Journal of Root Crops, 2016, Vol. 42 No. 1, pp. 82-91
Indian Society for Root Crops
ISSN 0378-2409, ISSN 2454-9053 (online)

Impact on Production and Consumption of Orange Sweet Potato Varieties in Homestead Vegetable Production System of Poor Farming Households in Bangladesh

M. Mokarrom Hossain, M. Shaifullah , K. K. Basak and
A.B.M .Mahfuzul Haque
WorldFish, Bangladesh & South Asia Office
Corresponding author: Mohammad Mokarrom Hossain; e-mail: md.hossain@cgiar.org
Received: 02 March 2016; Accepted: 01 June 2016

Abstract

Three orange sweet potato (OSP) varieties BARI SP-4, BARI SP-7 and BARI SP-8 were introduced in 20m² area within homestead vegetable production system of poor farming households in six agro-ecological regions of Bangladesh during 2011-12 and 2012-13. Data on different aspects of the study were collected from 196 randomly selected households. The average productions of roots and leaves of OSP per household were 33.65 and 12.11kg respectively from 20m² of land during 2011-12. However, during 2012-13 season average production of roots and leaves were 36.24 and 12.36kg respectively from same area of land. Of the average total production of roots and fresh leaves of 47.15kg per year, 34.66kg was consumed at household level, 6.84kg was sold and 5.89kg was gifted to neighbours and relatives. The average gross return from cultivation of OSP at household level from 20m² of land per year was BDT* 845.00. Organoleptic test revealed that the acceptability of OSP for consumption as boiled roots and leaves varied slightly from region to region and variety to variety.

*Bangladesh currency (Taka) 78 = US$ 01

Key words: Orange sweet potato (OSP), poor farming household, consumption, income

Introduction

Sweet potato (*Ipomoea batatas* Poir) belonging to the family Convolvulaceae is an important root crop rich in many nutrients including ß-carotene and anthocyanins, the precursors of vitamin-A. Dietary deficiencies of vitamin A can cause blindness, and this vitamin also possess anti-oxidant activity linked with anticancer and anti-ageing properties. Vitamin-A deficiency is a wide spread, global problem with severe consequences for young children in the developing world (Woolfe, 1992). Globally, 127 million children are estimated to be affected and estimated to account for more than 600,000 deaths each year among children below 5 years of age (West, 2002; Black et al., 2008). Along with other countries of the world, Bangladesh is challenged by hidden food insecurity issues, like micro-nutrient deficiency among small farming households in rural areas, in which more than 43% of preschool age children are stunted and 56% are underweight (USAID Horticulture Project, 2013). Also, vitamin-A deficiency is a major problem causing 30,000 children annually to suffer from blindness (Bhuiyan et al., 2008).

Intake of vitamin-A rich foods is common among nutrition sensitive food-based approaches to increase health and developmental resistance to micronutrient deficiencies (MND; Jan et al., 2007). OSP is a promising food from plant sources because of high levels of vitamin-A content ranging from 600 to 7500 IU per 100 g of

fresh root (Mondal et al., 2011) and on an average 1600 IU per 100 g of fresh leaves (Bhuiyan et al, 2008). OSP varieties are generally well accepted by young children (Hagenimana et al., 2001; Van Jaarsveld et al., 2006). The daily consumption of OSP has a positive effect on total body vitamin-A assimilation (Van Jaarsveld et al., 2005). Tumwegamire et al. (2004) reported that high yielding varieties of OSP can supply the least expensive, year-round source of dietary vitamin-A to resource poor small farming households. Thus, OSP is viewed as a most promising low-investment nutritional solution for resource poor farming households of developing countries like Bangladesh. Consequently, there is strong potential for reducing micro-nutrient deficiency, particularly vitamin-A deficiency through promoting OSP cultivation and consumption at household level. Moreover, due to its easy cultivation technology, vegetative propagation and to some extent drought and salinity tolerance, OSP can be one of the important vegetables for cultivation at homestead in different parts of Bangladesh. Considering the above, the present study was undertaken by introducing three OSP varieties BARI SP-04, SP-07 and SP-08 (varietal characteristics in Annexure 01) in homestead vegetable production system by involving women members of the small and marginal farming households to assess its impact on production and consumption in six different regions of Bangladesh.

Materials and Methods

The study was conducted in 6 (six) agro-ecological regions of Bangladesh namely Barisal, Faridpur, Jessore, Khulna, Mymensingh and Rangpur under the USAID funded Cereal Systems Initiative for South Asia in Bangladesh (CSISA-BD) project from November, 2011 to April, 2013. The Bangladesh Agricultural Research Institute (BARI) released OSP varieties namely BARI SP-04, BARI SP-07 and BARI SP-08 were introduced in the homestead vegetable production system. Selected women of the marginal and small farming households were provided training and supported by OSP vines to cultivate in small pieces of homestead land ($20m^2$) over two cultivation seasons of 2011-12 and 2012-13. Crop management practices of OSP including use of organic and inorganic fertilizers were followed as per recommendation of Bhuiyan et al. (2008).

