International Journal of Scientific & Engineering Research Volume 9, Issue 7, July-2018
1742
ISSN 2229-5518

Profitability of Investment in Biofortified Food Crop: A Case Study of Biofortified Cassava Value Chain in Nigeria.

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Abstract.. Biofortification is one of the promising interventions to address global micronutrient deficiencies and attaining the Sustainable Development Goals by year 2050. To achieve this goal, scaling up such an intervention by creating efficient marketing and supply chain systems would require private sector investments. One of the barriers to the uptake of new technology by the private sector is usually lack of empirical knowledge about return on investment. This study examined the profitability of private sector investments in biofortification using the case of biofortified vitamin A cassava value chain in Nigeria. A multistage random sampling was used to select 130 businesses. Findings from the study revealed that Vitamin A cassava has a high level of integration accounting for 53% of the total volume of cassava traded by all businesses surveyed. The result indicates that investing in vitamin A cassava as a business is very profitable with the level of profit ranging from 79% (micro scale investors) to 190% (medium scale investors). The larger the scale of investment into vitamin A cassava, the more profit investors earn. These results have implications for the design of effective advocacy strategies to attract more private sector investments into vitamin A cassava value chain in Nigeria.

Keywords: Biofortification, Vitamin A, Profitability, Investment, Value chain, Food crop, Cassava

1. INTRODUCTION

Vitamin A deficiency (VAD) is a global public health challenge causing preventable blindness in children and pregnant women. VAD leads to increased risk of disease and death from severe infection and especially heightened risk of maternal mortality among women. About 250 million preschool children are vitamin A deficient globally and up to half a million vitamin A-deficient children become blind yearly (WHO, 2014). Only a marginal reduction in stunting from 41% to 37% has been achieved in Nigeria over several decades. In Nigeria, about 30 percent of children under five are vitamin A deficient (Maziya-Dixon *et al*., 2006) and a recent study by De Moura *et al*. (2015) found that VAD was prevalent among 17 percent of children under five and 3 percent of women in the southern state of Akwa-Ibom in Nigeria.

With a population of 170 million in Nigeria where young people represent a significant quota, biofortification of commonly consumed staples to have higher micronutrient content is a strategic and urgently needed intervention. The development and delivery of vitamin A cassava in Nigeria, which has been ongoing for almost a decade is intended to complement existing national strategies (supplementation, industrial fortification and dietary diversification) in combating nutrient deficiency.

The International Institute of Tropical Agriculture (IITA) and National Root Crops Research Institute (NRCRI) in close collaboration with HarvestPlus have recently released six new biofortified yellow cassava varieties that are conventionally bred to have high beta-carotene contents. The goal is to promote adoption and consumption of vitamin A yellow cassava among farming households in the country. These households are encouraged to cultivate, process, and consume vitamin A cassava products at the household level. Apart from the basic products such as *gari*, *fufu*, *lafun* high quality cassava flour (HQCF), low quality cassava flour (LQCH), other value-added products such as *combobits* and *combostrips* have been developed from vitamin A cassava.

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Despite the huge potential in using biofortified (vitamin A) cassava production and processing to complement existing strategies in combating malnutrition, food insecurity and poverty in Nigeria, the vitamin A cassava industry is yet to attract adequate number of investors across its value chain. Since 2015, efforts have been made to encourage private sector to invest in the distribution of Vitamin A cassava stem and processing of the tubers into various products in order to ensure high level integration of this technology into households menu list particularly in all the 24 States where cassava production and consumption is highly important. Consequently, HarvestPlus aimed to ensure that 70,000,000 people are aware of pro-vitamin A, 500,000 new farmers plant vitamin A cassava, and 3 million persons consume the products annually and up to 1200 small and medium scale investors invest in the value chain to bridge the current gap between demand and supply of vitamin A cassava by the end of the year 2016. To achieve these goals, there is a need to empirically analyze the profitability of various types, levels and scale of investment along the vitamin A cassava value chain. Specifically, this study aimed at analyzing net returns on investment in each sub-sector and by level of investment, determines which node of investment that yields the best profit margin and examine the factors that affect profitability and account for its variations across the value chain. Findings from this study could serve as a tool to encourage scaling up among present investors and advocate for more investment along Vitamin A cassava value chain among potential investors.

