

Biofortification for Reducing Hidden Hunger: A Value Chain Analysis of Sweet Potato in Odisha, India

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Abstract

Nearly two billion people in the world suffer from micronutrient deficiencies, a condition commonly known as hidden hunger. Growing and eating biofortified crops can be an effective strategy for reducing hidden hunger. Orange-fleshed sweet potato or OFSP, released in 2007, was the one of the earliest successfully released biofortified crop. It has helped reduce vitamin A deficiency in countries of Africa. Odisha is the largest producer of sweet potato in India. We studied the value chain of sweet potato in Odisha—including production, marketing and wholesale and retail trade—to assess if production and consumption of OFSP can be encouraged in the state to reduce vitamin-A deficiency among affected populations. We surveyed 310 farmers and consumers, 25 aggregators, 12 wholesalers and 25 aggregators from 4 districts of Odisha and conducted semi-structured interviews with breeders and government extension officials. Unlike Africa, sweet potato is not a staple in Odisha even among households that grow it. It is consumed in small quantities, mainly on auspicious occasions. Farmers and consumers in Odisha are not aware of nutritional properties of OFSP. It is not in greater demand than the regular sweet potato and it does not fetch a higher price in the market. Therefore, only 11% farmers grow it. Generating demand for OFSP through an awareness campaign is essential for it to be effective against vitamin-A deficiency. .

Key words: Sweet potato, Orange-fleshed Sweet Potato, OFSP, Value chain, Odisha, Nutrition, Biofortification

JEL Classification: Q02, Q11, Q12, Q18

Introduction

Experts estimate that around two billion people in the world, mostly the poor, are afflicted by deficiency of micronutrients. Biofortification of food crops has emerged as a promising strategy for reduction of micronutrient deficiency. Biofortification uses conventional breeding techniques to breed new varieties of food crops with improved nutritional content. Providing malnourished communities

biofortified crops to grow and eat has been shown to be a highly effective strategy for addressing malnutrition (Bouis and Islam, 2012).

Biofortified varieties of many crops like beans, cassava, maize, pearl millet, rice, sweet potato and wheat have been released in different parts of Africa and Asia to address deficiencies of micronutrients like zinc, iron and vitamin A. However, sweet potato (*Ipomoea batatas*) is the first crop whose biofortified varieties were successfully released. In 2007, varieties of orange-fleshed sweet potato (OFSP), with very high

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levels of vitamin A, were released in Africa. Studies show that production and consumption of OFSP has helped increase vitamin A intake and improve vitamin A status among young children in countries like Uganda and Mozambique (Hotz *et al.*, 2011).

India has the one of the highest prevalence of vitamin A deficiency (VAD) in the world. 62% of preschool children in the country are reported to be deficient in vitamin A and supplementation programs to combat VAD have had only limited success over the last 3 decades (Akhtar *et al.*, 2013). Sweet potato is a rich source of carbohydrates and carotene (CIP, 2000 and FAO, 2002) and the seventh most important food crop of the world after wheat, rice, maize, potato, barely and cassava. In India, it is cultivated in 0.11 million ha land, mainly in Odisha, followed by Uttar Pradesh and West Bengal (DES, 2015). For the last few years, the state government, Indian Council of Agricultural Research (ICAR) and international organizations like the International Potato Centre (CIP) are trying to promote production of OFSP in Odisha to reduce widespread vitamin A deficiency in the state.

Success of biofortification, however, depends on high rates of adoption of biofortified varieties by both farmers and consumers. A value chain approach, where we look at all actors and links in the food supply chain—producers, intermediaries and consumers—to determine how incentives for adding nutritional value can be created for each actor, can be useful for assessing the potential of a biofortified crop in a new region. Value-chain concepts provide a framework within which opportunities for leveraging agriculture for nutrition can be identified, assessed and implemented (Hawkes and Ruel, 2012).

