

Productivity and profitability of rainfed vegetable + rice strip cropping systems under broad bed and furrow planting in bunded uplands of Eastern Ghats, Orissa

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Kandhamal district with elevation ranging from 300-1100m above mean sea level is situated in North Eastern Ghat agroclimatic zone (AESR 12.1) of Orissa. The atmospheric temperature, particularly the night temperature in the zone remains low as compared to other zones of the state. The area receives annual rainfall of 1440 mm in 66 rainy days. The land is invariably undulating and soil is light textured sandy loam. The climatic and edaphic conditions favour cultivation of a number of seasonal and off-season vegetables during rainy season. Regular toposequence from upper hill to valley bottom is noted through mid-hill, foot hill, unbunded upland, bunded upland, medium land and low land. The pulses, oilseeds, tuber crops and vegetables are grown mostly in unbunded uplands and backyard areas of scattered houses of tribal families because of proper drainage condition. The bunded uplands are mostly diverted for growing upland rice. These lands can be used for growing high value vegetable crops by suitably modifying the land to ridges and furrows or broad beds and furrows due to presence of better quality soil as compared to unbunded uplands. Behera *et al.* (2002) grew radish and okra successfully with upland rice keeping vegetables in ridges and rice in furrows, but the ridges were not stable and the height reduced during excess rain. Broad beds are likely to be more stable as compared to ridges. The present experiment was designed to study the performance of high value vegetable crops in broad beds and rice in furrows.

The five crop combinations compared against sole rice were tried in randomized block design with four replications at Research Farm, All India Co-ordinated Research Project for Dryland Agriculture, Orissa University of Agriculture and Technology, Phulbani (20°28' N, 84°14' E and 736 m above mean sea level) during rainy seasons of 2006. Phulbani is located in North Eastern Ghat Zone of Orissa and has a tropical sub-humid climate with pre-monsoon, monsoon and post-monsoon rainfall of 137, 1187 and 116 mm, respectively. The soil of the experimental site was acidic (pH-5.2), sandy loam with bulk density 1.6gcm⁻³, organic carbon 0.24%, electrical conductivity 0.02dSm⁻¹, available N 118 kg ha⁻¹, available P 23 kg ha⁻¹, available K 237 kg ha⁻¹ and available S 24 kg ha⁻¹. The land was modified to broad beds of 1m width and 15cm height and furrow of 75 cm

width. Seeds of cauliflower (Himlata hybrid), cabbage (Harekrishna hybrid), knolkhol (Winner hybrid) were sown in nursery beds on 27 June, 2006. Seedlings of these three cole crops were planted in broad beds on 28 July, 2006. Seeds of radish (cv. Pusa chetki) and okra (Makhmali hybrid) were also sown on the same day. Six rows of three week old rice seedlings (cv. ZHU 11-26) were planted in 75 cm wide furrows in 15 cm apart rows. In each bed two rows of cauliflower, cabbage, knolkhol and okra were planted with plant to plant distance of 30 cm whereas three rows of radish were taken in each bed with plant to plant spacing of 10 cm. Fertilizer doses of 125:40:60, 125:50:75, 125:50:50, 50:50:75, 75:50:50 and 40:20:20 kg N, P₂O₅ and K₂O ha⁻¹ were applied in cauliflower, cabbage, knolkhol, radish, okra and rice, respectively on proportionate area basis. In addition to major nutrients 12.5 kg borax per ha was applied to three cole crops. Sodium molybdate @ 1.5 g per litre of water was sprayed twice (1st spray at two weeks after planting and the 2nd spray at 15 days after the 1st spray) in three cole crops to improve quality of the produce. Plant protection measures against fruit borer in okra, diamond black moth in cole crops and leaf eating insects in radish were taken up. Rice was relatively free from diseases and insect pests.

Flower initiation in cauliflower was noted on 4th September at 69 days after sowing (DAS). The curds were ready for harvest first on 21st September (86 DAS). All curds were harvested in five phases during 21 September (86 DAS) to 12 October (107 DAS). In knolkhol, swelling of stem at the base was noted on 23rd August (57 DAS) and the crop was harvested in three phases during 25 September (90 DAS) to 5 October (100 DAS), 2006. The heads of cabbage was harvested in three phases during 2nd November (128 DAS) to 22 November (148 DAS). Harvested runoff water was applied in cabbage due to absence of rain in October and November, 2006. All other vegetables could be grown by utilizing rainfall only. Radish was harvested in three stages during 4th September (38 DAS) to 23rd September (57 DAS). Okra was harvested during 21st September (55 DAS) to 22nd November (97 DAS). Rice was harvested on 6 October at 70 days after transplanting (DAT). The yields were expressed as rice grain equivalent yield for better interpretation.