2 MATERIALS AND METHOD

2.1 Study Area and Sampling Techniques

The study was conducted in three States of Nigeria; Oyo, Akwa Ibom and Benue. These states were selected because they are major cassava-growing states where cassava is a staple in the diet; and they are the key target states for the HarvestPlus delivery program in Nigeria. The sampling of businesses was based on a list of existing businesses that have been investing and trading with vitamin A cassava in Nigeria. This list was obtained from the HarvestPlus program website. The list has already categorized businesses along the product line or business type in the vitamin A cassava value chain and these are (a) stem/tuber production, (b) processing (i.e. gari, fufu and HQCF), (c) value addition (processing of value added products which include Combobits, Combostrips, Chin Chin), (d) restaurants and (e) point of sale (POS). The sampled businesses in each sub-sector were selected along business types. Within each business type, HarvestPlus Nigeria program has classified the businesses into scale of investment based on its knowledge of the value of products that the businesses have capacity to process or trade. Firms were categorized into four scales of investment or operation: Micro (≤ ₦100,000.00), (ii). Small (₦100,000.00 - ₦999,999.99), (iii).Medium (₦1M – ₦10M), and (iv). Large (>₦10M).

A multi-stage cluster sampling procedure was used to select sample businesses. For ease of transportation logistics, Oyo State was divided into three zones: Zone 1 (Ibadan), Zone 2 (Ibarapa-Iseyin-Kajola) and Zone 3 (Oyo-Ogbomosho). In each zone, businesses were randomly selected proportionately to size. A total of 106 businesses were randomly selected in Oyo state but only 89 businesses' interviews were successfully completed owing to time constraints on the part of the business owners and their agents. Efforts were made to ensure that in most cases the business owners and the managers were interviewed, which required multiple re-visits to each business. The same sampling steps were followed to randomly select businesses in Akwa-Ibom and Benue states except that fewer numbers of businesses were randomly selected in these two states owing to budget and logistical constraints. First, in these states we selected businesses from stem/tuber production and processing business types only. Second, the numbers of businesses selected in these business types were significantly lower compared to those selected in Oyo state. Of all sampled businesses in Oyo state, stem/tuber production businesses represents about 36%, gari processing represents 33% while HQCF processing represents only 1%. In Akwa Ibom, a total of 21 businesses were randomly selected while only 20 interviews were successfully completed. In Benue State, a total of 19 businesses were randomly selected and all of the interviews were successfully completed. Table 1 summarizes the sample size by study location, sub-sector (i.e. business type) and investment scale.

2.2. Data Collection

The study was implemented by first conducting a book inventory for each business (in cases where records were kept) followed by the implementation of a pretested structured questionnaire covering various key variables required for margin computation. Subsequently case studies of two processing/trading batches were conducted for each business (except for stem/tuber producers). Evidence from (a) questionnaire and (b) case studies were triangulated to improve data validity and accuracy. Thus businesses were then defined along the product line as gari businesses, fufu businesses and HQCF businesses. The main respondents were the business owners. Information were collected on

general business parameters (such as year of establishment, number of employees, and socio-economic characteristics of business owners and their agents) and on variables required to compute profitability measures. The data collection instruments are described as follows:

(i) **Survey questionnaire:** Owing to the heterogeneity in scale and types of investments, different types of questionnaire were developed and used to collect business information required to compute profitability measures. This questionnaire-type was implemented with cassava processors, confectioneries' caterers and Point of Sale (POS) operators.

(ii) **Visual observation:** As a tool to enhance the validation process for the data collected, an observational batch instrument was also implemented. In this case, enumerators visually observed and documented business information for an ongoing processing and trading batch. Each steps of the batch operation was observed from cradle to grave i.e. the day-to-day activities/operations of each investor were visually observed and documented for one batch. This provided the contextual information needed to complement data collected for other reference periods.

