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Studies on crop diversification to provide nutritional security in Odisha

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Abstract
Agricultural intervention and farming systems research in India has been largely focussed on enhancing production, productivity and profitability of crop, animal and fisheries resources without much emphasis on better nutritional outcomes which is now a mandate for farm and non-farm families to be in nutritional security by their resource endowments and surrounding environment. The farmers in the study area were growing paddy based farming system followed by fruits and vegetables, livestock, fishery in each agro-climatic zone. Harfidahal Index indicated that the food items are diversified rather than specialized in each agro-climatic zone. Paddy was found to be the least diversified and the most specialized as its value was approaching 1. Fruits and vegetables are more diversified as its value was less than 0.5. Livestock and fishery were found to be the most diversified as its value was approaching 0. It was concluded that, people of Odisha can achieve nutritional security by different food based cropping system through improved agricultural production system, dietary diversification, income enhancement, greater nutritional awareness and changed behaviour patterns. Hence, it was suggested to go in for different food based cropping system in different problematic region in order to overcome malnutrition and to achieve nutritional security.

Keywords: Crop diversification, provide nutritional security, Odisha

Introduction
Sustainable development in agriculture and allied sectors is a major concern now-a-days to ensure food and nutrition security for an ever increasing population in view of global challenges viz. frequent occurrence of natural disasters and increased economic volatility. Limits on the ability to produce food in some regions, inequitable or inefficient food distribution mechanisms have been blamed widely for the persistence of hunger in the world today (Altieri, 1987) [1]. Food and nutrition security are closely associated. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security i.e., availability, accessibility, utilization and stability are most vital in this context (Committee on World Food Security, 2012) [3]. Crosson (1992) [4] described a sustainable agricultural system as one "that can indefinitely meet demands for food and fibre at socially acceptable economic and environmental costs". At the same time the nutritional dimension is integral part to this concept, nutrition security is considered to exist when food security is combined with a sanitary environment, adequate health services, and proper care and feeding practices to ensure a healthy life for all household members. Agriculture can be leveraged to be nutrition sensitive and thus promote food and nutritional security. Since agriculture is the primary source of livelihood in much of Asia's population, it has the potential to be a strong driver of nutritional improvement. It can sustainably contribute to improve dietary diversity and nutrition outcomes by agricultural extension services that offer communities information and improved inputs such as seed and cultivars for better crop diversity and biodiversity; integrated agroforestry systems that reduce deforestation and promote harvesting of nutrient-rich forest products; aquaculture and small livestock ventures that include indigenous as well as farmed species. Improvements in agricultural production alone will not be able to address the problem of malnutrition and provide for food and nutrition security without interventions to improve education, health, sanitation and ensure appropriate care and feeding practices in the community.

Agriculture, the principal occupation of around 60 percent population in India is still revolving around two major staple crops viz. paddy and wheat. Emphasis on crop diversification other than paddy and wheat is yet to be done both at Central and State level. The farming system develops and demonstrates a sustainable framework for nutritional security that can be used for up scaling and wider adoption.

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Agricultural intervention and farming systems research in India has been largely focused on enhancing production, productivity and profitability of crop and animal resources without much emphasis on better nutritional outcomes which is now a mandate for farm and non-farm families to be in nutritional security by their resource endowments and surrounding environment. The first revised estimates of 2013-14 revealed that Agriculture and Animal Husbandry sub-sector contributed 13.07% to the Gross State Domestic Product in 2004-05 (GoO, 2014) [7]. It is a fact that the share of the Agriculture Sector (which includes Agriculture & Animal Husbandry, Forestry and Fisheries sub sectors) in the States Gross Domestic Product has been declining over the years. Still this sector continues to be vital for the State's economy. About sixty percent population of the state draws its sustenance fully or partially from the Agriculture Sector. In Odisha, there is a lot of resources for agriculture and allied activity. Paddy- livestock, Paddy- vegetables and Paddy-fishery are some of the important farming systems mostly found in its ten agro-climatic zones which is an indicative towards nutritional security in the state. In this context, the present study has been conducted during 2014-15 covering all the ten agro-climatic zones of Odisha with the following objectives:-

(1) To find out the contribution of paddy, fruits and vegetables, livestock and fisheries sector to the food basket of Odisha State.
(2) To find out the extent of diversification among various agro-enterprises in Odisha which contribute to nutritional security.