Land selection and preparation

Well drained, sandy loam and sunny place of homestead was selected for OSP production. Deep ploughed with basal dose of fertilizers at the rate of organic matter: 4-5 kg, TSP: 300g, and 50% of total required urea:150g, and MOP: 180g per $20m^2$.

Cutting preparation and plantation

Insect and disease free stems with 3-4 nodes were selected. The length of cutting was 25-30cm, except top leaves, all leaves were removed. Cuttings were horizontally planted and 2-3 nodes were placed inside the soil and 1-2 nodes were above the soil. A total of 120 OSP cuttings were plated in $20m^2$ land following an approximate planting spacing of row to row 60cm and plant to plant 30cm.

Intercultural operations

Regular irrigations were provided at 30, 60 and 90 days after planting (DAP), dependent on raining. Earthing up of soil was done and rest of the urea and MOP was applied on 60 DAP in between two line of vines. Weeding was done when necessary and vines were lifted at 60 DAP, later on continued once in a month throughout the growing period.

Harvesting

Leaves harvesting started after 80 days of plantation and continued up-to root harvesting. Roots were harvested at 130 days after vine plantation through uprooting by spade.

Data were collected from randomly selected 196 project households (HHs) through face to face personal interview using structured questionnaires on performance of the three OSP varieties in homestead production system during 2011-12 and 2012-13. Also data in respect of crop management and farmers' behaviour for utilization and acceptance of OSP were also collected from the sample HHs. The collected data where necessary were analyzed using a Microsoft Excel Spread sheet.

Results and Discussion

Yield performance of three OSP varieties in homestead production system

The results on region wise yield performance in terms of tuberous roots and leaves of three OSP varieties during 2011-12 and 2012-13 under homestead production system in $20m^2$ of land is presented in Table 1. On an average

33.65 and 36.24 kg of tuberous roots and 12.11 and 12.36 kg of leaves were produced by each HH from 20m^2 of land during 2011-12 and 2012-13, respectively. There was significant regional variation (at 5 % level) among three OSP varieties for the yield of tuberous roots and leaves during 2011-12 and 2012-13. During 2011-12, the highest yield of tuberous roots 38.25kg from 20 m^2 was recorded in BARI SP-8 in Faridpur region which was statistically similar with BARI SP-4 in Faridpur, Jessore and Khulna regions, BARI SP-8 in Khulna region and Mymensingh. The lowest yield of tuberous roots 28.41 kg/20m^2 was recorded in the variety BARI SP-8 in Rangpur region during 2011-12 which was statistically similar with BARI SP-4 in Rangpur region and BARI SP-7 in Barisal region. On the other hand, during 2012-13, the highest yield of tuberous roots 43.83 kg/20m^2 was recorded in the variety BARI SP-7 in Barisal region which was statistically similar with BARI SP-4 in Mymensingh and Rangpur region, BARI SP-8 in Faridpur and Rangpur region. Similarly, the production of leaves per 20m^2 varied from region to region and variety to variety during 2011-12 and 2012-13 (Table 1) and no single variety was top of the list in all the six regions.

It is interesting to note that there was no significant variation (at 5% level) among the three OSP varieties in respect of their mean performance over the regions within the same year 2011-2012 and 2012-13 for yield of tuberous roots from 20m^2 of homestead land, however, year to year variation was observed (Table 2). It was also observed that the yield of all three OSP varieties was higher in 2012-13 compared to 2011-12. Similar trend was also observed in respect of production of leaves except in BARI OSP-8 where production of leaves was higher in 2011-12 compared to 2012-13. However, total production of roots and leaves followed the trend of tuberous root production, and it was higher in 2012-13 compared to 2011-12.

Performance of three OSP varieties in respect of Vitamin-A production

Tuberous roots and leaves of sweet potato are rich sources of vitamin-A along with other nutrients (Table 3). The results on performance of three OSP varieties in respect of vitamin-A production during 2011-12 and 2012-13 in six regions is presented in Table 1. Also the mean performances of three OSP varieties over the regions for vitamin-A production during 2011-12 and 2012-13 have been presented in Table 2. The highest total amounts of vitamin-A (665,050 IU) was recorded in the BARI SP-4 during 2012-13 from 20m^2 of land in the homestead production system in Mymensingh region which was statistically similar with BARI SP-4 in Rangpur region and BARI SP-7 in Barisal region during 2012-13 (Table 1). Considering the varietal performance for total vitamin-A production from tuberous roots and leaves; it was higher during 2012-13 compared to 2011-12 (Table 2). The mean total yield was the highest in BARI SP-4 (561,145 IU) followed by BARI SP-7 (435,190 IU) and BARI SP-8 (425,765 IU) from 20m^2 of homestead land.

