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Performance Study of selected Orange Fleshed Sweet Potato Varieties in North Eastern Bangladesh

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***Abstract*— *The study was conducted in Nilgaon and Chamurakandi of Sylhet Sadar Upazila under Sylhet district during the 2018-2019 crop seasons. Three orange fleshed sweet potato varieties (BARI SP-04, BARI SP-11 andBARI SP-12)and a local genotype were used in this study. The ultimate purpose of the experiment was to investigate the yield potentiality, suitability and acceptability of those varieties and genotype. The experiment was performed using 10ft x 10ft plot size with 3 replicas following the RCB design. The study showed hat BARI SP-12 performed better and local genotype performed least at both places. In Nilgaon BARI SP-12 gave the highest yield (35.27 t ha^{-1}) followed by BARI SP-04 (34.14 t ha^{-1}),BARI SP-11 (32.26 t ha$^{-1)}$ and the lowest yield was documented in local genotype (24.10 t ha^{-1}). BARI SP-12 also produced the highest yield (32.01 t ha^{-1}) at Chamurakandi followed by BARI SP-04 (28.43 t ha^{-1}),BARI SP-11 (28.00 t ha^{-1}) and the lowest was documented in local genotype (19.46 t ha^{-1}).However, the mean yield of two places appeared the highest in BARI SP-12 (33.64 t ha^{-1}) followed by BARI SP-04 (31.28 t ha^{-1}) and BARI SP-11 (30.13 t ha^{-1}) and the lowest was found in local genotype (21.78 t ha^{-1}). The average foliage yield of two places ranged from 4.82 to 5.38 t ha^{-1}. And no significant variations were found in foliage yield and foliage coverage (%) at both places.In the case of organoleptic assessment of storage roots and leaves, BARI SP-04 was the best choice by the respondents due to its appearances, color, taste, texture and fiber content; BARI SP-12 also got merely similar ranked by the respondents. Considering the yield potential and community acceptability, both BARI SP-04 and BARI SP-12 are suitable and potential for homestead food production system in north eastern region of Bangladesh.*

Keywords*— *Orange fleshed sweet potato; Potentiality; Foliage coverage; Organoleptic assessment; Homestead production system.

I. INTRODUCTION

Bangladesh is located in the South Asia between 20°34' to 26°38' N latitude and 88°01' to 92°42' E longitude with an area of 147570 sq km (Sunny et al., 2020a). The North-Eastern part of Bangladesh especially the Sylhet district is the most traditional in agriculture. In addition, floods caused by heavy rain in June- September adversely affected agriculture (Sunny et al., 2020b). On the other hand scarcity of irrigation water restricted agricultural production especially vegetables that caused price hike due to limited access of vegetables (Islam et al., 2018). The soil productivity is also low comparing with the other part of Bangladesh due to high acidic soil condition. Moreover that the people of the Sylhet regions usually cultivate Aman rice in their crop land and rest times keep fallow. After harvesting Aman rice, some produce Boro rice and some produce vegetables. However, most of the people usually produce vegetables in winter rather than summer due to abundant rainfall and waterlogging .Due to external market situation and climate change in part, vegetables usually grow towards the end of the winter that meets the needs of the household in this area. The poor people mostly intake potato and aroids as vegetables from local market during summer. Hence, the people especially women and children are suffering from hidden hunger due to minimal intake of vitamins and minerals from plant sources. According to the Bangladesh Demographic and Health Survey (BDHS 2014) Sylhet division has the highest rates

of child stunting (49.6%) and under-five mortality (67 per 1,000 live births) in the country. Sylhet also has the lowest female literacy rates, the worst school attendance rates for adolescent girls, the highest gender inequality scores, the worst performance against women's empowerment indicators, and overall the lowest proportion of empowered women in the nation. Suchana is a comprehensive project has been working through nutrition sensitive and nutrition specific intervention in Sylhet region to reduce chronic malnutrition of below 2 children. According to Global Nutrition Report 2018 about 22% and 36% children are suffering with stunting globally and nationally respectively