Materials and Methods
Seventy two farm households were contacted from each of the nineteen districts of the State covering all the ten agro-climatic zones of Odisha as depicted in Figure 1. Thus, a total of 1368 households (samples) were drawn for the study. Except Zone-7 (South Eastern Ghat Zone) representing Malkangiri district, two districts have been selected from each of the rest nine agro-climatic zones of the State by following

stratified random sampling. Further two blocks were randomly selected from each district and three villages selected as well from each of the selected blocks. Now, twelve farmers were randomly selected from each village, representing marginal, small and large farmers, for the study. The sample households were selected randomly from each zone basing on the criteria of which enterprises they are growing in Paddy based farming system; the area of production, productivity, income, percentage of contribution of individual food item to total yield. The farmers were growing Paddy based; fruit and vegetable based, livestock based and pisciculture based crops in the study area. Besides, calculating the relative contribution of each of the farm enterprises, the Harfindahal index was used to find out the extent of diversification among various enterprises.

Statistical tools used
Relative Contribution of Farm Enterprises
It was calculated by simple percentage contribution of each farm households of all the enterprises.

Harfindahl index
There is also a normalized Harfindahl index whereas the Harfindahl index ranges from 1/N to one, the normalized Harfindahl index ranges from 0 to 1. It is computed as follows:-

$$HI = I = 1n(PI)2$$

Where, $PI = Ai/inAi$
$I = 1, 2, 3.........$
I is number of crop enterprises,
Pi is the proportion of area under crops
Ai is the area under i^{th} crop
inAi is the gross cropped area of the farm.

The value of Harfindahl index varies from zero to one, where, one indicates complete specialization and zero perfect diversification i.e., it has inverse relationship with diversification.
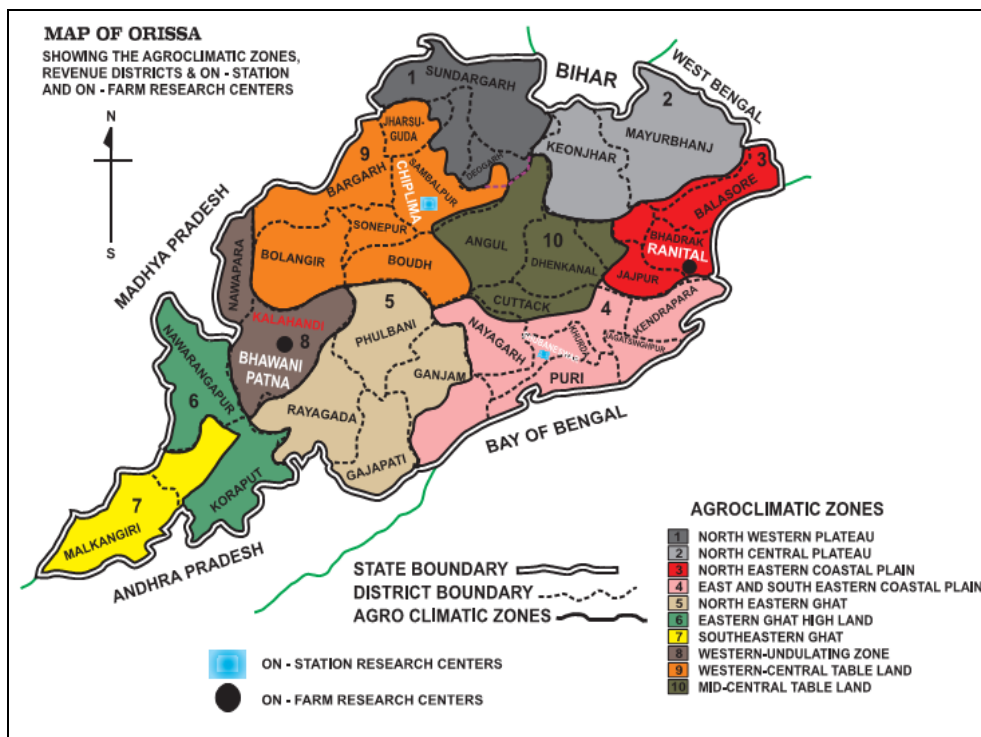

