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Tuber Crops for Improving Livelihood Security in the Disadvantaged Districts of Odisha

Antaryami Lenka, S.K. Jata and M. Nedunchezhiyan

Regional Centre of Central Tuber Crops Research Institute, Dumuduma, Bhubaneswar, Odisha 751 019, India
Corresponding author: M. Nedunchezhiyan, e-mail: mnedun@gmail.com
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Abstract

Root and tuber crops are important food crops that are climate resilient. Crop interventions involving tuber crops aimed at improving the livelihood security were demonstrated in the disadvantaged districts (Kandhamal, Kalahandi and Dhenkanal) of Odisha. Greater yam (var. Orissa Elite) produced average tuber yield of 24.3 t ha^{-1} with a net income of ₹ 5698 per household (200 m^2 demonstration). Elephant foot yam (var. Gajendra) yielded 35.0 t ha^{-1} with a net income of ₹ 4600 per household (100 m^2 demonstration). Orange-fleshed sweet potato variety ST-14 that contained 14 mg of β-carotene per 100 g fresh weight of tubers performed well in both the years in all the three districts. The average productivity of ST-14 was 10.5 t ha^{-1}, which was lesser than white-fleshed sweet potato variety Kishan. Cassava performed well in all the demonstrations during both the years. But lack of awareness about the food value and utilization of cassava tubers were observed to be the major hindrance in its popularization. Greater yam + maize intercropping produced 24.0 tonnes of tubers + 22500 cobs ha^{-1}. The average net income of this system was ₹ 4691 per household. Maize in this system not only provided additional yield but also acted as a live stake. Proximate composition of greater yam, elephant foot yam and sweet potato tubers were analyzed in terms of protein, fat, minerals, fibre and carbohydrates and are discussed in this paper. Improved varieties and production techniques offered good scope in improving the livelihood and nutritional security of rainfed farmers in the disadvantaged districts of Odisha.

Key words: Taro, elephant foot yam, greater yam, sweet potato, food security, nutrition

Introduction

Root and tuber crops are important food crops and cheap sources of energy. These crops serve as food, feed and raw material to the industries. Cassava (*Manihot esculenta*) and sweet potato (*Ipomoea batatas*) are secondary staples. Elephant foot yam (*Amorphophallus paeoniifolius*), greater yam (*Dioscorea alata*) and taro (*Colocasia esculenta*) are used as vegetables (Mohanty et al., 2010; Sahoo et al., 2012; Nedunchezhiyan and Sankaran, 2013). These crops can be grown under a wide range of conditions from small homesteads to large scale cultivation in the open fields. Further, they possess greater climate resilience. Cassava and greater yam are resistant to drought and high temperature (Nedunchezhiyan et al., 2012) and taro has flood tolerance. Sweet potato can tolerate flash floods and mid season drought. Root and tuber crops are also rich in minerals and vitamins. Elephant foot yam and taro are rich in P and Ca (Lenka and Nedunchezhiyan, 2013). Sweet potato is rich in β-carotene (Nedunchezhiyan et al., 2013).

Odisha, a high rainfall (1200 mm average annual rainfall) state in the eastern region of India consists of coastal plain, hilly and plateau areas. Indian Council of Agricultural Research has classified majority of the hilly and plateau districts of Odisha as disadvantaged. Majority of the tribal population of Odisha lives in hilly and plateau forest ecosystem and appear backward in many respects. Most of these tribals have small or marginal land holdings.

Food grains are hardly cultivated for 7 to 8 months. The rest of the period is totally dependent on the forest, from where they collect wild roots and tubers to meet their food demands (Vidyarathi, 1987). Majority of the soils fall under the order alfisols with a pH of 5 to 6. These soils are highly suitable for the cultivation of root and tuber crops. The hilly tribal farmers also have special affinity towards root and tuber crops (Jata et al., 2012). Three disadvantaged districts (Kandhamal, Kalahandi and Dhenkanal) of Odisha were selected to introduce tuber crops to study their effect on livelihood improvement of the rainfed farmers under the National Agricultural Innovation Programme.

