraput experiences in System of Ragi Intensification.
10. Swaminathan M.S and Bhavani R.V (2013), Food production and availability - Essential prerequisites for sustainable food security, *The Indian Journal of Medical Research*, Vol.138, No.3, Pages. 383-391.
11. World Bank. (2007). From Agriculture to Nutrition: Pathways, Synergies and Outcomes. Agriculture and Rural Development Department, Washington DC. Available at: http://siteresources.worldbank.org/INTARD/825826111113459820 4/21608903/January2008Final.pdf (accessed 21 August 2016).

Annexure I

Details of implemented OFDs under FSN during cropping period (2013-15)

Season	OFDs	Existing varieties/ technology	Introduced technology	No. of farmers	Total area under OFD (ha)	Introduced technology	No. of farmers	Total area under OFD (ha)	Introduced technology	No. of farmers	Total area under OFD (ha)
			2013 (Change in nutrient management, cropping pattern and varietal substitution)			2014 (Change in nutrient management, cropping pattern and varietal substitution)			2015 (Change in nutrient management, cropping pattern and varietal substitution)		
Kharif	Rice	Use of urea prills only;	• Use of urea super granule (USG) for higher nutrient use efficiency; • New varieties; • Proper management of fertilizer dose application (N, P, K)	3	3	• Use of urea super granule (USG) for higher nutrient use efficiency; • New varieties; Proper management of fertilizer dose application (N, P, K)	15	6	Introduction of short duration rice varieties in order to promote pulses in those fallows	31	7.3
	Mixed cropping	Mixed broadcasting of local varieties of finger millet +black gram or rice + maize+pigeon pea	•Improved varieties in finger millet and Maize; •Line sowing with different row proportions ; •Introduction of pop sorghum as a crop combination with finger millet and black gram	4	1.5	Intercropping of improved varieties of finger millet with black gram in 6: 2 (introduction of line sowing of finger millet with improved package of practices)	10	3	Line transplating of finger millet variety GPU-67	10	0.5
									Intercropping of fingermillet with black gram or pigeon pea	10	0.9

Season	**OFDs**	**Existing varieties/ technology**	**Introduced technology**	**No. of farmers**	**Total area under OFD (ha)**	**Introduced technology**	**No. of farmers**	**Total area under OFD (ha)**	**Introduced technology**	**No. of farmers**	**Total area under OFD (ha)**
			2013 (Change in nutrient management, cropping pattern and varietal substitution)			**2014 (Change in nutrient management, cropping pattern and varietal substitution)**			**2015 (Change in nutrient management, cropping pattern and varietal substitution)**		
Kharif									Intercropping of maize with pigeon pea (1:1)	13	0.7
	Sweet potato		OFSP	1	0.1				Multiplication of OFSP for planting material	22	0.01-0.5
Rabi	Rice	Urea prill	USG	1	1						
	Maize and any pulse	Mixed broadcasting	Intercropping of maize with cowpea (1:2)	1	0.5				Intercropping of maize with French bean and dolichos bean	19	0.5
		Mixed broadcasting of finger millet and blackgram	Intercropping of finger millet with blackgram (4:2)	1	0.3	Improved varieties and package of practices of green gram	20	5	Improved varieties and package of practices of green gram	48	9.8
						Improved varieties and package of practices of black gram	35	3	Improved varieties and package of practices of black gram	16	3.6
	Usually kept fallow								Short duration variety of fingermillet where irrigation is available	20	1.15

Annexure II

Nutrition composition of major food crops promoted through OFDs under FSN interventions:

Crop	Protein (g)	Total fat (g)	Dietary fibre (g)	Carbohydrate (g)	Energy (KJ)	Calcium (mg)	Phosphorous (mg)	Iron (mg)	Total Folates (µg)
Rice, raw, milled	7.94	0.52	2.81	78.24	1491	7.49	96	0.65	9.32
Rice, raw, brown	9.16	1.24	4.43	74.80	1480	10.93	267	1.02	11.51
Finger millet	7.16	1.92	11.18	66.82	1342	364	210	4.62	34.66
Maize, tender	3.57	1.40	3.67	22.69	502	6.35	163	0.71	59.71
Maize, dry	8.80	3.77	12.24	64.77	1398	8.91	279	2.49	25.81
Black gram, dal	23.06	1.69	11.93	51.00	1356	55.67	375	4.67	88.75
Black gram, whole	21.97	1.58	20.41	43.99	1219	86.18	345	5.97	134
Green gram, dal	23.88	1.35	9.37	52.59	1363	43.13	416	3.93	92.11
Green gram, whole	22.53	1.14	17.04	46.13	1229	92.43	353	4.89	145
Pigeonpea, dal	21.70	1.56	9.06	55.23	1384	71	328	3.9	108
Pigeon pea, whole	20.47	1.38	22.84	42.48	1146	139	312	5.37	229
Sweet potato	1.27	0.33	3.94	23.93	452	28.93	37.60	0.51	22.20

(All values are expressed per 100 gm of edible portion)

*(**Source:** Indian Food composition tables, 2017, NIN, Hyderabad)*