Fig 1: Map Showing Ten Agro-Climatic Zones of Odisha

Results and Discussion
Farming information of various households in different agro-climatic zone
The 10 agro climatic zones as well as the districts coming under each zone under National Agricultural Research Project (NARP) in Odisha has been depicted in Fig. 1. It was revealed from Table 1, that the farmers were growing various enterprises like paddy, fruits and vegetables, pulses, oilseeds, sugarcane, cotton, spices and enterprises like livestock, fishery etc. The crops grown were mainly classified as paddy based, fruits and vegetables based, livestock based, fisheries based, pulse based, oilseed based farming system basing on the relative contribution of dominant commodity in the system. The farming household number in each sample drawn in each agro-climatic zone was given in Table 1. It was recorded that highest number of farmers were growing paddy (90.97% to 60.47 followed by fruits and vegetables (31.25% to 01.39%), livestock (06.94% to 02.08%), and fishery (15.28% to 0.69%) in almost all the agro-climatic zone. The maximum numbers of farmers (90.97%) of were found to grow paddy in the Western Undulating Zone i.e., in the NARP Zone VIII whereas it was least in the Mid-Central Table Land Zone (NARP Zone X). Likewise maximum fruits and vegetables were found to grow in the Zone III i.e., in the North Eastern Coastal Plain Zone but least in Zone IV i.e., in the East & South Eastern Coastal Plain Zone. It may be due to diversion of cropping areas to rapid urbanisation in the Zone.

The Contribution of Various Agro-Enterprises in Percentage
It was evident from Table 2 that out of 1368 farmers drawn from the study areas, 67.76% of the total sample size practised paddy based farming system followed by fruits and vegetables (17.76%). Similarly, 8.77 percent and 5.71 percent of the total numbers of households practised livestock and fishery based farming systems, respectively. Thus, it was revealed that majority of farmers were growing paddy based farming system followed by fruits and vegetables based, livestock based and fishery based farming system.

Extent of Diversification in Various Agro-Enterprises
Harfidahal index (HI) indicates the extent of diversification in any system; it may be for crop, for other enterprises, for variety, for market etc. It is only an index. Its value varies from 0 to 1. It was recorded in Table 3 that The Harfidahal index (HI) is more than 0 and less than 1 for each enterprise i.e., Paddy, fruits and vegetables, livestock and fishery. For Paddy Harfidahal index is 0.98, for fruits and vegetables HI is 0.41, for livestock HI is 0.01, for fishery HI is 0.02 which indicated that the food items are diversified rather than specialized in each agro-climatic zone. Paddy was found to be the least diversified and the most specialized as its value was approaching 1. Fruits and vegetables which are more diversified as its value was less than 0.5. Livestock and fishery were found to be the most diversified as its value was approaching zero.

Nutritive value of various enterprises
Cereals particularly rice and wheat chiefly provide carbohydrates whereas fruits and vegetables, livestock, fishery, pulses provide vitamins, minerals, fat and protein besides carbohydrates essential for healthy living. For a decent living, we require 300 g of vegetables and 120 g of fruits per day besides 475 g cereals, 80 g pulses, 55 g protein, 450 mg calcium, 20 mg iron, 50 mg Vitamin C, 1.4 mg thiamine, 1.5 mg riboflavin, 19 mg niacin, 5 mg Vitamin D, 1.0 mg Vitamin $B_{12,}$ 100 mg folic acid, 3000 mg B-carotene, 200 ml milk, 40 mg sugar and 40 ml of oil constituting 2800 g of calories (NIN, 1980 and ICMR, 2012) [10, 5]. According to the studies of Indian Council of Medical Research, New Delhi and National Institute of Nutrition, Hyderabad, meagre intake of vegetables and low cost protective foods, is largely responsible for malnutrition among the majority of population. The chief deficiencies of our diet are calories, protein, Vitamin A and riboflavin. It was revealed from Table 1, Table 2 and Table 3 that various enterprises are diversified in all the ten Agro-climatic Zones although paddy (rice) were grown widely. Thus there is a large scope to minimise malnutrition through intake of protective foods in all the Zones. Fruits and vegetables, livestock, fishery, pulses and paddy grown in all the ten Agro-climatic Zones of Odisha State can provide all the essential nutrients like vitamins, minerals, fat and protein besides carbohydrates (Table 4 and Table 5). It will certainly help in eradicating malnutrition and to achieve nutritional security in Odisha.

Table 1: Farming Information of Various Households in Different Agro-Climatic Zone of Odisha.