Region wise production, consumption, disposal and income from OSP cultivation

The results of region wise production, consumption, disposal and gross return obtained through growing OSP at HH level during 2011-12 and 2012-13 is presented in Table 4. Major portion of the OSP (both roots and leaves) was consumed at HH level by the family members ranging from 30.75 to 39.11 kg. The gross income obtained per HH through production of tuberous roots and leaves of three OSP varieties from 20m^2 land ranged from BDT 766.00 to 954.00 with over all mean of BDT 845.00, revealed that growing sweet potato in the homestead could be an income generating activity by the household members. Also production of OSP vines for propagation purpose can be an alternative income generating activity as reported by USAID Horticulture project (2013).

Region wise consumer preference of three OSP varieties

The results on consumer preference of the tuberous roots of three OSP varieties based on different organoleptic parameters are presented in Table 5. In respect of fresh skin and flesh colour of tuberous roots, BARI SP-4 scored 1st preference in Barisal, Jessore and Khulna regions while BARI SP-8 scored 1st preference in Faridpur, Mymensingh and Rangpur regions (Table 5). On other hand, in respect of boiled flesh colour of tuberous roots, BARI SP-4 ranked 1st in all the regions though it was not included for organoleptic taste in Rangpur region. Regarding taste of the boiled tuberous roots, BARI SP-8 ranked 1st in all the regions except Faridpur region while BARI SP-4 was ranked 3rd in all the five regions by the panel members. As reported by the consumer panel members, the lowest preference of the BARI SP-4 was due to its less sweetness and watery texture after boiling the tuberous roots.

Table 1. Region wise yield performance (tuberous roots & leaves) of three OSP varieties during 2011-12 and 2012-13 in homestead production system

Region	Varieties	Yield of tuberous roots & leaves (kg) per 20 m^2 during						Production of vitamin-A (IU) by tuberous roots & leaves per 20 m^2 during					
		2011-12			2012-13			2011-12			2012-13		
		Tuberous roots	Leaves	Total	Tuberous roots	Leaves	Total	Tuberous roots	Leaves	Total	Tuberous roots	Leaves	Total
Barisal	BARI SP-4	33.51	10.32	43.83	31.43	10.5	41.93	351855	165120	516975	330015	168000	498015
	BARI SP-7	28.52	11.36	39.88	43.83	16.17	60	199640	181760	381400	306810	258720	565530
	BARI SP-8	32.33	12.51	44.84	-	-	210145	200160	410305	-	-	-	
	Mean	31.45	11.4	42.85	37.63	13.34	50.97	253880	182347	436227	318413	213360	531773
	SD (±)	2.61	1	3	9	4	13	85011	17527	71408	16408	64149	47740
Faridpur	BARI SP-4	36.23	9.78	46.01	31.69	12.77	44.46	380415	156480	536895	332745	204320	37065
	BARI SP-7	33.9	10.87	44.77	36.31	11.7	48.01	237300	173920	411220	254170	187200	441370
	BARI SP-8	38.25	13.01	51.26	41.09	11.01	52.1	248625	208160	456785	267085	176160	443245
	Mean	36.13	11.22	47.35	36.36	11.83	48.19	288780	179520	468300	284667	189227	473894
	SD (±)	2.18	2	3	5	1	4	79560	26291	63624	42135	14189	54716
Jessore	BARI SP-4	36.23	13.43	49.66	33.66	12.77	46.43	380415	214880	595295	353430	204320	557750
	BARI SP-7	30.94	12.08	43.02	36.85	11.7	48.55	216580	193280	409860	257950	187200	445150
	BARI SP-8	33.31	13.13	46.44	35.65	11.01	46.66	216515	210080	426595	231725	176160	407885
	Mean	33.49	12.88	46.37	35.39	11.83	47.22	271170	206080	477250	281035	189227	470262
	SD (±)	2.65	1	2	2	1	1	94609	11342	102572	64052	14189	78025
Khulna	BARI SP-4	36.46	13.77	50.23	31.37	12.78	44.15	382830	220320	603150	329385	204480	533865
	BARI SP-7	33.72	14.57	48.29	32.24	13.2	45.44	236040	233120	469160	225680	211200	436880
	BARI SP-8	35.73	11.86	47.59	33.59	11.53	45.12	232245	189760	422005	218335	184480	402815
	Mean	35.3	13.4	48.7	32.4	12.5	44.9	283705	214400	498105	257800	200053	457853
	SD(±)	1.42	1	1	1	1	1	85866	22278	93977	62103	13899	67996
Mymensingh	BARI SP-4	33	13.44	46.44	42.34	13.78	56.12	346500	215040	561540	444570	220480	665050
	BARI SP-7	35.28	10.58	45.86	32.55	9.12	41.67	246960	169280	416240	227850	145920	373770
	BARI SP-8	37.3	11.86	49.16	33.53	13.43	46.96	242450	189760	432210	217945	214880	432825
	Mean	35.19	11.96	47.15	36.14	12.11	48.25	278637	191360	469997	296788	193760	490548
	SD (±)	2.15	1	2	5	3	7	58815	22922	79680	128078	41525	153981
Rangpur	BARI SP-4	30.73	12.01	42.74	43.57	11.94	55.51	322665	192160	514825	457485	191040	648525
	BARI SP-7	31.87	12	43.87	35.94	12.78	48.72	215110	192000	407110	251580	204480	456060
	BARI SP-8	28.41	11.36	39.77	40.51	13.83	54.34	184665	181760	366425	263315	221280	484595
	Mean	30.34	11.79	42.13	40.01	12.85	52.86	240813	188640	429453	324127	205600	529727
	SD (±)	1.76	0.37	2	4	1	4	72502	5959	76682	115641	15151	103867
Overall mean		33.65	12.11	45.76	36.24	12.36	48.6	269498	193724	463222	276115	197665	473780
SD(±)		2.85	1.29	4.14	4.39	1.59	5.98	69609	20576	90185	76151	25478	101629