Materials and Methods

Under National Agricultural Innovation Programme, the Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar selected Kandhamal, Kalahandi and Dhenkanal districts of Odisha to study the impact of tuber crops interventions on livelihood improvement of the rainfed farmers. The study was carried out for two years. During the years 2010 and 2011, the following interventions were introduced: 1. Gajendra variety of elephant foot yam, 2. Orissa Elite variety of greater yam, 3. Kishan variety of sweet potato, 4. ST-14 variety of orange-fleshed sweet potato, 5. Sree Jaya, Sree Vijaya and Vellayani Hraswa varieties of cassava, 6. RM-1 variety of yam bean (*Pachyrrhizus erosus*), 7. Muktakeshi variety of taro and 8. Sweet potato + red gram intercropping system. During the year 2010, the interventions, greater yam + maize intercropping system and liming in sweet potato (@ 500 kg ha^{-1}) were also introduced. During the year 2011, 304 households spread over an area of 6.165 ha in all the three disadvantaged districts were the target group. During the year 2011, 394 households were covered under 8.695 ha of tuber crops. Quality planting material were supplied to the farmers as a critical input. The farmers' input were in terms of manures, fertilizers and labours. At harvest, yield was recorded. Proximate analysis of tubers of sweet potato, elephant foot yam and greater yam were conducted using standard analytical methods (AOAC, 1990).

Results and Discussion

In the three disadvantaged districts (Kandhamal, Kalahandi and Dhenkanal) of Odisha, short duration and high yielding varieties of tuber crops performed well. The varieties were widely accepted. This may be due to the easiness in adoption and management. Greater yam (var. Orissa Elite) produced average tuber yield of 24.3 t ha^{-1} with a net income of ₹ 5698 per household (200 m^2 demonstration) (Table 1). Among the technologies demonstrated, Orissa Elite variety of greater yam resulted in higher net income per household on unit area basis. Elephant foot yam (var. Gajendra) yielded 35.0 t ha^{-1} with a net income of ₹ 4600 per household (100 m^2 demonstration). This was the second best technology in terms of net income generation. Orissa Elite variety of greater yam and Gajendra variety of elephant foot yam played greater role in income generation of poor farmers in their marginal land holdings.The above two technologies ensured the farmers sustainable yield and assured market. Long storability of tubers of greater yam and elephant foot yam also ensured higher and stable price and staggered marketing. 'Kishan' variety of sweet potato, which was demonstrated during 2010 and 2011 produced 11.3 t ha^{-1} with a net income of ₹ 1516 per household (400 m^2 demonstration).

Orange-fleshed sweet potato variety ST-14 had 14 mg of β-carotene per 100 g fresh weight of tubers (Nedunchezhiyan et al., 2010). The variety ST-14 performed well in both the years in all the three districts. The average productivity of ST-14 was 10.5 t ha^{-1}, which was lesser than white-fleshed sweet potato variety Kishan. However, white-fleshed variety Kishan contained less than 2 mg of β-carotene per 100 g fresh weight of tubers (Nedunchezhiyan et al., 2003). Farmers consumed major portion of the harvested orange-fleshed sweet potato tubers and sold little in the market at higher price than white-fleshed sweet potato. Yam bean (RM-1 variety), consumed as salad after peeling the skin, resulted in a net income of ₹ 1946 per household (300 m^2 demonstration) with the average productivity of 19.4 t ha^{-1}. In spite of being profitable, farmers were quite reluctant to cultivate yam bean anticipating problems with marketing a new crop. Cultivation of Muktakeshi variety of taro resulted in a net income of ₹ 2981 per household (200 m^2 demonstration) with the average productivity of 22.1 t ha^{-1}. However, apprehensions were registered regarding the performance of the variety Muktakeshi in the upland rainfed ecosystem. Hence, only eight and five households (200 m^2 demonstration) could be covered during 2010 and 2011, respectively. Cassava performed well in all the demonstrations during both

Table 1. Productivity, profitability and net returns of the tuber crops interventions

Interventions	Area (ha)		Number of households (HH)		Yield (t ha^{-1})		Net income (₹ per HH)		
	2010	2011	2010	2011	2010	2011	2010	2011	Mean
Greater yam (var. Orissa elite)	1.22	1.84	61	92	30.50	43.40	4475	6921	5698
Elephant foot yam (var. Gajendra)	0.46	1.02	46	102	17.00	33.70	4600	4600	4600
Sweet potato (var. Kishan)	1.08	2.60	27	65	13.20	27.00	1640	1392	1516
Orange-fleshed sweet potato (var. ST-14)	0.40	0.44	20	11	4.30	4.50	1350	1400	1375
Short duration variety of cassava (var. Vellayani Hraswa)	0.21	0.20	41	39	4.50	3.20	210	230	220
High yielding variety of yam bean (var. RM-1)	1.80	2.10	59	70	36.70	38.40	2110	1781	1946
Leaf blight resistant variety of taro (var. Muktakeshi)	0.16	0.10	8	5	3.70	2.10	2990	2972	2981
Greater yam + maize intercroping	0.20	-	10	-	4.8 t+ 4500 cobs	-	4691	-	4691
Sweet potato + redgram intercroping	0.30	0.40	15	10	2.52 t+ 330 kg seeds	3.64 t + 344 kg seeds	1075	1948	1511
Liming in sweet potato	0.34	-	17	-	4.30	-	850	-	850

the years. But lack of awareness about the food value and utilization of cassava tubers was observed to be the major hindrance in its popularization.