Farming systems	No. of sample households	Per cent
NARP Zone I. : North Western Plateau Zone; Districts : Sundargarh & Deogarh		
Paddy (Cereal)	109	75.69
Fruits & Vegetables	25	17.36
Livestock	9	6.25
Fishery	1	0.69
Total	**144**	**100.00**
NARP Zone II. : North Central Plateau; Districts : Keonjhar & Mayurbhanja		
Paddy (Cereal)	96	66.67
Fruits & Vegetables	40	27.78
Livestock	7	4.86
Pulses	1	0.69
Total	**144**	**100.00**
NARP Zone III : North Eastern Coastal Plain; Districts : Jajpur & Bhadrak		
Paddy (Cereal)	62	43.06
Fruits & Vegetables	45	31.25
Fishery	22	15.28
Oilseed	7	4.86

Farming systems	No. of sample households	Per cent
Livestock	3	2.08
Sugarcane	3	2.08
Pulses	2	1.39
Total	**144**	**100.00**

NARP Zone IV. : East & South Eastern Coastal Plain; Districts : Khordha & Kendrapara

Farming systems	No. of sample households	Per cent
Paddy (Cereal)	107	74.31
Pulses	26	18.06
Oilseed	3	2.08
Livestock	3	2.08
Fruits & Vegetables	2	1.39
Fishery	2	1.39
Poultry	1	0.69
Total	**144**	**100.00**

NARP Zone V. : North Eastern Ghat Zone; Districts : Ganjam & Gajapati

Farming systems	No. of sample households	Per cent
Paddy (Cereal)	92	63.89
Fruits & Vegetables	43	29.86
Livestock	3	2.08
Fishery	3	2.08
Pulses	1	0.69
Sugarcane	1	0.69
Poultry	1	0.69
Total	**144**	**100.00**

NARP Zone VI : Easternghat Highland; Districts : Koraput & Nabarangpur

Farming systems	No. of sample households	Per cent
Cereal (Paddy & Ragi)	93	64.58
Fruits & Vegetables	32	22.22
Spices (Ginger)	9	6.25
Livestock	8	5.56
Pulses	2	1.39
Total	**144**	**100.00**

NARP Zone VII. : South Easternghat; District : Malkangiri

Farming systems	No. of sample households	Per cent
Cereal (Paddy)	59	81.94
Fruits & Vegetables	10	13.89
Oilseed (Groundnut)	3	4.17
Total	**72**	**100.00**

NARP ZoneVIII. : Western Undulating Zone; Districts : Kalahandi & Nuapada

Farming systems	No. of sample households	Per cent
Paddy	131	90.97
Fruits & Vegetables	11	7.64
Cotton	1	0.69
Fishery	1	0.69
Total	**144**	**100.00**

NARP Zone IX. : Western Central Table Land; Districts : Sonepur & Sambalpur

Farming systems	No. of sample households	Per cent
Paddy (Cereal)	125	86.81
Livestock	10	6.94
Fruits & Vegetables	6	4.17
Fishery	2	1.39
Sugarcane	1	0.69
Total	**144**	**100.00**

NARP Zone X. : Mid - Central Table Land; Districts : Dhenkanal & Angul

Farming systems	No. of sample households	Per cent
Paddy (Cereal)	87	60.42
Fruits & Vegetables	29	20.14
Sugarcane	9	6.25
Onion & Garlic	6	4.17
Livestock	6	4.17
Poultry	4	2.78
Oilseed	2	1.39
Fishery	1	0.69
Total	144	100.00

Table 2: Contribution of various Agro-Enterprises in the Food Basket (%).

Particular	No. of sample households	Per cent
Cereal (Paddy)	927	67.76
Fruits & Vegetables	243	17.76
Livestock	64	08.77
Fishery	41	05.71
Total	1368	100.00

Table 3: Harfidahal Index of Agro-Enterprises.

Particulars	Harfidahal Index
Paddy	0.98
Fruits and vegetables	0.41
Livestock	0.01
Fishery	0.02

Table 4: Nutritional value of Vegetables. (Per 100 g edible portion on fresh weight basis)

Name of crop	Moisture (g)	Carbohydrates (g)	Protein (g)	Fat (g)	Calorie (energy)	Vit. A (IU)	Thiamine (mg)	Riboflavin (mg)	Ascorbic acid (mg)	Calcium (mg)	Iron (mg)	Phosphorus (mg)
Potato	74.7	22.6	1.6	0.1	97	40	0.4	0.04	17.0	10.0	0.7	35.0
Tomato Green	93.1	3.6	1.9	0.1.0.1	23	307	0.07	0.01	31.0	20.0	1.80.4	-
Ripe	94.0	3.6	1.2		20	302	0.12	0.06	27.0	48.0		26.0
Cabbage	92.4	5.3	1.4	0.2	29	80	0.06	0.05	100.0	46.0	0.8	38.0
Cauliflower	91.7	4.9	2.4	0.2	31	70	0.04	0.03	75.0	30.0	17.0	76.0
Brinjal	92.7	4.0	1.4	0.3	24	118	0.04	0.11	12.0	18.0	0.9	47.0
Chilli	85.7	3.0	2.9	0.6	29	292	0.19	0.39	111.0	30.0	1.2	80.0

Source: 1. Bose, TK; Som, MG (Eds.). 1986. Vegetable Crops in India, Naya Prokash
2. Hazra, P; Som, MG. 2012. Vegetable Science, Kalyani Publisher.

