Growing orange-fleshed sweet potatoes to combat Vitamin A deficiency in Eastern India: experience of the International Potato Center (CIP)

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Abstract

Vitamin A deficiency is a serious problem among children in the eastern Indian region. The deficiency could be prevented in children by a regular daily intake of about 100g of orange-fleshed sweet potato (OFSP). OFSP is a ready and cheap source of high counts of beta-carotene, which is largely responsible for the orange colour of the flesh. OFSP is gaining importance as a dietary food product in eastern India, especially in the states of Orissa and eastern Uttar Pradesh (UP); and this popularity is promoted with the active participation of different international and national organisations. The International Potato Center (CIP), through its Regional Office for South, West, and Central Asia (SWCA), is playing a pivotal role in promoting OFSP in eastern India, especially in the state of Orissa. Organisations such as UNDP-Orissa, Western Orissa Rural Livelihood Project (WORLP), Indo Swiss Natural Resource Management Programme (ISNRMP) Orissa, the Central Tuber Crops Research Regional Station in Bubaneshwar, and the Participatory Rural Developmental Foundation (PRDF) in Gorakhpur, eastern Uttar Pradesh have partnered CIP to promote OFSP for food and nutritional security in their respective operating areas. CIP and its partners are evaluating over twenty germplasms in farmers' fields in different districts. The OFSP germplasms that help in food and nutritional security and which are successful in yield and dry matter in Orissa and eastern UP are IB-97-2/5, IB-97-6/15, CIP-SWA-2, and CIP-SWA-1, all of which are red skinned. White and yellow fleshed germplasms, which mainly serve food security and are successful in high yield and dry matter in drought prone areas of western Orissa are CIP-SWA-7, IB-91-26, and IB-97-12/24. The promotion of OFSP is being taken up on a large scale by different organisations in partnership with CIP to reduce vitamin A deficiency amongst the rural population, mostly the children, of eastern India.

Introduction

Dietary vitamin A deficiency is the world's most common cause of childhood blindness. The World Health Organization (WHO) estimated that as many as 228 million children are affected sub-clinically at a severe to moderate level by vitamin A deficiency (VAD), placing their health at risk. About three million of these children have some form of eye disease related to VAD, ranging from night blindness to irreversible partial or total blindness. Every year, at least 500,000 children become partially or totally blind as a result of VAD. Nearly half of the world's micronutrient deficient people can be found in India; vitamin A deficiency (VAD) is thought to cause an estimated 30,000 to 40,000 children to go blind each year in the country. VAD rates vary greatly among the states from 2.2% in Andhra Pradesh to 9.0% in Bihar; the overall prevalence of VAD is a significant public health problem.

In India, sweet potato is generally used as a food product and as a food base. In the states of Orissa, Uttar Pradesh (UP), and Bihar, sweet potato is used for consumption and for

commercial use. The three states also have an acute VAD problem. The use of orange fleshed sweet potato (OFSP) in the three states could provide a solution to vitamin A deficiency since the vegetable is a ready and cheap source of beta-carotene, which is largely responsible for the orange colour of the flesh (Simonne et al. 1993; Takahata et al. 1993). White and yellow fleshed sweet potatoes contain only very low or minute quantitities of beta-carotene. OFSPs contain 6-8 mg of beta-carotene per 100g, which is sufficient for the recommended vitamin A requirement. Thus regular intake of 100g per day of orange-fleshed sweet potato roots would provide the recommended daily amount of vitamin A for children and should be sufficient to protect them from blindness. OFSPs could be taken on a sustainable basis in those states where sweet potato is generally consumed for food and health. OFSPs could be used in Orissa, eastern UP, and Bihar to combat VAD. At present, promotion of OFSPs is done in a big way in these states. International, government, and non-government organisations are interested in introducing larger quantities of OFSPs in the VAD areas. Seed multiplication and distribution of OFSP to poor communities is the prime task for all these organisations. Out of the many readily available food sources, sweet potato is an important food crop that could meet the needs of farmers for both food and nutritional security in Orissa, UP, and Bihar.

