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Original Article

Benefit Cost Analysis of Orange Fleshed Sweet Potato (*Ipomoea batatas* L.) Varieties under Varying Planting Density

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Abstract

An investigation was conducted at the National Root Crops Research Institute, Umudike and at the Research Farm of Michael Okpara University of Agriculture Umudike, Umuahia, Abia State (Nigeria), to determine the benefit cost analysis of orange fleshed sweet potato (*Ipomoea batatas* L.) varieties under varying planting density (25,000; 33,333 and 50,000 plants/ha). The output of the production was computed by the use of benefit cost ratio (BCR) of the orange-fleshed sweet potato production. The benefit cost ratio analysis indicated that enterprise was successful and growing of the 'Melinda' variety at 50,000 plants/ha was a more profitable enterprise. The benefit cost-cost ratio of 'Melinda' variety at 50,000 plants/ha in 2015 and 2016 was 1.45 and 1.56 respectively while that of 'Tio-joe' at 50,000 plants/ha in both cropping seasons gave a benefit cost ratio of 1.14 and 1.42 respectively. The returns from selling of the vine cuttings brought about an incredible hike in the net return of the enterprise. 'Melinda' at 50,000 plants/ha is recommended to farmers as the most profitable venture in this experiment.

Keywords: benefit cost ratio; planting density; sweet potato

Introduction

Sweet potato *(Ipomoea batata* L.) is an important tuber crop in sub-Saharan Africa and ranks second after cassava in Malawi (Chipungu *et al*., 1999). It ranks as the world's seventh most important crop with an estimated annual production of 300 million metric tons and grown on 19 million hectares of land (Amamgbo and Nwachukwu, 2008; Kwach *et al*., 2010; Muthoni *et al*., 2011; Laurie *et al*., 2013).

Some new yellow and orange fleshed sweet potato genotypes with improved agronomic traits (especially vines and tuber yield) had been introduced to Umudike, Nigeria, from International Potato Centre, Lima, Peru between 2005 and 2006 (Ukpabi*et al*., 2012). Orange-fleshed sweet potato (OFSP) is both drought resistant and easily cultivated. Some (OFSP) varieties have high levels of beta-carotene (pro-vitamin A) in the roots, sufficient to play a key public health role in interventions aiming to reduce the prevalence of the vitamin A deficiencies that occur across much of Sub-Saharan Africa (Low *et al*., 2007).

Planting density is one of the most important factors contributing to high yield and vine production of sweet potato crop (Abdissa *et al*., 2011). For high net return in sweet potato tuber and vine production, Idoko *et al.* (2016) recommend intra row spacing of 20 cm as against 30 cm and 40 cm per hectare; Mortley *et al*. (1991); Sokoto *et al*. (2007) and Onunka *et al*. (2011) recommended 50,000 plants/ha, as against 33,333 plants/ha and 25,000 plants/ha and Belehu (2003) reported 55,555 plants/ha as optimum for sweet potato as against 75,000, 25,000 and 33,333 plants/ha respectively.

These authors had recommended various planting densities in sole cropping of sweet potato for tuber and vine production. Though much works had been done and published as touching performance of sweet potato in different planting density, there is dearth of information on the benefit cost ratio in the subject. Therefore this trial was carried out to determine the benefit cost analysis of orange fleshed sweet potato varieties under varying planting density in this agro-ecology.

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Materials and Methods

Field experiments were conducted at the western farm National Root Crops Research Institute (NRCRI) Umudike and Michael Okpara University Umudike Abia State Nigeria, during the 2015 and 2016 cropping seasons respectively to determine the benefit cost analysis of orange-fleshed sweet potato varieties in South Eastern Nigeria. The study sites were located on longitude 007° 31' E and latitude 05° 28' N at an elevation of 109 m above sea level and longitude 007° 33' E and latitude 05° 9' N at an elevation of 136 m above sea respectively in the tropical rain forest zone of Nigeria. The textures of the top soil (30 cm) of the two experimental sites were sandy loam (Table 1). The experiment was laid out in a 2 × 3 factorial fitted in a randomized complete block design (RCBD) with six replications.