Sweet potato (*Ipomoea batatas L.*) is one of the most traditional root crops in many countries like Bangladesh. Its can play an important role in the context of food security in Bangladesh (Hossain and Siddique, 1985). 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). Sweet potato is one of the most important food crops in terms of caloric value per cultivated area (Scott et. al., 1992). Sweet potato is remarkable because of its high yield, palatability and crude protein content. It'sa traditionally regarded as a 'poor man's crop as it is consumed by poor households. It gives satisfactory yield under adverse climatic and soil conditions, as well as under low or non-use of external inputs (Carey et al., 1999 and Kuddus et al., 2018). The sweet potato is rich in carbohydrates and vitamins (Villareal, 1982) and is a potential ally in the fight against vitamin A deficiency. Indeed, recent research results indicate increased availability of beta-carotene (Provitamin A) and crude protein for good nutrition and health (Ukom et al., 2009). Orange-fleshed varieties are rich in beta-carotene, while purple-fleshed varieties are high in anthocyanins, two important antioxidants thought to prevent chronic heart diseases and cancer (Teow et al., 2007). Significant amounts of essential minerals are found in the sweet potato, including manganese, copper, iron and potassium (Huang, 1982).Sweet potatoes are now being used in Africa to combat a widespread vitamin A deficiency in 250,000 – 500,000 children. About two-thirds of the children developing xerophthalmia, resulting from lack of vitamin A, die within a year of losing their sight. The strategy of increasing orange flesh sweet potato consumption helps to alleviate vitamin A deficiency (Anderson et al., 2007). Orange fleshed sweet potato 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 storage roots (Mondal et al., 2011) and on an average 1600 IU per 100 g of fresh leaves (Bhuiyan et al, 2008). Van Jaarsveld et al. (2005) stated that the daily consumption of OFSP have a positive effect on total body vitamin-A assimilation. Tumwegamire et al. (2004) reported that high yielding varieties of OFSP can supply the least expensive, year-round source of dietary vitamin-A to resource poor small farming households.

In addition, several studies showed that orange-fleshed sweet potato is a potential source of vitamin A, minerals (Fe, Zn, Mn), and other micronutrients such as polyphenols and carotenoids (Haskell et al., 2004). Hossain et al., 2016 stated OFSP 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 OFSP cultivation and consumption at household level. Though, OFSP production & propagation technology is very easy and to some extent drought and acidic tolerance so it could be one of the nutrient sources for poor community at homestead food production system in Sylhet as well as Bangladesh.

Considering above situation the researchers carried out a participatory performance study with four BARI released variety (BARISP-04, BARISP-07, BARISP-08 and BARISP-13) in Suchana working area in 2016-2017production period andBARISP-04 variety performance found better in terms of production and community acceptability. The present study has been conducted to identify more suitable & potential variety for Sylhet region in homestead vegetable production system by involving women members. The researchers has selected BARI released another two variety BARI SP-11, BARI SP-12 and a local genotype tocompare production as well as community acceptability (Fig.3). Physical appearance of root in raw & boil condition). So the aim of the study isto find out suitable, potential and acceptable variety for leaf and root production with high micronutrient content by involving women members of the marginal farming households.

II. MATERIALS AND METHODS

The study was carried out at two locations of Sylhet region during 2018-19 cropping season. Vines of three BARI developed sweet potato varieties viz. BARI SP-04, BARI SP-11 & BARI SP-12 were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and local genotype collected from the farmer of that area. Six

farmers were selected from Nilgaon and Chamurakandi villages of Sylhet Sadar Upazila of Sylhet district. Vines were planted on 19 November 2018 at both locations having plot size of 10ft x 10 ft with 3 replications following RCB design. Fertilizers were applied in the experimental plots @ 70-25-90 kg/ha of N-P-K as a source of Urea, TSP, and MoP, respectively. Weeding, irrigation, earthing-up, vine lifting and other intercultural operations were done as and when necessary. The sweet potato was harvested on 27 March 2019 and 28 March 2019 at Nilgaon (location 1) and Chamurakandi (location 2), respectively. All the yield and yield contributing characters were recorded and analyzed statistically by using Statistical Tool for Agricultural Research (STAR) software. Mean separation were done following Turkey's Honest Significant Difference (HSD) test at 0.05 level of probability.