We studied value chain of sweet potato in four districts of Odisha to assess if and how OFSP can be popularized in the state to increase vitamin A intake among vulnerable populations. Our work complements earlier studies by Campilan *et al.* (2009), Attaluri *et al.* (2010) and Singh *et al.* (2014) on different aspects of sustainable production and consumption of sweet potato in Odisha by focusing mainly on roles and activities of different value chain actors and the linkages among them. To the best of our knowledge, this is the first study of a sweet potato value chain in India and among few such studies globally (Sorwar *et al.*, 2015; Mmasa and Musuya, 2012; Chang and Kewa, 2014).

Data and Methodology

Primary survey for this study was conducted in four districts of Odisha viz. Ganjam, Koraput, Kalahandi and Kandhamal. In each district, we selected two blocks with the highest area under sweet potato. We randomly selected five villages; each from the sampled blocks in Ganjam and Koraput and three villages each from the sampled blocks of Kalahandi and Kandhamal. Ganjam and Koraput are major centres of sweet potato cultivation in Odisha. We included Kalahandi and Kandhamal in our study because these are among the two poorest districts of Odisha with a high burden of hidden hunger and these also host sites for implementation of the project that supported our study. In each village, we carried out a complete houselisting and then randomly selected 15 farming households for a detailed survey on production and consumption of sweet potato. Very few farmers in Kalahandi and Kandhamal grew sweet potato. Therefore, much of the data on sweet potato farming comes from Ganjam and Koraput districts only. We collected data on consumption habits of sweet potato from all 4 districts.

Our final sample consists of 452 households from 32 villages in 4 districts of Odisha. Of these, 310 households also grew sweet potato, while 142 were only consumers of sweet potato, but did not produce it.

Apart from households, we also surveyed 25 *aadhatias* or aggregators, 12 wholesalers and 25 retailers or green grocers (Table 1). Aggregators buy sweet potato from farmers and sell it in bulk to wholesalers in the neighboring town. Wholesalers may export sweet potato to other districts or states or sell it to the retailers and other bulk buyers in the neighboring areas. Most households buy sweet potato for home consumption from the local green grocers. All intermediaries (*aadhatias*, wholesalers and retailers) were surveyed in Ganjam and Koraput only. In Odisha, sweet potato is cooked mainly in homes and temples. We could not find any commercial processors of sweet potato in the state. Therefore, processors are not a part of our study.

Among the outcomes, primarily we wanted to assess the value distribution in the sweet potato value chain. Thus, the main indicator that we incorporate in

Table 1. Sampling plan

Criteria	Location				Total number of samples
	Ganjam	Koraput	Kalahandi	Kandhamal	
Producers and consumers	147	140	18	5	310
Aggregators	15	10	-	-	25
Wholesalers	7	5	-	-	12
Retailers	10	15	-	-	25
Only consumers	03	11	57	71	142

Source: Authors

this analysis is the level of prices offered to different agents in the value chain. Information was, thus, collected at each level of the value chain on these prices. To better understand price formation at different levels in the sweet potato value chain, additional variables were also collected that could explain the price formation of sweet potato along the chain. Such variables included input use, quantities sold, time of sales, type of buyers and payment modalities.

Results and Discussion

Table 2 presents the descriptive statistics of the farmers growing sweet potato. Average age of sweet potato growers was 46 years with average household size of 6.05. Heads of the family in 29 percent of the sweet potato farming households were illiterate, similar to the state average of 27 percent (Census, 2011). Farming was the primary occupation of 90% of the households in our sample while adult members in 52.90 percent of the families also engaged in wage labour as secondary occupation.

Table 2 shows household characteristics and consumption behaviour of sweet potato growers. The average landholding size of farmers in our sample was 1.23 hectare and the average area under sweet potato cultivation was 0.30 hectare. Unlike Africa, sweet potato is not a staple in Odisha; it is a cash crop there. Farmers keep less than 5% of their produce for home consumption and sell almost all of their produce soon after harvest to avoid any post-harvest loss. Farmers reported that less than 2 percent of their sweet potato output was wasted before, during, or after storage.

