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Varietal diversification of rice in Bhadrak district of Odisha

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ABSTRACT

A study was undertaken to evaluate diversification index and desirable traits linking rice varieties for its popularity in the Bhadrak district of Odisha. Primary data was collected from sample farmers in three blocks of Bhadrak district i.e. Tihidi, Basudevpur and Bonth by multistage random sampling method. The result revealed that the most popular variety was 'Swarna' followed by 'CR 1018' in the district. Highest numbers of varieties were reported from Tihidi block because of adverse agro-climatic situations to withstand. Few varieties, mostly high yielding were reported from irrigated area of Bonth block because of suitable agro-climatic condition. Low and medium lowlands were covered by local land races because of lack of suitable high yielding varieties which could withstand excess water stress. Desirable trait as perceived by the farmers was mostly high yielding potential. As farmers were not getting suitable seeds for adverse ecosystem, as per the study, it was suggested that suitable and quality rice cultivars should be developed with ability to withstand water logging and flash flood situation.

Key words: *rice, variety, desirable trait, diversification index*

The growing and unreliable needs of the population with challenges of a globalizing market in agriculture, many countries in South East Asia have undertaken crop diversification and varietal diversification in order to withstand unsympathetic climatic condition for encouraging outcome. Diversification takes place either through area augmentation or by crop, variety substitution. Farmers who participate in the market are more likely to grow Landraces (LRs) and Modern varieties (MVs) simultaneously, thus increasing the diversity (Gauchan *et al*., 2001). The creation of basic infrastructural facility is an essential pre-requisite for enabling conditions to foster the process of agricultural development and crop diversification as most of these parameters are found to influence the nature and extent of crop diversification (Achary *et al.*, 2011). If carried out appropriately, diversification can be used as a tool to augment farm income, alleviate poverty and conserve precious soil and water resources (Pingali and Rosegrant, 1995) and (Chand, 1996).

Rice is the staple food crops in the world particularly in India and improvement of its productivity has always been a prime focus (Subbaiah *et a*., 2011). It is having cultivars of maturity duration varying from less than 80 to more than 180 days, showing adaptability to a wide range of land types, ambiance and water regimes, including conditions of water profusion to water scarceness where no other crop could possibly be full-fledged. Variety plays a major role to withstand natures devil by it's adaptability which are diversified less to more from appropriate to hard conditions and rice is that crop which has generous cultivars ranging from traditional to modern i.e. landraces, to high yielding and hybrid ones. Though, rice has wide adaptability in shifting climate, soil type and moisture content, it can not accomplish the target food obligation of the growing population, which needs high yielding, diversified varieties according to the environment. The losses in rice area during drought years was much more in upland than in lowland where the moisture holding capacity of soils is low (Pandey *et al.*, 2007). Degree and duration of drought stress during the reproductive stage in rainfed lowland rice is in need of drought tolerant rice cultivars (Kamoshita *et al.*, 2008). It was estimated

that about 123 exotic rice varieties were included as local check with high value of genotypic and phenotypic coefficient of variation (Sharma and Koutu, 2013).

Odisha had only about 4% areas under modern varieties of rice during 1970. There has been a rapid adoption of modern varieties with the rate of adoption being 79% (GoO, 2009-10). Adoption rate increased almost linearly over time, with the coverage of improved varieties increasing at about 25% points every 10 years. On an average, rice yield increased by 120 kg/ha for each 10 percent increase in the share of area under modern rice varieties. Despite the high degree variability, the increase in yield is mainly due to the adoption of modern varieties as well as the increase in input usage. A change in any single economic factor is unlikely to cause farmers to change their variety and crop choice behavior (Smale *et al*., 1994). However there exist high degree of varietal diversity at farm front. On-farm varietal diversity is now highest in marginal agricultural environments like rain fed uplands and lowlands because unlike the case in more favorable environments, modern new high yielding varieties have not been sufficiently attractive to replace their traditional as well as old established improved/HYV rice cultivars. Emphasizing this situation, the study has been done upon rice varieties with the objectives to estimate the diversification indices and find of suitable traits linking modern rice variety for it's popularity