2.3. Profitability Computational Approach

Profitability estimates were computed within the reference period for the business operation activities that are only relevant to vitamin A cassava. Profitability was estimated for the 3-month reference period in the case of cassava processors, confectioneries and POS businesses while it was computed for the 12-month reference period for the stem/tuber production businesses. Descriptive statistics was used to describe the various activities and operations of investors in each business type using frequency counts, means, and standard deviations. The budgeting technique was used to outline various elements of cost and revenue for each business type along the value chain.

2.3.1 Total Fixed Cost (TFC) Computation

This is the computation of indirect production costs (fixed costs) which are independent of the level of production and volume of sales (at least over a certain range). In computing the TFC, the steps below were followed:

Step 1 (annual depreciation value): For each of the building or machineries that were used in the business operations within the reference period, its average market value obtained was divided by its useful life (number of years) using the straight line method, to give the annual depreciation value. The average lifespan of various fixed cost items are presented in Appendix II.

Step 2 (reference period adjustment): In the case of the 3-month reference period, the annual depreciation value for each fixed cost item was divided by 4 (i.e. 12 months/3 months) to obtain the three months' depreciation value. However, the annual depreciation value is directly applicable for the 12-month reference period.

Step 3 (product output ratio adjustment): Since each business can produce more than one cassava products, the estimates for each fixed cost item in step 2 were further divided by the product ratio to give the actual fixed cost incurred on each product from the range of products produced by each business enterprise. This is not applicable to POS businesses but to businesses involved in production, processing and value addition. The different products produced are: gari, high quality cassava flour (HQCF), fufu, lafun, combobit, combostrips and chin-chin. The product ratio for product, *j* and business, *i* was computed as:

$$\text{Product ratio}_{ij} = \frac{\text{Quantity of specific product of interest}_{ij}}{\text{Total quantity of all products produced}_{ij}} \quad \ldots(1)$$

Step 4 (total fixed cost): The estimated value from step 3 represents the fixed cost (also referred to as use cost) for each of the individual fixed cost items within the reference period. The summation of all the individual item fixed costs gives the total fixed cost (TFC) for a particular product per business.

2.3.2 Total Variable Cost (TFC) Computation

This is the computation of direct production costs (variable costs) that include cost items such as labor, materials and supplies, which are consumed directly in the production process. In computing the TVC, these steps were followed:

Step 1 (product output ratio adjustment): Raw material costs were obtained directly for each product produced within the reference period. Thus, there is no need to adjust the raw material costs for product output ratios. However, for each of the other variable costs, the cost information obtained was jointly shared among different products produced by the business enterprise within the reference period. For instance, finished products are typically jointly transported to customers. Therefore, for these variable costs,

applicable cost data were adjusted based on the number of products produced by each business enterprise, using the product ratio formula.

Step 2 (Summation of all variable cost items): Costs across all individual variable cost items are summed to give the total variable cost (TVC) per business enterprise.

2.3.3 Total Cost (TC) Computation

This is the summation of the total fixed cost and the total variable cost for product, *j and* business, *i* as follows:

$$TC_{ij} = TFC_{ij} + TVC_{ij} \quad \text{.....(2)}$$

2.3.4 Total Revenue (TR) Computation

TR is the monetary value of product output sold by a business enterprise within a reference period. Thus TR is the product of output quantity (Q) and unit price (P). The quantity is measured in Kg and the unit price is Naira per Kg.

$$TR = Q\ x\ P \quad \text{.....(3)}$$

The summation of the total revenue is referred to as the total cash revenue. The total quantity used for other purposes (such as gift or home consumption) was multiplied with wholesale price and this is referred to as the total non-cash revenue (Abeywardhana, 2015).