Table 3 and 4 present data on crop economics and selling patterns of sweet potato. Average area under sweet potato was 0.30 ha in our sample and the average

Table 2. Household characteristics of sweet potato farmers

	Values
Number of observations	310
Age head of household in years	46.34
Household size (number)	6.05
Illiterate heads of household (in %)	29.03
Primary occupation (in %)	
Farming	95.48
Wage labour	1.94
Others*	2.58
Secondary occupation (in %)	
Farming	23.23
Wage labour	52.90
Others*	23.66
Ration card holders (% yes)	26.77
Total area of land owned (in ha)	1.23
Area under sweet potato cultivation (in ha)	0.30
Own consumption (in %)	3.24
Post-harvest losses (in %)	1.92
Quantity sold (in %)	94.82
Total sweet potato sales in 2015-Kharif season (quintals)	32.00

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Note: *Self-employment, traders and salary workers

yield was 7.9 tons per hectare. In 2015, farmers received, on average, ₹ 996.80/quintal of sweet potato, but there is a lot of variation in prices realized. We analysed price realization in detail in subsequent paragraphs.

Human labour and chemical fertilizers (mainly urea) & manure account for 59 per cent and 19 per

Table 3. Sweet potato production during Kharif season of 2015-16

	Unit	Value
Input use		
Share of expenditure on vine materials	%	4.54
Total expenditure on vine materials	₹/ha	1590.95
Share of expenditure on chemical fertilizer/manure	%	18.65
Total expenditure on chemical fertilizer/manure	₹/ha	6534.06
Share of expenditure on pesticides-herbicides	%	0.36
Total expenditure on pesticides-herbicides	₹/ha	126.58
Share of expenditure on irrigation	%	1.94
Total expenditure on irrigation	₹/ha	680.96
Share of expenditure on human labour	%	59.14
Total expenditure on human labour	₹/ha	20715.89
Technology adoption		
Share of expenditure on animal traction	%	7.42
Total expenditure on animal traction	₹/ha	2598.83
Share of expenditure on tractor/power tiller	%	7.94
Total expenditure on tractor/power tiller	₹/ha	2781.53
Variety use		
Local variety	%	88.00
Improved variety	%	12.00
OFSP	%	11.00
Gouri	%	1.00
Land size, production and price		
Average area under sweet potato	Hectare	0.30
Average production	quintal	32.0

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

cent of the cost of cultivation. Most farmers use vines from their own nurseries and mostly grow local varieties. OFSP covered 11% of the area under sweet potato in our sample, compared to 88% area under local varieties. Farmers reported that they preferred local varieties because they had higher yields and assured demand for sweet potatoes of these varieties in the market. Sweet potato is mainly an unirrigated crop in Odisha. Most farmers in our sample did not have access to irrigation. Application of pesticides, weedicides or other chemicals is also uncommon. Pest attack is a problem only when there are prolong dry conditions. The few farmers who have access to irrigation, use it to protect their crop from moisture stress. Some farmers also use better water control to time the harvest of sweet potato to match the periods of peak demand and secure better prices.

As discussed earlier, most farmers sell bulk of their harvest immediately after harvest in the field itself or within the first few days of harvest for cash. Very few farmers get advanced payments from their buyers and even fewer sell their produce on credit. Most farmers sell their produce to the wholesalers (69.70%) and aggregators (20.54%). Direct sales to individual or institutional consumers is uncommon (4.72%). Ease of access to the buyers and immediate cash payments are the main drivers of choice of buyers for most farmers. Instead of storing their produce, farmers time their harvest to match the peak demand periods to get higher prices. In Odisha, Hindu households use sweet potato in place of potato on auspicious occasions and during religious fasts. Therefore, the demand for sweet potato is high during the festival season from October to December.

Table 4. Marketing by sweet potato farmers (% of transaction)

	Unit	Value
Average price realized	₹/quintal	996.80
Time of sales		
Immediate sales	%	84.81
Later sales	%	15.18
Month of sales		
Oct	%	17.85
Nov	%	40.07
Dec	%	10.77
Others*	%	31.31
Type of buyer		
Aggregators	%	20.54
Wholesalers	%	69.70
Retailers	%	5.05
Consumers	%	4.72
Major reason for the choice of buyers		
Easy access	%	62.30
Door step delivery	%	11.48
Selling since many years	%	16.72
Input supplies plus he gives higher price	%	9.50
Timing of payment		
Immediate payment	%	94.61
Advance payment	%	1.01
Late payment	%	4.38