Table 1. Performance of vegetable + rice strip cropping systems under broad bed and furrow planting

Treatment	Grain yield of rice (q ha ⁻¹)	Vegetable yield (q ha ⁻¹)	Rice equivalent yield (q ha ⁻¹)	Gross Return (Rs. ha ⁻¹)	Net Return (Rs. ha ⁻¹)
T ₁ - Clf (bed)+ Rc(furrow)	4.5	53.9(curd)	193.8	1,10,472	73,983
T ₂ - Cbg(bed)+ Rc(furrow)	4.6	90.9(head)	132.3	75,411	38,144
T ₃ -Knl (bed) + Rc(furrow)	4.3	57.2(knob)	124.8	71,130	38,236
T ₄ - Rd (bed)+ Rc(furrow)	4.3	108.9 (root +top)	81.1	46,238	15,184
T ₅ - Ok(bed) + Rc(furrow)	5.3	66.3(fruit)	98.4	56,088	26,506
T ₆ - Rice in Flat bed	17.5	-	17.5	9,981	1,973
SE(m)	0.7	-	6.6	3,762	-
CD(0.05)	2.1	-	19.9	11,337	-

N.B.: Clf - Cauliflower, Cbg - Cabbage, Knl - Knolkhol, Rd - Radish, Ok - Okra

Price : Rice - Rs. 570 q⁻¹, Cauliflower - Rs. 2,000 q⁻¹, Cabbage - Rs. 800 q⁻¹, Knolkhol - Rs. 1,200 q⁻¹, Radish - Rs. 400 q⁻¹, Okra - Rs. 800 q⁻¹

Harvested run-off was stored in on-farm water harvesting pond constructed at the lower reach of the plots utilizing 10% of the land and lined with soil:cement mortar 6:1 of 6 cm thickness. The water was lifted by Krushak Bandhu Treadle Pump and applied in furrows between cabbage rows.

Growth parameters and yield attributes of vegetable crops Cauliflower

Fresh bio-mass per plant in cauliflower varied from 250-540 g with mean of 396 g. Leaf number varied from 12-20 with mean of 16.4 per plant. Leaves had on an average length of 33 cm and breadth of 15.6 cm. Curd weight ranged from 150-270 g with mean of 196 g.

Cabbage

Mean biomass per plant in cabbage was 798 g. Head weight varied from 350-600 g with mean of 450 g. Mean head girth was 36.7 cm. Number of fully opened leaves varied from 8-12 with mean of 10.4 per plant.

Knolkhol

Plant biomass varied from 330-550 g with mean of 436 g per plant. Knolkhol weight varied from 200-350 g with mean of 280 g and girth varied from 24-27.5 cm with mean of 25.2 cm. There were 10-14 leaves per plant with mean of 12.4. Leaf length varied from 29-37 cm (mean 34 cm) and breadth varied from 16-18 cm (mean 16.4 cm).

Okra

Okra plants on an average were 178.5 cm tall and each plant had on an average 20.5 fruits.

Radish

Radish had twelve leaves per plant having weight of 71.8 g and mean length of 32.8 cm. Swollen root had length of 15.1 cm, girth of 12.1 cm and weight of 82.5 g per plant.

Crop yield and economics

Sole rice in flat bed recorded grain yield of 17.5 q ha⁻¹. Rice yield declined in various rice + vegetable cropping systems due to decrease in area for rice as compared to sole rice. Various vegetable + rice strip cropping systems gave statistically similar grain yield of rice. Among vegetable crops radish gave the highest economic yield (root + top) while cauliflower gave the minimum economic yield (curd). Cauliflower + rice system gave the maximum rice equivalent yield of 193.8 q ha⁻¹ and gross return of Rs. 1,10,472/- which is almost 11 times of that in sole rice raised on flat bed. Other vegetable + rice systems viz. cabbage + rice, knolkhol + rice, okra + rice and radish + rice gave rice equivalent yield of 132.3, 124.8, 98.4 and 81.1 q ha⁻¹ and gross return of Rs. 75,411, Rs. 71,130, Rs. 56,088 and Rs. 46,238 per ha, respectively. Ratha and Swain (2006) got similar high rice equivalent yield and gross return by raising high value vegetable crops and spices in mango orchards as compared to sole rice. Cauliflower + rice strip cropping proved the most remunerative with net return of Rs 73,983 per ha as against Rs 1,973 per ha from sole rice.

Among the systems, cauliflower + rice strip cropping in broad bed and furrow planting provides scope for getting higher yield and net return in banded uplands of Eastern Ghats of Orissa. This will ensure cash security to the cash starved tribal farmers of the zone in lean *kharif* season.

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