Leaf production data was collected after one month of transplanting & root production data collected at final harvesting time and sensory test was also done after final harvesting. At harvesting stage, participatory variety selection as well as organoleptic evaluation test for leaves and storage roots was done at both locations. Twenty and twenty one participants (scientists, extension staffs and farmers) were gathered to choose better one of the studied sweetpotato variety for storage roots and leaves, respectively at the time of harvesting and the process was done in two separate days. At first, the author briefed the trial objectives and the procedure of evaluation. Then individual voting was done to select the best variety for storage roots and leaves. Each participant tested the variety one after one and placed tick mark range from 1-5. Two kilograms of sweetpotato roots from each variety was boiled. Each boiled variety was placed on a separate plate and clearly identified by number as well as name tag. On the other side's 500 gm of leaves of each variety was fried with equal amount oil and spices by one cook. In case of root, each panelist was given an evaluation form which was used to record the evaluation in reference to the appearance, flesh color, fiber, texture and taste of each variety. And in case of leaves, panelist provided vote for appearance, texture and taste also. The procedures of evaluation were explained to the members of the panels using simple words.

Evaluation of storage roots:

a. Appearance: The appearance refers to the visual aspect: how the boiled sweetpotatoes from each variety look when presented on plates (Scale: 5=Excellent, 4=Good, 3=Fair, 2=Bad and 1=Very bad)
b. Flesh color: After cross section of boiled sweetpotatoes, how the flesh color look of each variety (Scale: 5= Excellent,, 4=Good, 3=Fair, 2=Bad and 1=Very bad)
c. Taste: The taste is very personal criterion (Scale: 5= Excellent,, 4=Good, 3=Fair, 2=bad and 1=very bad)
d. Texture: The texture refers to the dry matter that the sweetpotatoes possess (Scale: 5=Mealy/Floury, 4=Less floury, 3=Fair/Intermediate, 2=Watery/soggy and 1= More watery/soggy)
e. Fiber: The fiber refers to the presence of fiber in boiled sweetpotato flesh with nacked eye (Scale: 5= No fiber present, 4=Less fiber present, 3=Fair/moderate fiber present, 2=Bad/high fiber present and 1= Roots are fibrous)

Evaluation of leaves:

a. Appearance: The appearance refers to the visual aspect: how the fried sweetpotatoes from each variety look when presented on plates (Scale: 5= Excellent, 4=Good, 3=Fair, 2=Bad and 1=Very bad)
b. Taste: The taste is very personal criterion (Scale: 5= Excellent,, 4=Good, 3=Fair, 2=Bad and 1=Very bad)
c. Texture: The texture refers to the stickiness that the sweet potato leaves possess (Scale: 5=Mealy, 4=Less mealy, 3=Fair/Intermediate, 2=Watery/soggy and 1= More watery/soggy)

III. RESULTS AND DISCUSSION

There were no significant difference was found in the case of foliage coverage (%)at 90 DAP in both places (Table 1). BAR SP-11 and local genotype exhibited the highest foliage coverage (100%) &BARI SP-12 showed99.33%foliage coverage and inboth locationsbut the lowest result 97.67% recorded in case of BARI SP-04. According to the findings of Burgos et al. (2009) and Kuddus et al.(2018) there was no significant variation of foliage coverage of OFSP genotypes and BARI SP-04. BARI SP-07, BARI SP-08 & BARI SP-13 variety respectively.