2.3.5 Profitability Measures' Computation

Profit margins show a firm's overall efficiency in generating returns and performance. Profitability measures for each business enterprise were computed as follows:

(a) Net Profit (NP): The gross net profit is computed by deducting the total cost (TC) which is made up of the total fixed cost (TFC) and total variable cost (TVC) from the total revenue (TR). That is,

$$NP_{ij} = TR_{ij} - TC_{ij} \quad \text{.....(4)}$$

(b) Return on Investment (ROI): ROI is a percentage measure computed by dividing the net profit by the total cost (TC). That is,

$$ROI_{ij} = \frac{NP_{ij}}{TC_{ij}}. \quad \text{.....(5)}$$

(c) Gross Profit Margin (GPM): GPM is a margin ratio computed from the ratio of net profit to total revenue (TR) expressed as percentage. That is,

$$GPM_{ij} = \frac{NP_{ij}}{TR_{ij}} \quad \text{.....(6)}$$

3 RESULTS AND DISCUSSION

3.1 Vitamin A Cassava Market Structure

The percentage of firms investing in Vitamin A cassava by scale of operation is shown in Table 1 below, stem/tuber production, gari processing and fufu processing are the most concentrated sub-sectors in terms of number of businesses in the cassava industry. A majority of the businesses are operating in the gari processing sub-sector (34%), which requires less technology input compared with the HQCF processing sub-sector where the smallest number of businesses operates (2%). By scale of operation, a relatively larger percentage of businesses across the different product lines are at the micro level. For example, micro stem/tuber producers represent about 44%, gari processors 61% and fufu processors 47%. The relatively larger percentage of micro scale businesses may suggest that, as a new technology in the market, many investors in vitamin A cassava tend to start small to guide against the risks that may be associated with the early stage of a new technology.

3.2 Socio-Economic Characteristics of Investors

In 83% of businesses, the business owner was the respondent while in 17% of all cases, the company manager, operations or sales representative was interviewed. Respondents representing the medium and large scale businesses completed higher years of education compared with those representing the micro and small scale businesses (Figure 3). The business owners are about 49 years old on average and this is not significantly different across scales of investment. Women owned a majority of the businesses surveyed (59%). With the exception of medium scale businesses, all other investment scales are dominated by female investors. This suggests that trading in vitamin A cassava is favorable among female investors, which is more likely due to the nutrition appeal nature of biofortified cassava. However, this is also due to the nature of the business. For example about 88% of stem/tuber producing businesses is owned by men while all catering (confectioneries) businesses are owned by women (Figure 1).

3.3 Share of Vitamin A Cassava in Total Cassava Quantity Traded

Respondents were asked to state the percentage of total cassava traded that was vitamin A cassava within the referenced period. The share of vitamin A cassava in total cassava produced by the stem/tuber producing businesses within the 12 month reference period is about 47% (Figure 2a). The POS operators and confectioneries (caterers) traded with vitamin A cassava products only. This is as expected

since these two business types were specifically created by the HarvestPlus program to attract private sector investments. It is however interesting to find that vitamin A cassava composes 40% and above in the total quantity of cassava traded by all other business types. This high level of vitamin A cassava integration into cassava businesses surveyed suggests that vitamin A cassava would at least have the same profitability level as the white cassava for it to gain such level of penetration into investors' businesses. Figure 2b shows that the share of vitamin A cassava in total cassava traded increases with the scale of investment. The micro scale businesses which are the majority of the sample have less than half of their cassava trade integrated with vitamin A cassava while other business scales have more than half.

3.4. Average Fixed Cost

The average fixed cost for the study's reference periods used increases with the scale of investment (Table 2). Table 2 also shows that the average fixed cost is highest for stem/tuber and HQCF production, which require a significant amount of land and building cost compared with other businesses such as gari and fufu processing. Restaurant and POS businesses have the least fixed cost, which is more likely due to their micro and small scale nature of operation.

3.5 Average Operating (Variable) Cost

The average variable cost for businesses surveyed is presented in Table 3. The result shows that for each scale of investment, the cost of labor and raw materials is highest on average. Table 3 also shows that total variable cost for micro scale businesses is only about 2% of the total variable cost for the large scale businesses, while those of small and medium scale businesses are 4% and 19% respectively.