Sweet potato is grown on an area of 6.91 million hectares in Asia, with a total production of 119 million metric tons (t) and productivity of 17.26 t/ha. Asia as a whole accounts for 78% of the world's sweet potatoes in terms of area cultivated and 92% of the world production, but nearly 85% of this is contributed by China which is the largest producer and consumer of sweet potatoes in the world with 68% of the area cultivated and 86% of the production. In contrast Africa, thought by many to be the home of sweet potato, has less than 18% of the area and 5.5% of the world production. (FAO 1998)

The total sweet potato production in South Asia is about 1.6 million tonnes on 0.2 million hectares. India accounts for 68% of the total production followed by 27% in Bangladesh and about 5% in Sri Lanka. In India, sweet potato is cultivated mainly in the states of Orissa, Bihar, and Uttar Pradesh. It is the most important root crop in Bihar and Orissa, covering 17,900 and 47,900 ha of land with a production of 170,700t and 364,900t, respectively. It is also an important root crop in Uttar Pradesh, covering 30,600 ha of land with a production of 285,900t (Table 1). Sweet potato is usually raised as a rainfed crop from June-September ('kharif' crop); supplementary irrigation is provided from October-January for winter planting ('rabi' crop)

CIP activities with partner organisations

The International Potato Center (CIP) commenced collaborative work and popularisation of OFSPs in India from 2001 with organisations like the Central Tuber Crops' Research Regional Station in Bhubaneswar, UNDP Orissa, Western Orissa Rural Livelihood Project (WORLP), Indo Swiss Natural Resource Management Programme (ISNRMP) Orissa, and the Participatory Rural Developmental Foundation (PRDF) in Gorakhpur eastern Uttar Pradesh. The collaborating organisations have partnered CIP to promote orange fleshed sweet potatoes for food and nutritional security in their respective operating areas in eastern India. Over the past two years, approximately twenty germplasms have been evaluated in different parts of the country. Sweet potato germplasms were evaluated in participatory farmers' field trials. Most of the germplasms preferred by the farmers were those of orange-fleshed sweet potatoes.

Table 1: **Area, production and productivity* of sweet potato in leading states in India**

State	Area ('000 ha)	Production ('000t)	Productivity (t haÎ¹)
Orissa	43.9	361.2	8.2
Bihar	9.9	135.2	13.7
Uttar Pradesh	25.6	302.1	11.8
Assam	8.9	31.0	3.5
Karnataka	3.1	23.3	7.5
Kerala	1.1	11.9	10.8
Tamil Nadu	1.9	32.2	16.9
India total	114	1007	8.8

* Source: Indian Horticultural Database (2001)

Materials and Methods

Sweet potato germplasm was introduced in batches to all areas selected after initial evaluation at the CIP research farm. The places chosen for participatory field evaluation were in Ganjam and Gajapathi districts (monitored by ISNRMP), Nuapada and Kalahandi districts (UNDP), Bolangir and Nuapada districts (WORLP), and certain districts of eastern Uttar Pradesh (PRDF). Details of the number of germplasms monitored by each organisation are given in the sections below. The trials consisted of three replications of 30 plants each.

Evaluation trials

Multi-locational trials were carried out in all areas over two seasons on farmers' fields. In all, from 10 to 14 germplasms were evaluated under the supervision of different organisations in different places. The highest marketable root yields from the trials were recorded in all areas. Five to six germplasms were short-listed on the basis of marketable root yield and taste as identified in the results of the multi-locational trials.

Results and Discussion

Indo Swiss Natural Resource Management Programme (ISNRMP), Orissa

Collaborative work to promote sweet potatoes, especially orange-fleshed sweet potatoes, started in 2002 in the Ganjam and Gajapati districts of Orissa. Large numbers of children in the tribal areas of both districts suffer from malnutrition. CIP and ISNRMP together identified the places where orange-fleshed sweet potatoes were to be promoted. After initial evaluation at the CIP research farm, the farmers were given high-yielding germplasms to be tried and tested in their fields with the support of local NGOs. Out of ten germplasms (Table 2), three orange-fleshed germplasms with high contents of dry matter were particularly successful: IB-97-6/15, CIP-SWA–1, and CIP-SWA-2; as were two yellow/white varieties: IB-91-26 and CIP-SWA-7. Orange-fleshed sweet potatoes were distributed and sold at market after the harvest. Farmers were convinced of the germplasms being able to meet their needs from the perspectives of food and nutritional security.