In case of number of storage roots plant^{-1} varied significantly at ($p< 0.05$) level in both the locations. From location 1, number of storage root per plant^{-1} ranged from 3.33 to 4.67 whereas at location 2 it varied from 3.67 to 5.67 (Table 1). The highest number of storage roots plant^{-1} was recorded in BARI SP-04 (4.67)in location 1 and BARI SP-11 (5.67) in location 2 and the lowest (3.33 & 3.67) in

local genotype at both location. Farooque and Husain (1973) reported that the number of storage roots plant^{-1} varied from 4.70 to 11.76. Siddique (1985) and Kuddus et al (2018) also found the number of storage roots plant^{-1} which varied from 1.73 to 6.03 and 2.33 to 5.00 respectively.

Table.1: Foliage cover (FC) at 90 DAP and no. of storage roots plant^{-1} at two locations of Sylhet region of Bangladesh during 2018-2019 growing season

Variety	FC (%) at 90 DAP		Avg.	No. of storage roots plant^{-1}		Avg.
	Location 1	Location 2		Location 1	Location 2	
BARI SP-04	98.33^{a}	97.67^{a}	98.00	4.67^{a}	4.33^{bc}	4.50^{b}
BARI SP-11	100.00^{a}	100.00^{a}	100.00	4.33^{a}	5.67^{a}	5.00^{a}
BARI SP-12	99.33^{a}	99.33^{a}	99.33	4.00^{ab}	5.00^{ab}	4.50^{b}
Local	100.00^{a}	100.00^{a}	100.00	3.33^{b}	3.67^{c}	3.50^{c}
Mean	99.42	99.25	99.33	4.08	4.67	4.38
CV (%)	0.543			9.71		
LS	NS			0.05		

Means with the same letters in a column are not significantly different at 5% level of probability

In case of storage root length a significant difference were found at ($p< 0.05$) level among the studied varieties in both locations. At location 1, the highest root length (13.59 cm) was found in BARI SP-04 followed by BARI SP-12 (12.98 cm)&BARI SP-11 (11.58 cm) while the lowest was in local genotype (10.73 cm). But in case of location 2 the highest result shown by BARI SP-12 (12.65 cm) followed by BARI SP-04 (11.57 cm) & BARI SP-11 (10.73 cm) and the local genotype showed same result trend of location 1 (Table 2). Considering both the locations, average root length ranged from10.45 cm to 12.58 cm. The storage root length was a genetic character which differed from variety to variety that agreed with the findings of Siddique (1985) and Kuddus et al (2018).

The study recorded significant variations at $p< 0.05$ level among the varieties on storage root diameter in both locations (Table 2). In location 1, the highest diameter was recorded in BARI SP-12 (16.17 cm) followed by BARI SP-04 (13.91 cm), local genotype (13.73 cm) while the lowest was in BARI SP-11(13.17 cm). But in the case of location 2 the highest diameter (11.40 cm) was recorded in local genotype followed by BARI SP-04 (10.63 cm), BARI SP-12 (9.30 cm) and the lowest was found in BARI SP-11 (8.43 cm). The mean diameters were varied from 10.80 cm to 12.74 cm. From the study of Kuddus et al., 2018 found that OFSP root diameter varied variety to variety and location to location.

Table.2: Storage root length (cm) and diameter (cm) of sweetpotato at two locations of Sylhet region of Bangladesh during 2018-2019 growing seasons

Variety	Storage root length (cm))		Avg.	Storage root diameter (cm)		Avg.
	Location 1	Location 2		Location 1	Location 2	
BARI-SP -04	13.59^{a}	11.57^{b}	12.58	13.91^{b}	10.63^{a}	12.27
BARI-SP -11	11.58^{b}	10.73^{c}	11.16	13.17^{b}	8.43^{b}	10.80
BARI-SP -12	12.98^{a}	12.65^{a}	12.82	16.17^{a}	9.30^{b}	12.74
Local	10.73^{c}	10.17^{c}	10.45	13.73^{b}	11.40^{a}	12.57
Mean	12.22	11.28	11.75	14.24	9.94	12.09
CV (%)	3.52			5.09		