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Note: *January, February, March, April, May, June and September

Table 5 presents results from a multivariate regression that shows importance of different factors that determine farm harvest price of sweet potato. We use the logarithm of the price per kg as a dependent variable and included a number of explanatory variables to better understand the factors associated with better price realization by farmers. Farmers who sold the sweet potato immediately after harvest were able to obtain a significantly higher price than those who sold after storage. This is because poor storage conditions, as obtained in farmer households, results in loss of quality and poorer appearance of the produce. Farmers with larger producer surpluses realize higher prices. Selling sweet potato to wholesalers fetched higher price than selling it to aggregators. However,

Table 5. Determinants of farm prices of sweet potato

Dependent variable- log (₹/kg)	OLS		
	Coefficient	t-value	
Characteristics of transactions			
Immediate sale	yes=1	0.83	13.09***
Quantity sold in quintal	Logs	0.05	3.07***
Immediate payment	yes=1	-0.00	-0.08
Type of buyers			
Wholesalers	yes=1	0.03	2.09**
Retailers	yes=1	-0.05	-0.81
Consumers	yes=1	-0.03	-0.50
Month of sales			
Oct	yes=1	0.06	2.02**
Nov	yes=1	0.05	1.87*
Dec	yes=1	0.07	2.05**
Jan	yes=1	0.15	2.46**
Feb	yes=1	0.08	2.17**
Mar	yes=1	0.01	0.34
Characteristics of farmers			
Age (head of the household)	years	-0.00	-1.24
Size of the household	number	0.00	0.75
Head of household is literate	yes=1	0.01	1.02
Distance	Km	-0.00	-0.85
Intercept		0.03	0.49
Number of observations		310	
R-Squared		0.74	
Root Mean Square Error		0.12	

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Note: ***, ** and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

selling to wholesalers requires farmers to bring their produce to the wholesalers godown or shop at their own cost. Aggregators often collect the produce from the farmer's field. Sweet potato fetches the highest prices for farmers during the festival season and auspicious times of the year (generally from October to January).

Since price of sweet potato varies significantly over time, storage could potentially play an important role in the price realization of farmers, but it does not. Most farmers do not store sweet potato for long. The few who do, spread it on the floor of their house for a short

Table 6. Storage pattern of sweet potato by farmers

	Unit	Value
Where do you store sweet potato?		
Spread in the floor inside house	%	100.00
Why do you store them?		
To wait for better price	%	82.35
To meet home consumption	%	17.65
How long do you store sweet potato?	Days	9.11

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Note: *February, April, June and July, The figures within the parentheses indicate stored amount as a share of sales

period of a week to two weeks when they can find a suitable buyer (Table 6).

Aggregators

Table 7 shows descriptive statistics of surveys of aggregators in the value chain of sweet potato. The average age of the sweet potato aggregators was 38 years with 11.52 years of experience in sweet potato trade which indicated that young people are not engaged in sweet potato business upstream or downstream. Moreover, 16 percent of the sweet potato aggregators were found to be illiterate. The total quantity sold during Kharif 2015 was 898.16 quintal. As sweet potato is a seasonal crop, no specialized traders for sweet potato trading was observed and it was estimated that 92 percent of the aggregators deal sweet potato along with other commodities.

The aggregators were basically the sellers of seasonal vegetables and spices. On an average, the maximum distance covered by the aggregators to producers place was 18.76 km and 96 per cent of the transport cost was borne by buyers and rest 4 per cent by the sellers. An average aggregator covered 17 villages in a season to procure sweet potato from farmers. This clearly indicates that aggregators go to different locations to purchase sweet potato from farmers' fields. Almost all the sales of sweet potato happen over a short period of time and none of the aggregators stored sweet potato to avoid price risk. Aggregators sell mainly to the local wholesalers.