UNDP Orissa, Western Orissa Rural Livelihood Project (WORLP)

Both UNDP and WORLP were working in the western part of Orissa, which is drought prone; the farmers' field trials were held in three districts, namely, Bolangir, Nuapada, and Kalahandi. Farmers' enthusiasm to plant the newly-introduced, orange-fleshed sweet

Table 2: **Germplasms evaluated in the Ganjam and Gajapathi districts by ISNRMP with marketable yield and taste**

Name	Flesh colour	Marketable yield t haÎ¹	Taste
CIP-SWA-1	Orange	23.6	Very Good
CIP-SWA-2	Orange	21.2	Excellent
CIP-SWA-3	White	18.2	Good
CIP-SWA-4	Yellow	16.6	Good
CIP-SWA-7	Yellow	24.2	Very Good
IB-97-13/11	Yellow	17.6	Good
IB-97-6/15	Orange	22.8	Very Good
IB-97-2/5	Orange	19.8	Good
IB-91-26	White	23.1	Very Good
IB-96-7/25/16/26	yellow	15.2	Good
Mean		20.23	
CV (coefficient of var iation)		15.85	

potatoes in their fields has been increasing since 2003. Of the twelve germplasms tested (Table 3), four orange-fleshed varieties demonstrated better marketable root yields, taste, and a high-level of acceptability among farmers: CIP-SWA-1, CIP-SWA-2, IB-97-6/15, and IB-97-2/5; as did three white-fleshed varieties: CIP-SWA-7, IB-91-26, and IB-97-12/24. The promotion of orange-fleshed sweet potatoes is being taken up on a large scale by the two organisations in collaboration with CIP. Vitamin A deficiency is prevalent in Western Orissa and farmers came forward to receive high carotene vines to plant in their fields. Some women farmers took the vine cuttings to plant in their backyards to be used to feed their children.

Participatory Rural Development Foundation (PRDF)

Sweet potato is widely cultivated in the eastern part of Uttar Pradesh, and through PRDF's collaboration with CIP the opportunity was given to the farmers in this region to introduce orange-fleshed sweet-potato germplasms for trials on farmers' fields. Fourteen germplasms were introduced (Table 4), of which six (four orange-fleshed, two yellow-fleshed) have thrived well as indicated by marketable root yield and taste: CIP 440074, IB-97-12/7, CIP-SWA-2, CIP-SWA-1, IB-90-12-29 and IB-97-7/2. Uttar Pradesh is one of the states in India where acute vitamin A deficiency prevails.

Conclusions

The partner organisations of CIP spearheaded the promotion of orange-fleshed sweet potatoes in Orissa and in eastern UP especially to help children suffering from malnutrition and vitamin A deficiency. The germplasms of orange-fleshed sweet potato were found to be the best in terms of both food and nutritional security. The multi-locational trials followed after selection, and some farmers expressed an interest in growing the plants commercially on a large scale.

Table 3: **Germplasms evaluated in the Bolangir, Nuapada and Kalahandi districts by UNDP and WORLP, with marketable yield and taste**

Name	Flesh colour	Marketable yield t haî ¹	Taste
CIP-SWA-1	Orange	21.2	Very Good
CIP-SWA-2	Orange	23.6	Excellent
CIP-SWA-3	White	14.7	Average
CIPS-WA-4	Yellow	12.5	Average
CIPS-WA-7	Yellow	23.1	Very Good
IB-97-13/11	Yellow	15.2	Good
IB-97-6/15	Orange	24.3	Very Good
IB-97-2/5	Orange	20.7	Good
IB-91-26	White	24.1	Very good
IB-96-7/25/16/26	Yellow	13.7	Good
IB-97-12/24	White	20.8	Good
IB-97-12/7	Orange	18.8	Good
Mean		19.39	
CV (co-efficient of variation)		22.23	

Table 4: **Germplasms evaluated in Gorakhpur and adjoining districts of Eastern UP by PRDF, with marketable yield and taste**

Name	Flesh colour	Marketable yield t haî ¹	Taste
CIP-SWA-2	Orange	24.2	Very Good
CIP-440074	Orange	20.1	Very Good
IB-97-12/7	Orange	16.4	Very Good
IB-97-12/24	White	19.6	Average
IB-91-26	White	22.4	Good
IB-90-10-20	Orange	18.0	Very Good
IB-97-7/2	Yellow	17.5	Very Good
IB-97-6/7	Yellow	12.2	Good
CIP-SWA-1	Orange	22.9	Excellent
IB-97-2/5	Orange	14.9	Good
IB-97-6/15	Orange	14.3	Very Good
IB-90-12-29	Yellow	20.8	Very Good
IB-90-5/5	Orange	11.1	Average
IB-97-5/7	White	16.3	Good
Mean		17.90	
CV (coefficient of variation)		22.27	

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