Means with the same letters in a column are not significantly different at 5% level of probability

The factor storage roots weight plant^{-1}, significant effect was recorded in case all the varieties and both locations at $p< 0.05$ level. The highest storage roots weight plant^{-1} was recorded (0.94 kg and 0.85 kg) in BARI SP-12 at location 1 & location 2 respectively while lowest was observed in (0.64 kg and 0.52 kg) in local genotype at location 1 & location 2 respectively (Table 3). The mean root weight plant^{-1} ranged from 0.58 kg to 0.90 kg. Considering the factor storage root weight plot^{-1} there is significant variations were foundat $p< 0.05$ level among the varieties in both locations. In location 1, the maximum root weight plot^{-1}(32.78 Kg) was noted in BARI SP-12 followed by BARI SP-04 (31.73 kg) and BARI SP-11 (29.98 kg) while the lowest was in local genotype (22.40 kg). And in location 2, the highest root weight plot^{-1}(29.75 kg) was also found in BAR SP-12 followed by (26.95 Kg & 26.43 Kg) in BARI SP-11 & BARI SP-04 respectively but the lowest root weight plot^{-1} was found in local genotype (18.08 kg). The average root weight plot^{-1} of two locations ranged from 20.24 kg to 31.27 kg (Table 3). From the study of Kuddus et al., 2018 was found that storage root weight plant $^{-1}$ and plot^{-1} also varied significantly in different variety and different location.

Table.3: Fresh storage root weight (kg plant^{-1}) and root weight (kg plot^{-1}) of sweetpotatoat two locations of Sylhet region of Bangladesh during 2018-2019 growing seasons

Variety	Storage root weight (Kg plant^{-1})		Avg.	Storage roots weight (Kg plot^{-1})		Avg.
	Location 1	Location 2		Location 1	Location 2	
BARI-SP- 04	0.91^{a}	0.76^{b}	0.84	31.73^{a}	26.43^{b}	29.08
BARI-SP- 11	0.86^{b}	0.77^{b}	0.82	29.98^{b}	26.95^{b}	28.47
BARI-SP-12	0.94^{a}	0.85^{a}	0.90	32.78^{a}	29.75^{a}	31.27
Local	0.64^{c}	0.52^{c}	0.58	22.40^{c}	18.08^{c}	20.24
Mean	0.84	0.72	0.78	29.23	25.30	27.26
CV (%)	2.39			2.34		

Means with the same letters in a column are not significantly different at 5% level of probability

The yield contributing factor storage roots per hectare varied significantly at $p< 0.05$ level among the studied varieties in both locations. Due to higher adaptability& suitability of Sylhet climatic condition, BARI SP-12 produced the highest yield (35.27 t ha^{-1}) followed by BARI SP-04 (34.14 t ha^{1}) and BARI SP-11 (32.26 t ha^{-1}) while the lowest was produced by local variety (24.10 t ha^{1}) in location 1. At location 2 BARI SP-12 also produced the highest yield (32.10 t ha^{1}) which was statistically significant with BARI SP-04 (28.43 t ha^{1}) and BARI SP-11 (28.00 t ha^{1}) while, the lowest was also produced by local genotype (19.46 t ha^{1}). The result trend of location 2 was found comparatively lower than location 1 it may due to soil condition and other intercultural practices done by the farmers. However, the mean yield of two locations appeared the highest in BARI SP-12 (33.64 t ha^{1}) followed by BARI SP-04 (31.28 t ha^{1}) and BARI SP-11 (30.13 t ha^{1}) and the lowest was recorded in local genotype (19.46 t ha^{1}) (Table 4). The storage root yield of different varieties varied location to location also reported by Hossain et al. (2016) and Kuddus et al. (2018).