MATERIALS AND METHODS

Bhadrak district of Odisha was purposefully selected as it is coming under different types of fragile ecosystem such as waterlogged, flash flood and salinity situation. On the other hand it is also irrigated by river Salandi and high level irrigation system (Bonth block). Sizable area was is irrigated by creak irrigation, (i.e. Tihidi block). Therefore, it was assumed that plant diversity would differ considerably from favorable ecosystem (irrigated area) to fragile one. Multistage random sampling was employed for the sample collection during 2010-11. About 33 percent of blocks i.e. Basudevpur, Tihidi and Bonth of Bhadrak district were selected, and from each block 3 to 5 per cent of villages were chosen and from each village 15 per cent of farm households were drawn to constitute the sample space. As per 2001 Odisha Agriculture Census per cent of marginal, small and semi medium to large were 56, 27 and 13 per cent respectively. Hence from each village 56 per cent of semi medium to 13 per cent of large farmers were interviewed for the present study.

Actual area under each crop along with its share to gross cropped area over time has been used to study the process of diversification. Moreover various indices like Herfindhal index (Eq. 1), Entropy index (Eq. 2). Modified entropy index (Eq. 3) and Composite entropy index (Eq. 4) have been employed to study the pattern and process of crop diversification in the district (Achary *et al.*, 2011).

RESULTS AND DISCUSSION

There were as many as 43 varieties mostly traditional were grown by the farmers. There were 4 types of lands such as upland, medium land, medium lowland (shallow lowland) and lowland. Analysis was done according to land type. In upland out of 10 farmers, 8 farmers grew Motora, one farmer Mandu, one farmer Aswini. Motora accounted 69.64% of paddy area followed by Mandu followed by Aswini. The per hectare yield of Mandu 1.24 tons ha^{-1}, Aswini 1.98 tons ha^{-1} Table 1.

In medium land situation out of 256 farmers, 239 farmers grew Swarna, 11 farmers MTU 1001, 4 farmers Surendra, one each Lilabati and Basmati (Table 2). The latter two were traditional varieties. Swarna accounted for 97.95% paddy area, followed by MTU 1001 followed by Surendra. Both Basmati and Lilabati grown were scented rice in minimum area.

In Basudevpur block a part of medium land was affected by salinity. As many as 15 different types of rice cultivar were used by the farmers which were adapted to at least one of the above adverse ecosystems. CR 1018, a modern variety occupied about 36.57% of total low land with per hectare yield potential of 2.33 t ha^{-1}. As many as 7 modern varieties were grown accounting for about 68% of total medium low land area Table 3. The modern rice varieties grown in this land type were CR 1018, CR 1009, Swarna, Moti, Pooja, Indravati and Dharitri. It was also observed that traditional rice cultivar Odasiali yielded about 4.32 t ha^{-1} higher than most popular modern variety CR 1018 (2.33 t ha^{-1}). The average yield of rice cultivar Swarna was 0.69 t ha^{-1} which was least. In medium low land Swarna could not withstand water logging conditions resulted in poor plant stand and low yield. The best suited rice variety was CR 1008 on the basis of per

Table 1. Distribution of wet season rice area and variety in upland situation of Bhadrak district

Name of the variety	No. of farm	% farm	Area (ha)	% of area	Yield (t ha^{-1})	SE mean
Mootora (TV)	8	80	1.39	69.64	1.75	0.2623
Mandu (TV)	1	10	0.40	20.24	1.24	
Aswini (TV)	1	10	0.20	10.12	1.98	
Total	10	100	2.00	100.00	1.72	0.2150

Table 2. Distribution of wet season rice area and variety in medium land of Bhadrak district