3.6. Average Revenue

Table 4 presents the average cash and non-cash revenue generated within the reference periods used by businesses surveyed. Similar to the market share computation, the results show that a majority of the cash revenue were obtained by the stem and tuber producing, and gari and HQCF processing firms. Non-cash revenue is significantly higher for the stem and tuber, gari and confectioneries firms compared to the rest of the firms. This is consistent since such businesses could use some of their inventories as gifts, for home consumption and other purposes. However, Figure 3 shows that only micro and medium scale businesses utilize a share of their vitamin A cassava product inventory for purposes other than business. Micro scale businesses used on average about 15% but this decreases with the scale of investment.

3.7 Profitability Measures

The results of the profitability analysis[1] in Table 5 show that businesses investing in Vitamin A cassava are profitable. On the positive side, 95% of the firms were profitable within the reference period while about 5% of the businesses had negative net profit value. For those businesses losing, their loss in terms of the gross profit margin (GPM) ratio ranges from -135% to -7%. On average, profitable businesses earned GPM of about 48% (±20%). The result shows that while Stem/tuber producers earned about ₦657,000/annum on average, gari and HQCF processors earned₦435,000 and ₦462,000 respectively on average within 3 months of operation (March – May, 2015). If we assume that sales is consistent across the year, this result means that on an annual basis gari and HQCF processors, respectively, can earn about ₦1.74 million and ₦1.85 million per annum on average. However, this is not likely to be the case as cassava sales in Nigeria is very seasonal (Chan *et al,* 2011).

The result (Table 5) further suggests that gari and HQCF processing have the highest net profit in Naira, stem and tuber producers have lower gross profit margin than processing businesses while the medium and large scale businesses also have the highest gross profit margin and return on investment.

When the GPM and ROI are considered simultaneously (Figure 4), the medium scale businesses are the most profitable followed by the large scale businesses. This role of the significantly larger fixed cost as the reason why larger firms have same GPM level as the medium scale businesses is corroborated by their ROI values. While the medium scale businesses have a ROI of about 190% on average, the large scale businesses have a lower ROI of about 161%. The implication of these results is that, first, the larger the scale of investment in vitamin A cassava, the more profit investors earn. Second, vitamin A cassava is a very profitable business for investors. All scales of cassava business that have invested in the production of vitamin A cassava stem and tubers have earned an average gross margin profit ratio of 33% within 12 months of operation. Similarly all scales of businesses that have invested in processing vitamin A cassava products have earned an average gross profit margin ratio of about 46% within 3 months of operation

while POS and restaurant businesses earned about 34% GPM on average. This is irrespective of the state in which the business is located. Thus these values suggest the potential margins that an investor interested in vitamin A cassava can earn per annum.

4 CONCLUSIONS AND POLICY IMPLICATIONS

This study concluded that businesses investing in biofortified vitamin A cassava are very profitable, the larger the scale of investment, the more profit margin and return on investment investors earned. The most profitable business types across the states on average are fufu, HQCF and gari processing businesses with a gross margin ratio of 56%, 55% and 53% respectively. The least profitable business types on average across the states are stem/tuber production and POS operation with gross profit margin ratio of 30% and 33%, respectively. Also, we found that vitamin A cassava has gained a very high level of integration into the cassava businesses surveyed. This result suggests that the supply-side of the market is not yet robust and this shows that there is a significant business opportunity on the supply-side of the vitamin A cassava market in Nigeria. To enhance program sustainability of this innovation, more investors need to be attracted to stem and tuber production. Also the technology delivery program needs to provide the right incentives to attract more investors into stem and tuber production node of the vitamin A cassava value chain.

ACKNOWLEDGEMENTS

We would also like to acknowledge the financial support provided by HarvestPlus, International Food Policy Research Institute, Washington DC, and the support given by HarvestPlus staff in Nigeria who provided invaluable facilitation of the study. We are grateful to all business decision makers who were interviewed out of their business schedules to make this project a success. We thank the Agricultural Development Programs (ADP) officers in the Ministry of Agriculture and Rural Development in Akwa-Ibom, Benue and Oyo states who assisted in data collection. Finally, we specially appreciate Obafemi Awolowo University, Ile-Ife, Nigeria, for providing an enabling environment in which this study was undertaken.