Among the studied varieties, there were no significant variations in leave yield (t ha^{1}) in both locations. At location 1, the leaves yield ranged from 4.88 t ha^{1} to 5.34 t ha^{1} and in location 2 it was varied from 4.76 to 5.41 t ha^{1}. The average leave yield of two location ranged from 4.82 to 5.38 t ha^{1} (Table 4).

Table.4: Storage root and leaves yield (t ha^{-1}) of sweetpotatoat two locations of Sylhet region of Bangladesh during 2018-2019 growing seasons

Variety	Storage root yield (t ha^{-1})	Avg.	Leaves yield (t ha^{-1})	Avg.

	Location 1	Location 2		Location 1	Location 2	
BARI-SP-04	34.14[a]	28.43[b]	31.28	5.16	5.41	5.23
BARI-SP-11	32.26[b]	28.00[b]	30.13	4.88	4.76	4.82
BARI-SP-12	35.27[a]	32.01[a]	33.64	5.34	5.41	5.38
Local	24.10[c]	19.46[c]	21.78	4.98	4.88	4.93
Mean	31.44	27.22	29.33	5.09	5.12	5.10
CV (%)	2.34			10.05		

Means with the same letters in a column are not significantly different at 5 % level of probability

Organoleptic evaluation of sweetpotato leaves and storage roots:

Storage root evaluation: Twenty participants (male and female farmers, scientists and extension staffs) participated in the organoleptic evaluation of storage roots. Considering appearance of the roots, flesh color, taste, presence of fiber and flesh texture, BARI SP-04 ranked first followed by BAR SP-12 while participants' choice was the poorest to BAR SP-11 followed by local genotype (Fig. 1). From the study of (Kuddus et al., 2018) same result trend was found and evaluation panel selected BARI SP-04 as the best one.

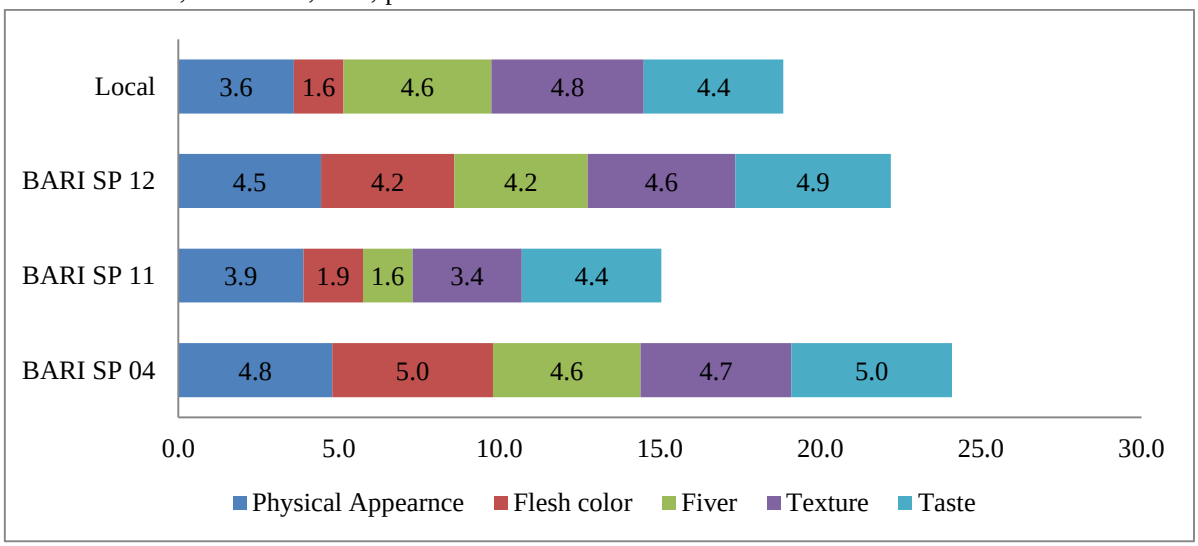

Fig.1. Organoleptic evaluation of storage roots of sweetpotato varieties at SylhetRegion during 2018-2019 growing season. Overall Scale: 5- Excellent, 4-Good, 3- Fair, 2-Bad and I-Very bad