Name of the variety	No. of farm	% farm	Area (ha)	% of area	Yield (t ha^{-1})	SE mean
Swarna (MV)	239	93.39	179.99	97.95	3.48	0.0924
MTU1001 (MV)	11	4.30	3.07	1.76	2.60	0.2739
Surendra (MV)	4	1,56	1.17	0.64	3.46	0.1747
Basmati(TV)	1	0.39	0.02	0.01	1.85	
Lilabati (TV)	1	0.39	0.06	0.04	1.54	
Total	256	100.00	184.31	100.00	3.43	0.0883

Table 3. Distribution of wet season rice area and variety in medium low land of Bhadrak district

Name of the variety	No. of farm	% farm	Area(ha)	% of area	Yield(t ha^{-1})	SE mean
CR 1018 (MV)	77	39.49	33.75	36.57	2.33	0.1261
CR 1008 (MV)	30	15.38	10.34	11.30	5.80	0.2325
Gopalbhog (TV)	24	12.31	20.45	22.33	0.49	0.0356
Gitanjai (TV)	15	7.96	4.19	4.58	2.46	0.1303
Swarna (MV)	14	7.18	9.21	10.66	0.69	0.1632
Moti (MV)	9	4.62	2.23	2.43	2.30	0.2753
Saruchunamali (TV)	7	3.59	2.44	2.47	1.31	0.1936
Pooja (MV)	5	2.56	3.77	4.11	2.05	0.8016
Rajshree (TV)	4	2.05	1.33	1.45	2.60	0.2176
Indrabati (MV)	3	1.54	1.92	2.10	2.32	0.8845
Mugudhi (TV)	2	1.03	0.46	0.50	2.78	0.3058
Dharitri (MV)	1	.051	0.40	0.44	3.01	
Odasiali (TV)	1	.051	0.16	0.18	4.32	
Samulei (TV)	1	.051	0.29	0.32	2.74	
Harimali (TV)	1	.051	0.19	0.44	1.98	
Total	195	100.00	91.55	100.00	2.50	0.1323

TV - Traditional Variety, MV - Modern Variety

unit yield potential.

The farmers in this ecosystem were growing 23 different rice cultivars that belonged to traditional varieties. So far no modern variety has developed to adapt to this handicapped ecosystem, it was found that Khadiasula was the most popular rice cultivar accounting for 28.49% of low land area Table 4. Khadiasula was cultivated by 15.14% of farmers. As it is most fragile ecosystem during wet season the variation of per hectare rice productivity was highest. It ranged from as low on 0.37 t ha^{-1} in Godikhajura to 2.16 t ha^{-1} in Mugudhi. In low land situation the mean yield was 1.13 t ha^{-1}. Lack of scope to use of plant nutrient, lack of suitable high yield variety and sub-optimum plant population might be attributed to low yield potential of traditional rice cultivars in low land situation but reverse in case of modern varieties. Turning to the adaptability analysis designed to assess the robustness of varieties across different environments, the results indicated that with no inorganic fertilizer, all the improved aquatic rice varieties yielded more under better environments (Samba *et al.*, 1998).

Based upon different indices of diversification Table 5, it was found that highest value was observed

Table 4. Distribution of wet season rice area and variety in low land of Bhadrak district

Name of the variety	No. of farm	% farm	Area(ha)	% of area	Yield(t ha^{-1})	SE mean
Khadiasula	12	17.14	8.75	28.49	0.45	0.0334
Baunsagaja	11	15.71	6.68	21.74	0.58	0.1461
Kakhuria (TV)	7	10.00	2.82	9.17	1.83	0.0981
Odasiali (TV)	6	8.57	0.92	2.99	1.62	0.0903
Mugudhi(TV)	6	8.57	1.57	5.11	2.16	0.1935
Champasula	6	8.57	2.53	8.24	0.43	0.0888
Samulai	3	4.29	1.12	4.61	1.78	0.1973
Geleigeti	3	4.29	1.42	3.64	1.07	0.2178
Singa	2	2.86	0.81	4.61	0.80	0.0618
Godikhajura	1	1.43	0.40	2.64	0.37	
Nalipatelli	1	1.43	0.27	1.32	1.87	
Latakalama	1	1.43	0.16	0.87	1.39	
Mutura	1	1.43	0.10	0.53	1.80	
Hirakani	1	1.43	0.40	0.32	0.74	
Puntia	1	1.43	0.40	1.32	0.49	
Nilabati	1	1.43	0.20	1.32	1.73	
Harimali	1	1.43	0.24	0.66	1.65	
Kalaakhi	1	1.43	0.40	0.79	1.48	
Bhulia	1	1.43	0.20	1.32	1.48	
Panisandha	1	1.43	0.20	0.66	1.98	
Sarasamuli	1	1.43	0.20	0.66	1.24	
Bhundi	1	1.43	0.61	1.98	0.99	
Kalamuna	1	1.43	0.30	0.99	1.98	
Total	70	100.00	30.72	100.00	1.13	