*Vitamin-A content in tuberous roots was calculated @ 1050, 700 and 650 IU per 100 g fresh weight of tuberous roots for BARI SP-04, BARI SP 07 and BARI SP 08, respectively (Mondal et al., 2011)

**Vitamin-A content in leaves of three sweet potato varieties was calculated @1600 IU per 100 g fresh weight (Bhuiyan et al., 2008)

Table 2. Mean yield of tuberous roots, and vitamin-A by three OSP varieties in homestead production system during 2011-12 and 2012-13

OSP Variety	Year	Yield of tuberous roots and leaves per 20 m^2 (kg)			Vit-A production by tuberous roots* and leaves**per 20 m^2 (IU)		
		Tuberous roots	Leaves	Total	Tuberous roots	Leaves	Total
BARI SP-4	2011-12	33.78	12.13	45.91	354690	194080	548770
	2012-13	35.68	12.43	48.11	374640	198880	573520
	Mean	34.73	12.28	47.01	364660	196480	561145
	SD(±)	1.34	0.21	1.55	14100	3390	17500
BARI SP-7	2011-12	32.37	11.91	44.28	226590	190560	417150
	2012-13	36.29	12.45	48.74	254030	199200	453230
	Mean	34.33	12.18	46.51	240310	194880	435190
	SD(±)	2.77	0.38	3.15	19400	6110	25512
BARI SP-8	2011-12	34.22	12.39	46.61	222430	198240	420670
	2012-13	36.87	11.95	48.82	239660	191200	430860
	Mean	35.55	12.17	47.72	231050	194720	425765
	SD(±)	1.87	0.31	1.56	12180	4970	7205
Overall mean		34.87	12.21	47.09	278670	195360	474033
SD(±)		1.7	0.24	1.81	67810	3930	69084

*Vitamin-A content in tuberous roots was calculated @ 1050, 700 and 650 IU per 100 g fresh weight of tuberous roots for BARI SP-04, BARI SP 07 and BARI SP 08, respectively (Mondal et al., 2011)

**Vitamin-A content in leaves of three sweet potato varieties was calculated @1600 IU per 100 g fresh weight (Bhuiyan et al., 2008)

Table 3. Nutrient composition per 100 g of tuberous roots and shoots/leaves of sweet potato (Mohanta et al., 2015)

Nutrients	Tuberous roots	Shoots/Leaves	Nutrients	Tuberous roots	Shoots/Leaves
Water	70.0 g	87.7 g	Potassium	530.0 mg	-
Starch	19-23 g	9.7 g	Sodium	13.0 mg	-
Protein	1.5 – 2.0 g	4.2 g	Chlorine	85 mg	-
Fat	0.7 g	0.8 g	Sulphur	26 mg	-
Fibre	1.0 g	2.4 g	Thiamine	0.08 mg	0.07 mg
Sugar	3.6 g	-	Riboflavin	0.04 mg	0.24 mg
Calcium	46 mg	360 mg	Niacin	0.70 mg	1.7
Phosphorus	49 mg	60 mg	Vitamin-C	24.0 mg	27.0 mg
Iron	0.8 mg	10 mg	Vitamin-A	700-800 IU (up to 7500 IU)	1600 IU
Magnesium	24.0 mg	Magnesium	Calorie	120 Kcal	63

Table 4. Region wise production, consumption, disposal and gross income from growing of OSP varieties at HH level during 2011-12 and 2012-13

Region	Year	Production of tuberous roots and leaves per 20 m^2 (kg)			Consumption & disposal pattern of tuberous roots and leaves of OSP (kg)			Gross income per HH (BDT*)
		Tuberous roots	Leaves	Total	Quantity consumed	Quantity sold	Gift	
Barisal	2011-12	31.45	11.41	42.86	31.29	6	5.57	766
	2012-13	37.63	13.34	50.97	37.72	7.65	6.12	913
Faridpur	2011-12	36.13	11.22	47.35	34.57	6.63	6.16	857
	2012-13	34.71	11.83	46.54	34.44	6.98	5.59	836
Jessore	2011-12	33.49	12.88	46.37	33.85	6.49	6.03	824
	2012-13	35.39	11.83	47.22	34.94	7.08	5.67	850
Khulna	2011-12	35.3	13.4	48.7	35.55	6.82	6.33	867
	2012-13	32.4	12.5	44.9	33.23	6.74	5.39	798