Treatments consisted of two varieties of orange-fleshed sweet potato ('Tio-joe' and 'Melinda') varieties at three planting densities (25,000; 33,333 and 50,000 plants/ha), giving a total of 6 treatment combinations. The planting materials used in the two cropping seasons were sweetpotato vines obtained from National Root Crops Research Institute Umudike, Abia State. Sweet potato vine cuttings of 20-25 cm were planted on the crest of the ridges with the varying planting density in the two cropping seasons (2015 and 2016) of the experiment.

Weeding was carried out at 4 and 8 weeks after planting (WAP) in each cropping season. Fertilizer application for the two cropping seasons was with NPK 15:15:15, which was applied at 4 WAP at the rate of 450 kg/ha immediately after the first weeding. The following growth parameters were taken at 8 WAP: number of branches, vine length and vine girth; while the marketable roots (comprised of tuberous roots > 150g which are not infested by pest and diseases respectively), and unmarketable roots (comprised of roots < 150g) were taken at 14 WAP at harvest.

The output of the production was computed by the use of benefit cost ratio (BCR) of the orange-fleshed sweet potato production. According to Aiyeloja (2007) the methodology of interpreting benefit cost ratio indicates that BCR greater than 1, means that the Net Profit Value (NPV) of the project benefits outweigh the Net Profit (NPV) Value of the costs. Therefore, the project should be considered if the value is significantly greater than 1. If the BCR is equal to 1, the ratio indicates that the NPV of expected profits equal the costs. If a project's BCR is less than 1, the project's costs outweigh the benefits and it should not be considered.

This helps the entrepreneur to know if he remains in business or out of it. The benefit cost ratio (BCR) is given as:

$$BCR = \sum B / \sum C$$

Where $\sum B$ = Total net benefit and

$\sum C$ = Total cost of production of the enterprise

Results

From Tables 2 and 3, 'Melinda' at 50,000 plants/ha gave the highest total revenue of N1,218,000 and N1,390,950 in both cropping seasons while 'Tio-joe' at 25,000 plants/ha gave the lowest total revenue of N808,000 and N874,800 in both seasons respectively. The Net profit generated from the enterprise was highest at 'Melinda' × 50,000 plants/ha giving N720,676.20 and N 847,663.29 from both cropping seasons respectively, while the lowest the net profit of N 417,142.88 was obtained from 'Tio-joe' × 25,000 plants/ha at the first cropping season and a N436,813.29 was obtained from 'Melinda' × 25,000 plants/ha.

The economic analysis showed that growing of 'Melinda' variety × 50,000 plants/ha recorded the highest benefit cost ratio of 1.45 in 2015 and 1.56 in 2016 respectively (Tables 2 and 3). The least benefit cost ratio was recorded from 'Tio-joe' × 25,000 plants/ha (1.07) in 2015 and 'Melinda' × 25,000 plants/ha (1.01) in 2016.

Discussion

In both seasons the total variable cost and total revenue of the varieties increased as the planting density increased, this agrees with the findings Idoko *et al*. (2016) in which it was observed that intra row spacing of 20 cm gave the highest net return per hectare as against 30 cm and 40 cm in sweet potato production. The 1.56 benefit cost ratio of 'Melinda' variety at 50,000 plants/ha implied that for every N1.00 invested on 'Melinda' variety grown at 50,000 plants/ha planting density N1.56k is realizable.

Table 1. Soil analysis of the experimental sites in 2015 and 2016

Physical characteristics	2015	2016
Sand (%)	67.2	75.8
Silt (%)	9.0	10.8
Clay (%)	23.8	13.4
Textural class	Sandy loam	Sandy loam
Chemical properties		
pH (H_2O)	5.2	5.8
Organic matter (%)	0.87	1.93
Total nitrogen (%)	0.182	0.097
Avail. P (mg kg^{-1})	67.8	33.4
Exchangeable K (cmol kg^{-1})	0.079	0.221
Exchangeable Ca (cmol kg^{-1})	2.80	3.20
Exchangeable Mg (cmol kg^{-1})	1.60	1.20

Table 2. Benefit cost ratio analysis of the orange-fleshed sweet potato at 2015 cropping season