Leaves evaluation: During leaves evaluation, 21 participants (male and female farmers, scientists and extension staffs) participated in the organoleptic evaluation of leaves. The evaluation was done in same way in reference to the appearance, texture and taste of each variety. Considering appearance of the fried leaves, texture and taste, BARI SP-04 ranked first followed by BAR SP-12 while participants' choice was the poorest to BAR SP-11 followed by local genotype (Fig. 2).

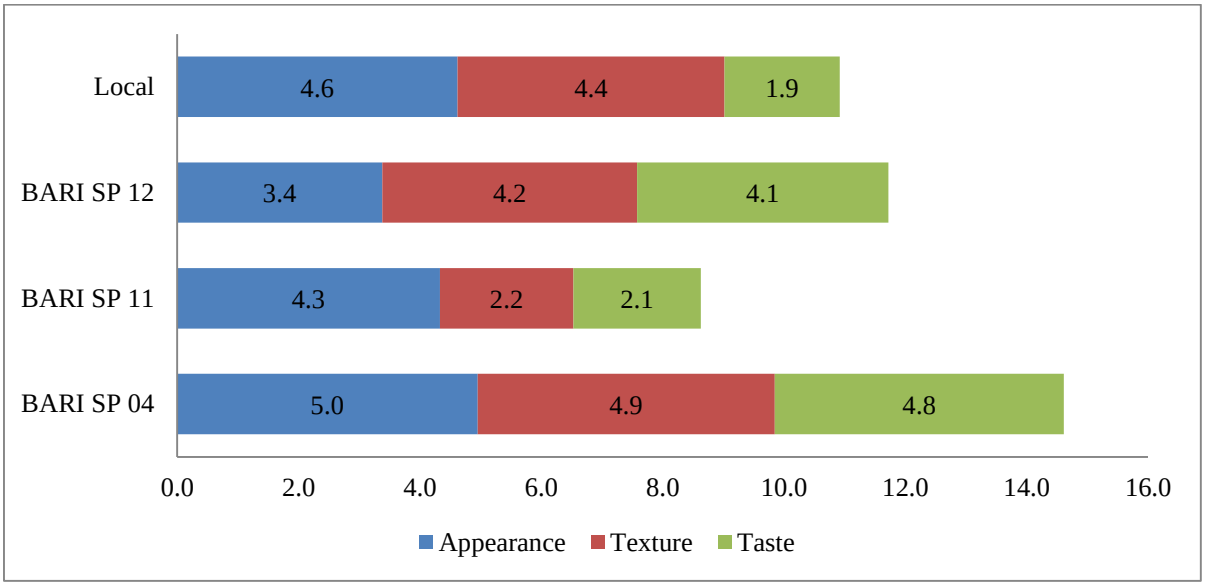

Fig.2: Organoleptic evaluation of leaves of sweetpotato varieties at Sylhet Region during 2018-2019 growing seasons. Overall Scale: 5- Excellent, 4-Good, 3-Fair, 2-Bad and I-Very bad

Fig.3: Physical appearance of three varieties and one genotype roots in raw and boil condition

IV. SUMMARY AND CONCLUSION

According to yield and yield contributing characters, BARI SP-12 was the highest root producer among the studied varieties and genotype followed by BARI SP-04 and BARI SP-11. And the organoleptic evaluation of roots and leaves BARI SP-04 and BARI SP-12 both were found good to excellent and accepted by the farmers. Considering the all aspects, BARI SP-12 and BARI SP-04 both varieties performed better in homestead food production system in north eastern Bangladesh. So,more pragmatic and nutrition sensitive initiative should be taken by the government and nongovernment organizations to promote theses verities up to the marginal community.

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