Mymensingh	2011-12	35.19	11.95	47.15	34.42	6.6	6.13	847
	2012-13	36.14	12.61	48.75	36.07	7.31	5.85	874
Rangpur	2011-12	30.33	11.79	42.12	30.75	5.9	5.48	748
	2012-13	40	12.85	52.86	39.11	7.93	6.34	954
Overall mean		34.85	12.3	47.15	34.66	6.84	5.89	845
SD(±)		2.66	0.73	3.19	2.36	0.6	0.33	57

*BDT= Bangladeshi Taka (Bangladesh currency (Taka) 78 = US$ 01)

Table 5. Region wise consumers' preference of OSP varieties based on different parameters of fresh and boiled tuberous roots

Region	OSP Variety	Consumers' choice for (ranking in %)								
		Skin & flesh colour of fresh tuberous roots			Flesh colour of boiled tuberous roots			Taste of boiled tuberous roots		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Barisal	BARI SP-4	47.37	31.58	21.05	63.16	31.58	5.26	21.05	31.58	52.94
	BARI SP-7	21.05	31.58	47.37	15.79	36.84	47.37	36.84	42.11	23.53
	BARI SP-8	31.58	36.84	31.58	21.05	31.58	47.37	42.11	26.32	35.29
Faridpur	BARI SP-4	35	45	20	50	45	5	15	40	45
	BARI SP-7	25	20	55	15	35	50	45	40	15
	BARI SP-8	40	35	25	35	20	45	40	20	40
Jessore	BARI SP-4	72.22	16.67	11.11	50	33.33	16.67	11.11	44.44	44.44
	BARI SP-7	11.11	33.33	55.56	11.11	38.89	50	38.89	33.33	27.78
	BARI SP-8	16.67	50	33.33	38.89	27.78	33.33	50	22.22	27.78
Khulna	BARI SP-4	52.63	36.84	10.53	57.89	36.84	5.26	15.79	21.05	47.37
	BARI SP-7	10.53	21.05	68.42	5.26	15.79	78.95	31.58	36.84	36.84
	BARI SP-8	36.84	42.11	21.05	36.84	47.37	15.79	52.63	31.58	15.79
Mymensingh	BARI SP-4	41.18	47.06	11.76	58.82	29.41	11.76	5.88	35.29	58.82
	BARI SP-7	11.76	23.53	64.71	11.76	23.53	64.71	35.29	35.29	11.76
	BARI SP-8	47.06	29.41	23.53	29.41	47.06	23.53	58.82	52.94	29.41
Rangpur	BARI SP-4	-	-	-	-	-	-	-	-	-
	BARI SP-7	29.41	70.59	0	35.29	64.71	0	47.06	52.94	2.94
	BARI SP-8	70.59	29.41	0	64.71	35.29	0	52.94	47.06	0
Mean		35.29	35.29	29.41	35.29	35.29	29.41	35.29	36.06	30.28
SD (±)		18.33	12.76	20.95	19.13	11.21	23.81	15.64	9.85	16.64

The results on region wise consumers' preference of three OSP varieties for leaves for culinary purposes are presented in Table 6. Regarding colour of fresh and cooked leaves as well as taste of cooked leaves, BARI SP-4 was ranked 1st in all the regions except Rangpur where it was not included for the panel taste. On the other hand mixed observations for 2nd and 3rd positions were recorded for BARI SP-7 and BARI SP-8 in different regions of the present study (Table 6).

Region wise comparative advantages and problems of OSP cultivation in the homestead area

Results on region wise comparative advantages of cultivation of three OSP varieties at homestead level in small area of land (20m^2) as reported by the participant household respondents is presented in Table 7. It was noticed that responses varied from region to region. However, considering the mean of the regions, the highest score (34.79%) was provided for more nutritious compared to other vegetables followed by regular supply of leaves as vegetables (34.58%), low labour requirement, higher profit per unit area and the least score was provided by the respondents for higher yield compared to other vegetables.

The results on region wise different problems faced by the growers in the homestead level cultivation of OSP are presented in Table 8. The mean results over the regions in this respect indicate that the major problems faced by the majority of the growers (67.86%) in homestead cultivation of OSP is damage from domestic animals which is very common as vines of OSP is a good feed for different domestic animals such as cattle, goat and poultry followed

Table 6. Region wise preference of three OSP varieties for fresh and cooked leaves