Input/ Output	Melinda × 25,000 plants/ha	Melinda × 33,333 plants/ha	Melinda × 50,000 plants/ha	Tio-joe × 25,000 plants/ha	Tio-joe × 33,333 plants/ha	Tio-joe × 50,000 plants/ha
			Input (₦/ha)			
Cost of planting material	101,333.32	133,333.33	208,000	101,333.32	133,333.33	208,000
Land preparation	34,800	34,800	34,800	34,800	34,800	34,800
Planting of the vines	30,000	30,000	30,000	30,000	30,000	30,000
Weeding	65,231.5	65,231.5	65,231.5	65,231.5	65,231.5	65,231.5
Fertilizer application	42,083	42,083	42,083	42,083	42,083	42,083
Harvesting	30,509.3	30,509.3	30,509.3	30,509.3	30,509.3	30,509.3
Total cost	390,857.12	422,857.13	497,523.8	390,857.12	422,857.13	497,523.8
			Output (kg/ha)			
Tuber	7,100	5,500	9,500	13,600	13,900	13,200
Vines (bundle)	1,667	2,000	2,333	1,000	1,333	1,667
			Revenue (₦/ha)			
Tuber	213,000	165,000	285,000	408,000	417,000	396,000
Vines (bundle)	666,800	800,000	933,200	400,000	533,333	666,800
Total revenue	879,800	965,000	1,218,200	808,000	950,333	1,062,800
Net profit	488,942.88	542,142.87	720,676.2	417,142.88	527,475.87	565,276.2
Benefit-cost ratio	1.25	1.28	1.45	1.07	1.25	1.14

Source of cost; NRCRI, farm gate price of N30 per kg for sweet potato roots and N400 per bundle of orange-fleshed sweet potato vine cutting

Table 3. Benefit cost ratio analysis of the orange-fleshed sweet potato at 2016 cropping season

Input/ Output	Melinda × 25,000 plants/ha	Melinda × 33,333 plants/ha	Melinda × 50,000 plants/ha	Tio-joe × 25,000 plants/ha	Tio-joe × 33,333 plants/ha	Tio-joe × 50,000 plants/ha
			Input (₦/ha)			
Cost of planting material	114,000	150,000	225,000	114,000	150,000	225,000
Land preparation	92,592.59	92,592.59	92,592.59	92,592.59	92,592.59	92,592.59
Planting of the vines	46,296.29	46,296.29	46,296.29	46,296.29	46,296.29	46,296.29
Weeding	81,018.51	81,018.51	81,018.51	81,018.51	81,018.51	81,018.51
Fertilizer application	52,083	52,083	52,083	52,083	52,083	52,083
Harvesting	46,296.29	46,296.29	46,296.29	46,296.29	46,296.29	46,296.29
Total cost	432,286.71	468,286.71	543,286.71	432,286.71	468,286.71	543,286.71
			Output (kg/ha)			
Tuber	4,780	3,670	6,360	9,160	9,370	8,790
Vines (bundle)	1667	2,333	2,667	1,333	2,000	2,333
			Revenue (₦/ha)			
Tuber	213,000	165,000	285,000	408,000	417,000	396,000
Vines (bundle)	750,000	1,049,850	1,200,150	600,000	900,000	1,049,850
Total Revenue	893,400	1,159,950	1,390,950	874,800	1,181,100	1,313,550
Net profit	436,813.29	691,663.29	847,663.29	442,513.29	712,813.29	770,263.29
Benefit cost ratio	1.01	1.48	1.56	1.02	1.52	1.42

Source of cost; NRCRI farm gate price of N30 per kg for sweet potato roots and N450 per bundle of orange-fleshed sweet potato vine cutting

This agreed with the findings of Toluwase and Abduraheem (2013) who recorded a benefit cost ratio of 1:2.19; in a cassava production which indicates that for every N1.00 investment on cassava production N2.19 is realizable. From Tables 2and 3, it was observed that the benefit cost ratio of the enterprise in the two seasons was greater than 1, which implied that the benefit of the project outweighed the cost.

Conclusions

From this work, the benefit cost ratio calculation showed that the enterprise was successful and the highest benefit cost ratio was obtained from 'Melinda' at 50,000 plants/ha in 2015 and 2016. The returns from selling of the vine cuttings brought about a hike in the net return of the enterprise. 'Melinda' at 50,000 plants/ha will be of great interest to farmers as the most profitable venture in this agro ecology.

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