Farmers, aggregators and wholesalers use cellphones to contact each other and to find out prices

Table 7. Descriptive statistics of aggregators

	Unit	Value
Number of observations	Number	25
Do you deal in any other commodities?	% yes	92.00
Rank sweet potato in order of value of your business	number	5.00
Experience in sweet potato business	years	11.52
Type of sellers		
Producers	%	100.00
Quantity procured in 2015 during Kharif season	quintal	867.16
Number of villages covered	number	17.00
Maximum distance	km	18.76
Who pay the transport cost if you purchase the product from farm gate		
Sellers	%	4.00
Buyers	%	96.00
Type of buyers		
Wholesalers	%	100.00
Average quantity sold in 2015 during Kharif season*	quintal	898.16

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Note: *Including own sweet potato production of aggregators

in the principal markets, often located in the district headquarters. Use of cellphones has reduced information asymmetry between different players, but it has not necessarily made the market more competitive for the farmers. In each market, only a few wholesalers deal in sweet potato. Even for these wholesalers, sweet potato is only one of the many commodities they trade and often a less important commodity. Aggregators and traders use cellphones to collect advanced information about production and daily arrival of sweet potato and predict price fluctuations. They report high levels of confidence in their ability to predict arrivals and prices, but we did not have data to test if their claims were correct.

Though use of sweet potato is largely limited to special occasions, it is widely believed to be a healthier option than potato. All respondents reported that its consumption has increased over the last few years and

Table 8. Market intelligence by sweet potato aggregators

	Unit	Value
In last 10 years, has your purchase of sweet potato from farmers increased? (yes = 1)	%	100.00
Has number of buyers of sweet potato increased? (yes = 1)	%	100.00
Do farmers contact you for sale of sweet potato? (yes = 1)	%	92.00
Telephone	%	86.96
Personal interaction	%	13.04
Whether you contact farmers for sale of sweet potato? (yes =1)	%	88.00
By cell phone	%	79.16
By meeting them in person	%	15.78
By visiting the sweet potato fields	%	6.66
Do you collect information on the expected production of sweet potato? (yes=1)	%	52.00
Are you able to anticipate prices in advance? (yes = 1)	%	100.00
Is sweet potato considered a nutritious food? (yes = 1)	%	100.00
Your outlook on consumption of sweet potato in the next 5 years		
Will increase	%	100

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Table 9. Descriptive statistics of wholesalers

	Unit	Value
Number of observations	number	12
Do you deal in any other commodities?	% yes	100.00
Rank sweet potato in order of value of your business	number	2.91
Experience in sweet potato business	years	15.66
Type of sellers you buy from		
Producers	%	46.34
Aggregators	%	53.65
Quantity purchased in 2015 during Kharif season	Quintal	1547.75
Do you store the sweet potato after purchase?	% yes	16.67
Number of days you store sweet potato	Days	2.5

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

the rising trend was likely to continue in years to come. If true, the rising consumption of sweet potato offers an opportunity to increase intake of vitamin A by substituting existing varieties of sweet potato by OFSP.

Wholesalers

Table 9 shows descriptive statistics on characteristics of sweet potato wholesalers. No

specialized traders for sweet potato were found in the study area and it is estimated that all the respondents' dealt sweet potato along with other commodities. The wholesalers had an average experience of 16 years in the business. On an average, the wholesalers ranked sweet potatoes third in order of value of their business. About 46 per cent of the wholesalers purchased sweet potato from the producers and rest from the aggregators. The average quantity purchased during the Kharif season was 1548 quintal. Only about 17 per cent of the wholesalers stored the sweet potato and rest sold it immediately after purchase and maximum period of storage was about 2.5 days.

Table 10 depicts the marketing pattern of a typical sweet potato wholesaler. More than 91 per cent of the wholesalers had marketed sweet potato to other smaller wholesalers at terminal markets within a few days of purchasing it. November is the peak month of business, though small quantities of sweet potato is sold in other months of the year too. Most wholesalers of sweet potato also sell other vegetables too. Bulk of the business is in cash. Selling on credit is uncommon.