Region	OFSP Variety	Consumers' choice for (ranking in %)								
		Colour of fresh leaves			Colour of cooked leaves			Taste of cooked leaves		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Barisal	BARI SP-4	52.63	28.95	18.42	47.37	34.21	18.42	50	36.84	13.16
	BARI SP-7	21.05	34.21	44.74	23.68	31.58	44.74	26.32	39.47	34.21
	BARI SP-8	26.32	36.84	36.84	28.95	34.21	36.84	23.68	23.68	52.63
Faridpur	BARI SP-4	47.06	35.29	15.79	42.11	15.79	31.58	34.21	28.95	26.32
	BARI SP-7	23.53	35.29	36.84	18.42	34.21	36.84	23.68	31.58	34.21
	BARI SP-8	29.41	29.41	36.84	28.95	39.47	21.05	31.58	28.95	28.95
Jessore	BARI SP-4	57.14	28.57	14.29	57.14	28.57	14.29	57.14	33.33	9.52
	BARI SP-7	19.05	33.33	47.62	9.52	42.86	47.62	4.76	38.1	57.14
	BARI SP-8	23.81	38.1	38.1	33.33	28.57	38.1	38.1	28.57	33.33
Khulna	BARI SP-4	40	36.67	23.33	53.33	26.67	20	43.33	36.67	20
	BARI SP-7	33.33	26.67	40	20	36.67	43.33	26.67	23.33	50
	BARI SP-8	26.67	36.67	36.67	26.67	36.67	36.67	30	40	30
Mymensingh	BARI SP-4	54.29	28.57	17.14	45.71	28.57	25.71	51.43	37.14	11.43
	BARI SP-7	25.71	31.43	42.86	28.57	31.43	40	25.71	34.29	40
	BARI SP-8	20	40	40	25.71	40	34.29	22.86	28.57	48.57
Rangpur	BARI SP-4	-	-	-	-	-	-	-	-	-
	BARI SP-7	48.48	51.52	0	54.55	45.45	0	48.48	51.52	0
	BARI SP-8	51.52	48.48	0	45.45	54.55	0	51.52	48.48	0
Mean		35.29	35.29	28.79	34.67	34.67	28.79	34.67	34.67	28.79

Table 7. Region wise comparative advantages of production/cultivation of OSP

Region	Comparative advantages (Growers' ranking in %)				
	Higher yield compared to other vegetables	Low labour requirement for cultivation	Regular supply of leaves as vegetables	Higher profit per unit area	Nutritious compared to other vegetables
Barisal	19.05	35.71	33.33	7.14	38.10
Faridpur	0.00	26.87	29.85	4.48	38.81
Jessore	0.00	38.36	27.40	0.00	34.25
Khulna	0.00	25.00	32.89	0.00	42.11
Mymensingh	0.00	13.04	47.83	10.14	28.99
Rangpur	1.72	13.79	36.21	20.69	27.59
Mean	3.46	25.46	34.58	7.08	34.97

by damage from insects and low yield compared other vegetables, diseases and others (Table 8).

OSP is a promising food from plant sources because of high levels of vitamin-A content ranging from 600 to 7,500 IU per 100 g of fresh root (Mondal *et al.,* 2011) and on an average 1,600 IU per 100 g of fresh leaves (Bhuiyan *et al.*, 2008) along with other nutrients such as vitamins and micronutrients (Mahanto *et al*. 2015). As a strategy to combat micronutrient like vitamin-A deficiency problem in the marginal and small household level in different agro-ecological regions of Bangladesh, three OSP varieties namely BARI SP-4, BARI SP-7 and BARI SP-8 were successfully introduced in homestead production system of small and marginal farming families in 20m^2 of land managed by the women. The results of the present study revealed that a mean yield of 34.94 kg of tuberous roots and 12.23 kg of leaves per year producing 468,501 IU Vitamin-A along with other foods such as starch, other vitamins and minerals round the year were produced by each participating household with the average gross income of BDT 845.00 if sold in the existing market price. The main advantage of growing OSP under homestead production system is the easy access and use of the readily available sources of vitamin-A rich plant materials by members of the household members round the year. Mitra (2012) also stated that consumption of some of the orange-fleshed sweet potato cultivars like ST-14, 372-7, Kamala Sundari, CIPSWA-2 and 440038 with high retinol

Table 8. Region wise problems of OSP production

Region	Problems (Growers' ranking in %)				
	Insect pests	Diseases	Damage from domestic animals	Low yield compared to other vegetables	Others
Barisal	37.74	1.89	58.49	1.89	0
Faridpur	14.71	0	82.35	2.94	0
Jessore	9.68	0	54.84	32.26	3.23
Khulna	12.96	14.81	53.7	12.96	5.56
Mymensingh	5.36	0	80.36	14.29	0
Rangpur	6.45	0	77.42	16.13	0
Mean	14.48	2.78	67.86	13.41	1.46