Table 5: Nutritional value of some common food ingredients other than vegetables. (Per 100 g on fresh weight basis)

Name of Food Ingredients	Carbohydrates (g)	Protein (g)	Fat (g)	Calorie (energy)	Vit. A (IU)	Thiamine (mg)	Riboflavin (mg)	Calcium (mg)	Iron (mg)	Vit. C (mg)
Rice	**79.0**	**6.4**	**0.4**	**345.0**	**15.0**	**0.21**	**0.09**	**24.0**	**0.8**	**-**
Flour Plain	69.4	12.1	1.7	341.0	95.7	0.55	0.12	41.0	3.3	-
Husked	73.9	11.0	0.9	348.0	-	0.12	0.07	23.0	2.5	-
Gram	59.8	20.8	5.6	385.0	216.0	0.48	0.18	56.0	9.1	1.0
Green gram	59.9	24.5	1.2	358.0	161.7	0.46	0.21	75.0	8.5	-
Lentil	59.9	25.1	0.7	371.0	450.0	0.45	0.49	69.0	4.8	-
Egg (Chicken)	-	13.3	13.3	173.0	1200.0	0.10	0.18	60.0	2.1	-
Fish (Rohu)	4.4	16.6	1.4	97.0	-	0.05	0.07	650.0	1.0	-
Mutton	1.0	18.5	13.5	194.0	31.0	0.18	0.27	150.0	2.5	-
Ginger	12.3	2.3	0.9	67.0	67.0	0.06	0.03	20.0	2.6	6.0
Turmeric	69.4	13.1	5.1	376.0	50.0	0.03	-	150.0	18.6	-
Banana	22.5	0.8	0.5	98.0	50.8	0.03	-	10.0	0.5	8.0
Guava	11.2	0.9	0.33	51.0	-	0.30	0.10	10.0	1.4	212.0

Source: Indian Council of Medical Research (ICMR).

Conclusion

Agricultural intervention and farming systems research in India has been largely focussed on enhancing production, productivity and profitability of crop, animal and fisheries resources without much emphasis on better nutritional outcomes which is now a mandate for farm and non-farm families to be in nutritional security by their resource endowments and surrounding environment. The farmers in the study area were growing paddy based farming system followed by fruits and vegetables, livestock, fishery in each agro-climatic zone. Harfidahal Index indicated that the food items are diversified rather than specialized in each agro-climatic zone. Paddy was found to be the least diversified and the most specialized as its value was approaching 1. Fruits and vegetables are more diversified as its value was less than 0.5. Livestock and fishery were found to be the most diversified as its value was approaching 0. It was concluded that, people of Odisha can achieve nutritional security by different food based cropping system through improved agricultural production system, dietary diversification, income enhancement, greater nutritional awareness and changed behaviour patterns. Hence, it was suggested to go in for different food based cropping system in different problematic region in order to overcome malnutrition and to achieve nutritional security.

References

1. Altieri M. Agroecology: The Scientific Basis for Alternative Agriculture, Boulder: Westview Press, 1987
2. Bose TK, Som MG. (Eds.). Vegetable Crops in India, Naya Prokash, Kolkata, 1986.
3. Committee on World Food Security. Investing In Small holder Agriculture for Food and Nutrition Security, 2012.
4. Crosson P. Sustainable Agriculture Resources. 1992; 106:14-17.

5. Indian Council of Medical Research (ICMR), New Delhi Daily requirement of food, 2012.
6. De Schutter O. Agro-Ecology and the Right to Food, Report Submitted by the Special Rapporteur on the Right to Food. UN General Assembly. Human Rights Council, Sixteenth session, 2010.
7. GoO. Government of Odisha, Odisha Agricultural Statistics, 2014.
8. website: http//www.orissa.nic.in
9. Hazra P, Som MG. Role of Vegetables in Nutrition, Vegetable Science, Kalyani Publisher, 2012.
10. National Institute of Nutrition, Hyderabad, Nutritive value of Indian Food, 1980.