in Tihidi block while lowest in Bonth block. Block Tihidi and Basudevpur were more ecologically handicapped affected by flood, drought and salinity which compelled the farmers to take more number of rice cultivars suitable to various land situations as a measure of coping mechanisms. This might be the reason of highest diversification index. On the other hand endowed with irrigation facility to the extent of percent of the total cultivated area and least affected by natural calamities few varieties were grown i.e. modern varieties with high yield potential in Bonth block which lead to low value of diversifications index.

All the farmers described high yield as their first choice. Second choice as preferred by the farmers were lodging resistance, higher grain weight, good taste for eating, high grain quality and suitability for watery rice (Table 6). Traits under third choice were good grain quality i.e. suitability of grains for making flattened, puffed, pop rice (traditional processed dry rice) or puffed rice and quality of straw. High yield followed by lodging resistance and good taste were identified as main reasons for liking and adopting the modern rice varieties. Not much difference of opinion was observed among different farm sizes for traits linking the popularity of modern varieties. Since the farmers of the district experienced frequent recurring of flood and cyclone during same crop season, high yielding potential, lodging resistant, good testing rice cultivars were preferred.

Based on the findings of the study undertaken, it was concluded that the highest number of varieties were cultivated in Tihidi block with highest diversification index in order to combat adverse agro-climatic situation whereas, lower number of varieties in Bonth block with lowest suitable index due to appropriate climate. After variety Swarna, CR 1018 was the next best popular variety. High yielding varieties like CR 1018, Moti etc. were not adopted quickly because of their low adaptability. From the findings it was observed that 'high yield' was the most desirable trait. It is implicated that suitable rice cultivar to be developed to withstand water logging and flash flood situation through participatory rice breeding on priority basis.

Table 5. Diversification indices of sample blocks of Bhadrak district

Diversification Index	Block Bonth	Block Basudevpur	Block Tihidi
Herifindhal Index	0.438	0.050	0.054
Entropy Index	0.490	1.328	1.300
Modified Entropy Index	0.580	0.975	0.955
Composite Entropy Index	0.555	0.933	0.956

Table 6. Traits linking of modern variety by farm size

	Percentage of response					
Traits	Up to 1 ac	1.0-2.5	2.5-5.0	5.0-7.5	7.5-10.0	10+
First choice						
High yield	100	100	100	100	100	100
Second choice						
Lodging resistance	52.63	49.47	46.15	50.00	12.50	
Higher grain weight	17.54	25.26	15.38	16.67	25.00	66.67
Good taste for eating	21.05	16.84	20.51	11.11	25.00	
High grain quality	7.02	6.32	12.82	16.67		
Good for watery rice	1.75	2.11	5.13	5.56	37.50	33.33
Third choice						
Higher grain weight	1.75	2.11	5.56	12.50		
Good taste for eating	50.88	50.53	46.05	37.50		
Good grain quality	3.51	3.16	13.16	37.50		
Good for watery rice	36.84	37.89	25.00		100.00	
Good for dry rice	7.02	5.26	7.89	12.50		
More & better straw quality		1.05				
Total	100.00	100.00	100.00	100.00	100.00	100.00

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