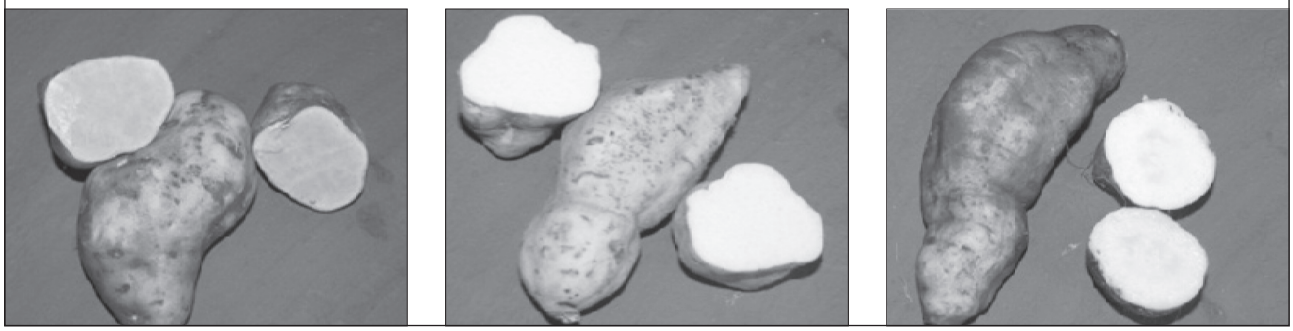
equivalents can make a significant contribution in alleviating vitamin A malnutrition and combating night blindness which is a major public health problem in poverty stricken small and marginal farming communities in many countries of the world. CIP/AVRDC (2013) reported that marginal and small women farmers in southern part of Bangladesh can earn Tk 8,000-10,000 per year through selling vines of OSP varieties produced from 200 m^2 of land. The average consumption of tubers and leaves per household was 34.66 kg (73.51% of the average total production) indicating consumption of the major portion of the total production of OSP roots and leaves by household members thus increasing the intake of vitamin-A. Van Jaarsveld et al. (2005) stated that the daily consumption of OSP has a positive effect on total body vitamin-A assimilation. High yielding varieties of OSP are believed to supply the least expensive, year-round source of dietary vitamin-A available to resource poor small farming households (Tumwegamire et al., 2004). Similar findings were also reported by Low et al. (2007) and Hortz *et al. (*2012). The degree of acceptance of the three OSP varieties by households in the present study varied from region to region also among the varieties which is quite obvious as preference of the foods depends on culture, age and many other factors of the consumers. Although the total yield of tuberous roots and leaves was reasonably high and the productions of vitamin-A were the highest in both the years in case of BARI SP-4, it was scored the lowest for the consumers' preference of its boiled roots because of less sweetness and watery texture of the flesh. Generally the people of Bangladesh like high sweetness and relatively hard texture of the tuberous roots of sweet potato after boiling. Among three OSP varieties, the tuberous root of BARI SP-4 contains the highest amount vitamin-A (1050 IU per 100 g fresh weight). Therefore, care should be taken for expansion of the cultivation of OSP variety which is not well accepted by the consumers. Also, other than the above three OSP varieties, Tuber Crop Research Center (TCRC) of BARI released more OSP varieties among them BARI SP-12 and SP-13 are better yielder and high vitamin-A content contains 13,200 and 8,800 IU vitamin-A respectively per 100 g fresh weight can be considered for cultivation at farmers' level. Also, the overall yield of the three sweet potato varieties under homestead production system appeared to be low compared to the other vegetables as reported by the participating household in the study (Table 8). The potential yield of the three OSP ranged from 40-45 tons per hectare i.e. 4-5 kg per m^2 with the production of 650-1050 IU vitamin A per 100 g fresh weight (Mondal et al., 2011). In the present study, the highest production of tuberous roots per 20m^2 of homestead land was recorded in the BARI SP-7 was 43.83 kg i.e 2.19 kg/m^2 which is obviously low compared to the potential yield of three OSP varieties as mentioned by Mondal et al. (2011). This lower production might resulted in this study because the farming family were encouraged to consume leaves regularly after around 80 days of plantation. Regular harvesting of leaves probably caused the low productivity of roots; however, further study is justified to identify actual causes of the gap between potential yield of the three OSP varieties and the actual yield with comparative economic value at homestead production system including regular consumption of leaves.

Conclusion

Results of the present study revealed that three OSP varieties viz. BARI OSP-04, BARI OSP-07 and BARI OSP-08 released by Bangladesh Agricultural Research Institute (BARI) can be successfully cultivated in

Characteristics of three OSP (BARI SP-4, BARI SP-7 and BARI SP-8) varieties

BARI SP-4	BARI SP- 7	BARI SP- 8
Stem-green, apex- purple, mature leaves-green, young leaves-purple in colour, tuber skin and flesh cream in colour, flesh medium hard/dry in texture, vitamin-A content- 1050 IU per 100 g, dry mater 27.2%, yield - 40-45 tons ha^{-1}, crop duration - 120-130 days.	Stem purple in colour, old and young leaves- green in colour, tuber skin-white, flesh- creamy, flesh hard and dry in texture, vitamin-A content-700 IU per 100 g, dry mater 35%, yield- 40-50 tons ha^{-1}, can tolerate salinity and drought and less susceptible to sweet potato weevil, crop duration-120-130 days.	Stem and leaves- green in colour, tuber skin red in colour, flesh yellow in colour, flesh hard & dry in texture, vitamin A content- 650 IU per 100 g, dry mater 35.3%, yield- 40-45 tons ha^{-1}, can tolerate drought and less susceptible to sweet potato weevil, crop duration-120-135 days.



homestead vegetable production system in small area of land ($20m^2$) with reasonable yield by the marginal and small women farmers as one of the means of constant supply of nutritious food and vitamin-A to the household members round the year with reasonable household income. Consumers' preference and comparative advantage responses indicate that urgent attention is needed by the government agencies and private sectors for expansion of the cultivation of OSP varieties at homestead level by the marginal and small women farmers to combat the chronic vitamin-A and other micronutrient deficiency. Also other varieties like BARI SP-12 and SP-13 with high vitamin-A content may be tried for cultivation in homestead level.