Intercropping offers insurance against crop failure and also helps in soil fertility buildup. Greater yam + maize intercropping produced 24.0 tonnes of tubers + 22500 cobs ha^{-1}. The average net income of this system was ₹ 4691. Maize in this system not only provided additional yield but also acted as a live stake. The organic C content of the soil was enriched by the addition of dried maize haulms. Sweet potato (Kishan) + red gram (UPAS-120) intercropping produced 8.75 tonnes of tubers + 980 kg seed yield ha^{-1} with a net income of ₹ 1511 per household (400 m^2 demonstration). Red gram fixes atmospheric N in the soil, which will be utilized by the subsequent crops. Demonstration of lime application in sweet potato resulted in 12.6 t ha^{-1} of tubers with a net income of ₹ 850 (400 m^2 demonstration). Due to additional cost of liming, the net income was lesser.

Proximate composition of greater yam (var. Orissa Elite) tubers revealed that while the crop from Kandhamal was rich in protein, fat and minerals, that from Dhenkanal proved superior in fibre and carbohydrate contents (Table 2). This may be due to the climatic and location specific edaphic effects on tuber quality. In elephant foot yam (var. Gajendra) tubers, higher proteins and minerals were observed in crops cultivated at Kandhamal, whereas fat and fibre were rich in the crops grown at Dhenkanal (Table 3). Not much variation was observed in carbohydrate content among the

Table 2. Proximate composition of greater yam tubers (var. Orissa Elite) (g 100 g^{-1} on DW basis) in three districts

District	Protein			Fat			Minerals			Fibre			Carbohydrates		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Kandhamal	4.9	4.7	4.8	0.3	0.2	0.3	5.6	5.3	5.5	3.4	3.3	3.4	85.8	86.5	86.2
Kalahandi	4.6	4.5	4.6	0.2	0.2	0.2	5.4	5.1	5.3	3.9	4.1	4.0	86.9	87.2	87.1
Dhenkanal	4.5	4.3	4.4	0.2	0.2	0.2	5.3	5.0	5.2	3.9	4.2	4.1	87.0	87.3	87.2

Table 3. Proximate composition of elephant foot yam corms (var. Gajendra) (g 100 g^{-1} on DW basis) in three districts

District	Protein			Fat			Minerals			Fibre			Carbohydrates		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Kandhamal	5.5	5.6	5.6	0.4	0.5	0.5	3.9	3.8	3.9	3.8	3.8	3.8	86.4	86.3	86.4
Kalahandi	5.3	5.5	5.4	0.4	0.6	0.5	3.6	3.6	3.6	3.8	4.0	3.9	86.4	86.6	86.5
Dhenkanal	5.1	5.5	5.3	0.6	0.5	0.6	3.4	3.3	3.4	4.0	4.1	4.1	86.3	86.5	86.4

Table 4. Proximate composition of sweet potato tubers (var. Kishan) (g 100 g^{-1} on DW basis) in three districts

District	Protein			Fat			Minerals			Fibre			Carbohydrates		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Kandhamal	3.9	3.8	3.9	0.6	0.7	0.7	3.8	3.9	3.9	2.8	2.6	2.7	88.9	88.8	88.9
Kalahandi	5.6	5.4	5.5	0.6	0.5	0.6	3.7	3.9	3.8	2.7	2.9	2.8	88.9	88.4	88.7
Dhenkanal	5.3	5.6	5.5	0.6	0.3	0.5	3.8	3.6	3.7	2.8	2.9	2.9	88.7	88.5	88.6

districts. Sweet potato tubers (var. Kishan) from Kalahandi contained high protein (Table 4). Fats, minerals and carbohydrates were higher in sweet potato cultivated at Kandhamal (var. Kishan). At Dhenkanal, sweet potatoes (var. Kishan) were rich in fibre. Similar variations in tuber quality has been reported by Lenka and Nedunchezhiyan (2013).

Conclusion

Root and tuber crops can be successfully grown by small and marginal resource poor tribal farmers. Root and tubers can be stored for 3-4 months safely and consumed at times when other foods are scarce. The nutritive value of tuber crops also make them invaluable, especially in resource constrained regions. Thus, improved varieties and production techniques of root and tuber crops offer good scope in improving the livelihood and nutritional security of rainfed farmers of Kandhamal, Kalahandi and Dhenkanal, the disadvantaged districts of Odisha.

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