Like aggregators, wholesalers also try to acquire advanced information on area sowed with sweet potato and expected production during the season. This information is collected from aggregators and even directly from farmers through cellphones. The wholesalers told us that the information so collected is

Table 10. Marketing by wholesalers of sweet potato (% transaction)

	Unit	Immediate sale	Later sale
Type of buyers			
Other wholesalers	%	91.67	16.67
Retailers	%	8.33	-
Month of sale			
November	%	83.33	16.67
December	%	8.33	-
January	%	8.33	-
Average quantity sold/year	quintal	1051.83	1700
Price	₹/kg	12.95	11.00
Maximum distance	Km	18.75	50.00
Time of payment			
Immediate payment	%	100.00	100.0

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

quite reliable and allows them to make decent predictions of arrival of sweet potato in the season (Table 11).

Retailers

Households buy sweet potato from regular green grocers who also sell other vegetables. Many retailers in rural areas buy sweet potato directly from the

producers. Aggregators and wholesalers are other key sources of sweet potato for retailers. Retailers themselves visit the source (a farmer or the wholesaler) for the purchase and bear the transportation cost from the source to their shop. Once purchased, retailers like other actors in the value-chain, retailers also try to sell their stock within a few days of their purchase (Table 12).

Majority (71.87%) of the retailers sold sweet potato to household consumers. Restaurants and street hawkers selling boiled or baked sweet potato were the other key buyers (Table 13).

Consumers

An average household in Kalahandi and Kandhamal consumed about 8 kg of sweet potato in a year. In comparison, households in Ganjam and Koraput, most of whom also produced sweet potato, consumed nearly 19 kg of it per year. Household consumption of sweet potato is seasonal with bulk of consumption taking place during months of October to January specially, around major festivals and days of religious fasting. Sweet potato is used as substitute for potato on auspicious days. Though potato and sweet potato both came to India from Americas, Hindu households in Odisha consider sweet potato to be of local origin, as opposed to potato, and therefore acceptable on religious occasions. Sweet potato is consumed mainly after boiling or roasting. In major

Table 11. Market intelligence by wholesalers of sweet potato

	Unit	Value
Do you collect advance information on area and production of sweet potato?	% yes	33.33
How much in advance do you collect this information?		
Beginning of the season	%	57.14
During the season	%	42.85
Is the information reliable?		
Very reliable	%	75.00
Sometime reliable	%	25.00
Has production of sweet potato changed since you started your business?		
Increased	%	91.67
Decreased	%	8.33
Has consumption of sweet potato changed since you started your business?		
Increased	%	91.67
Decreased	%	8.33

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Table 12. Descriptive statistics of retailers of sweet potato

	Unit	Value
Number of observations	Number	25
Years in sweet potato business	Years	10.92
Type of retailers		
Small kiosk	%	88.00
hawkers	%	12.00
Type of seller		
Farmers/Producers	%	66.66
Local market	%	25.00
Aggregators	%	5.55
Wholesalers	%	2.77
Average number of customers served daily	number	21.44
Do you deal any other commodities	%	96.00
Average quantity procured during 2016	Quintal	3.44
Do you store the sweet potato after purchase	% yes	40.00
Maximum how long do you store sweet potato	Days	4.2

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

Table 13. Marketing by sweet potato retailers

	Unit	Immediate sale	Later sale
Type of buyers			
Household consumers	%	71.87	100.00
Restaurants/hotel/mess	%	25.00	-
Hawkers selling snacks	%	3.12	-
Month of sales			
Nov	%	70.96	100.00
Average quantity sold	Quintal	1.913	1.95
Average price	₹/kg	18.69	20
Time of payment			
Immediate payment	%	100.00	100.00

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

producing areas of Odisha, households also prepare delicacies from sweet potato.

Margins and price spread in marketing of sweet potato

In 2015, farmers received an average price of ₹ 975 per quintal of sweet potato. This is nearly half

Table 14. Price spread in sweet potato value chain

Particulars	Amount (₹ /qtl)	Share of consumers' price (%)
I. Producers		
Farm harvest price	975.00	52.16
Cost of cultivation	523.47	28.00
Net profit	451.53	24.15
II. Aggregators		
Average purchase price	975.00	52.16
Transaction costs	102.52	5.48
Average sale price	1150.00	61.52
Average profit margin	72.48	3.88
III. Wholesalers		
Average purchase price	1150.00	61.52
Average transportation cost	141.69	7.58
Average sales price	1402.00	75.00
Profit margin	110.31	5.90
IV. Retailers		
Average purchase price	1402.00	75.00
Transport costs	29.60	1.58
Average sales price	1869.40	100.00
Profit margin	437.40	23.40