Acknowledgement

The authors like to acknowledge the support provided by the WorldFish Bangladesh under the USAID funded CSISA-BD project for conducting the study. We like to acknowledge the support of BARI and BRAC Seed and Agro Enterprise for supplying OSP vines for the study. We are grateful to the colleagues of WorldFish, deployed in CSISA-BD for active participation in implementing the trial and regular data recording and collection. Dr. Md. Golam Rabbani, BAU was helpful in preparing the manuscript. The authors acknowledge the advice, suggestions and encouragement received from Bill Collis, Craig A Meisner, Shakuntala Thilsted and Sonia Allauca. Finally, the authors gratefully acknowledge the support of the participating women of the farming households in the study.

References

Bhuiyan, M. K. R., Alam, M. S., Islam, A. T. M. T., Hossain, M., Begum, S. N. 2008. Production technology of newly released sweet potato varieties (In Bangla), Tuber Crops Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur-1701. 8 p.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfied, L. E., de Onis M., Ezzati, M., Mathers, C., Rivera, J. 2008. Maternal and child under nutrition study group. Maternal and child under nutrition: global and regional exposures and health consequences. Lancer, **371**: 243-260

CIP/AVRDC. 2013. Strengthening nutrition, incomes and women in Bangladesh through orange-fleshed sweet potato project. House-74 Road-07, Block-H, Banani, Dhaka. 3 p.

FAO/WHO. 2001. Human vitamin and mineral requirements. Report of a joint FAO/WHO expert consultation Bangkok, Thailand. 286 p.

Hagenimana, V., Low, J., Anyango, M., Kurz, K., Gichuki, S. T., Kabira ,J. 2001. Enhancing vitamin A intake in young children in Western Kenya: orange-fleshed sweet potatoes and women farmers can serve as key entry points. *Food Nutr. Bull.*, **22**:321-329

Hortz , C., Loechl, C., Lubowa, A., Tumwine, J. K., Ndeezi, G., Masawi, A. N., Baingana, R., Carriquiry, A., deBrauw, A., Meenakshi, V. J., Daniel, G. O. 2012. Introduction of β-carotene-rich orange sweet potato in rural Uganda resulted in increased vitamin A intakes among children and women and improved vitamin A status among children 1-3. *J. Nutr.*,**142**: 1871-1880

Low, J. W,, Arimond, M., Osman, N., Cunguara ,B., Zano, F., Tschirley, D. 2007. A food based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique. *J. Nutr.*, **137**: 1320-1327

Mitra, S. 2012. Nutritional status of orange-fleshed sweet potatoes in alleviating vitamin A malnutrition through a food-based approach. *J. Nutr. Food Sci.*, **2**: 160

Mohanta, H. C., Bhuiyan, M. K. R., Sultana, S., Parvin, S., Hossain, M. J. 2015. High yielding varieties of sweet potato and its improved production practices (In Bangla), Tuber Crops Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur-1701. 20 p.

Mondal, M. R. I., Islam, M. S., Bhuiyan, M. A. J., Rahman, M. M. Alam, M. S., Rahman, M. S. H. 2011. Handbook on Agro-technology (First part).5th edition. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur-1701. 488 p.

Tumwegamire, S., Kapinga, R., Zhang, D., Crissman, C., Agili, S. 2004. Opportunities for promoting orange-fleshed sweet potato as a mechanism for combat vitamin-A deficiency in Sub-Saharan Africa. *J. African Crop Science.,* **12**(3): 241-252

USAID Horticulture Project.2013.CIP/AVRDC,House-74, Road-07, 4th Floor, Block-H, Dhaka-1215

Van Jaarsveld, P. J., Faber, M., Tanumihardjo, S.A., Nestel ,P., Lombard, C.J., Benade, A. J. 2005. Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with modified-relative-dose-response test. *Am. J. Clin Nutr.,* **81**:1080-1087.

Van Jaarsveld, P. J., Marais, D. W., Harmse, E., Nestel, P., Rodriguez-Amaya, D. B. 2006. Retention of β-carotene in boiled, mashed orange-fleshed sweet potato. *J Food Compos. Anl.,* **19**: 321-329.

West, K.P. 2002. Extent of vitamin A deficiency among preschool children and women of reproductive age. *J. Nutr.*, **132**: S2857-2866.

Woolfe, J. 1992. Sweet potato: an untapped resource. Cambridge University Press, Cambridge.