Source: Authors calculations using data from the sweet potato value chain surveys, 2016, Odisha, India

(52 percent) of the average price that consumers paid for it. The average cost of production of sweet potato was ₹ 523 per quintal. This includes all cash costs and the cost of family labor, but not land rent and depreciation. Further this table shows that retailers share was the major constituent of the total marketing margin. The intermediaries were exploiting the farmers by way of taking more profit and this could be eliminated by formation of farmers producers organization and reforming marketing system in Odisha will likely provide better avenue for increasing farmers income.

Awareness of orange-fleshed sweet potato

Orange-fleshed sweet potato is the first widely released biofortified staple. There is strong evidence that the beta-carotene in OFSP is bioavailable and can improve Vitamin A status in vulnerable populations. Government of Odisha is working with ICAR-Central

Tuber Crop Research Institute (ICAR-CTCRI) and International Potato Center (CIP) to promote cultivation of OFSP in the state by raising awareness about its nutritional properties and by distributing free vines of OFSP for planting. In our survey of farmers and consumers, we asked them about their awareness of OFSP and its nutritional properties. We also tried to assess its demand from other actors in the value chain.

Nearly one-third (32 per cent) of the farmers in our sample had heard of OFSP and knew that it was highly nutritious. However, only 15 percent of sweet potato farmers knew that it was rich in Vitamin A. Very few households not growing sweet potato had heard of OFSP or its nutritional properties. Aggregators, wholesalers and retailers were largely unaware of OFSP. They told us that there was no demand for this type of sweet potato and it did not command any premium in the market. This lack of demand pull is one of the reasons why very few farmers in our sample were cultivating OFSP. Farmers also told us that they prefer growing local varieties of sweet potato because they are tried and tested and offer good yields. Farmers are unlikely to switch to OFSP unless consumers start demanding it. OFSP varieties have to offer higher yields or fetch higher prices than the currently popular varieties for farmers to make the switch. Only supply side push is unlikely to make OFSP popular in Odisha. Increasing production and consumption of OFSP requires an awareness campaign among consumers in combination with extension efforts with farmers.

Conclusion and Policy Implications

OFSP has been shown to be highly effective in mitigating VAD and improving Vitamin A status among vulnerable populations in countries of Africa like Mozambique, Uganda and South Africa (Bouis and Islam, 2012). In fact, 125 grams of most OFSP varieties can supply the recommended daily allowance of vitamin A for children and non-lactating women (Andrade *et al.*, 2009). VAD is highly prevalent in India also. Government and international agencies are, therefore, promoting cultivation of OFSP in Odisha, the state with the largest area under sweet potato in India. We studied value-chain of sweet potato in Odisha to assess if there are opportunities for leveraging large scale sweet potato cultivation in the state for improving nutrition. The value-chain framework helps in identifying such opportunities and understanding ways

in which agriculture for nutrition programs can be implemented more effectively.

From surveying farmers, consumers and other actors in the value-chain of sweet potato, including extension officials and researchers, we learned that unlike Africa, sweet potato is not a staple in Odisha. It is a marginal crop in the state that is consumed in small quantities on only a few days in the year. People consider sweet potato to be nutritionally rich, but do not consume it regularly.

Therefore, OFSP may not be as effective a vehicle for improving Vitamin A status in Odisha as it is in many countries of Africa. Furthermore, supply-side efforts, like giving free vines or organizing awareness programs with farmers, to promote cultivation of OFSP in place of regular varieties of sweet potato, are unlikely to succeed on a significant scale unless they are combined with a larger awareness campaign to increase the demand for OFSP. At present, farmers in Odisha know more about OFSP and its nutritional properties than the consumers and the intermediaries. It does not fetch higher prices to farmers nor is it the preferred product among different types of sweet potato for consumers. Biofortification is effective only if the fortified variety is widely adopted by consumers and producers both. Increase consumers' awareness and demand for OFSP is essential to increase both its local production and consumption in Odisha, India.

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