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Tables and Figures

Table 1: Percentage of firms by scale of operation

Business Type	Micro	Small	Medium	Large	Total

	(n=64)	(n=49)	(n=12)	(n=5)	(n=130)
Stem/tuber producers	43.9	36.6	14.6	4.9	31.5
Gari processors	61.4	27.3	4.5	6.8	33.8
Fufu processors	47.4	42.1	10.5	0.0	14.6
HQCF processors	0.0	66.7	33.3	0.0	2.3
Caterers (Confectioneries)	42.9	42.9	14.3	0.0	5.4
Restaurant operators	50.0	50.0	0.0	0.0	6.2
Point of Sale (POS) operators	37.5	62.5	0.0	0.0	6.2
Share of all businesses	**49.2**	**37.7**	**9.2**	**3.8**	**100.0**

Table 2: Mean (± std. dev.) Fixed Cost by Scale of Investment and Business Type ('000 Naira)

Fixed cost item	Micro	Small	Medium	Large
Building/Trading Space	5.2±9.5	14.4±15.8	52.6±77.4	198.0±170.6
Machinery/Equipment	3.2±10.5	6.0±14.1	104.1±183.6	405.8±242.6
Total Fixed Cost*	6.7±14.2	17.1±23.6	148.0±222.1	603.7±356.3

*adjusted for reference period's depreciation cost; Exchange rate at the time of the survey: US $1 = N200 (May, 2015)

Table 3: Mean (± std. dev.) Variable Cost by Scale of Investment ('000 Naira)

Variable cost item	Micro	Small	Medium	Large
	N = 64	N= 49	N = 12	N = 5
Raw material cost	23±19	61±72	178±278	1110±650
Energy/fuel cost	5±8	9±9	30±24	634±583
Labor cost	18±32	54±75	330±257	1032±1208
Equipment maintenance/repair cost	14±10	15±14	46±40	438±455
Transportation cost	15±11	27±27	131±109	471±578
Packaging material cost	4±5	6±7	95±130	66±13
Marketing and advertisement cost	1±2	8±14	12±9	72±66
Administrative cost	3±5	8±14	53±52	130±98
Total variable cost (TVC)	58±45	132±94	721±379	3745±2966

Exchange rate at the time of the survey: US $1 = N200 (May, 2015)

Table 4: Mean (± std. dev.) Revenue by Business Type ('000 Naira) (N = 130)

Variable cost item	Period of operation	Cash Revenue	Non-Cash Revenue	Total Revenue
Stem/tuber producers (n = 41)	12 months	1267±3322	45±65	1312±3312
Gari processors (n = 44)	3 months	652±1777	36±65	688±1789
Fufu processors (n = 19)	3 months	404±776	7±7	410±780
HQCF processors (n = 3)	3 months	794±693	2±4	796±690
Caterers (Confectioneries) (n = 7)	3 months	357±407	10±19	367±420
Restaurant operators (n = 8)	3 months	124±179	3±3	153±172
Point of Sale (POS) operators (n = 8)	3 months	241±298	0.5±1	241±298

Exchange rate at the time of the survey: US $1 = N200 (May, 2015)

Table 5: Average profitability of businesses investing in vitamin A cassava* ('000 Naira)

Business type	Period of operation	% losing	Total fixed cost	Total variable cost	Total cost	Total Revenue	Net profit	Gross profit margin ratio
Stem/tuber producers (n = 41)	12 months	7%	89.4 (224.8)	565 (1469)	655 (1680)	1312 (3312)	657 (1699)	33% (39)
Gari processors (n = 44)	3 months	5%	34.6 (103.9)	221 (512)	254 (598)	688 (1789)	435 (1196)	46% (27)
Fufu processors (n = 19)	3 months	0%	33.9 (132.1)	140 (233)	174 (342)	410 (780)	236 (463)	55% (17)
HQCF processors (n = 3)	3 months	0%	64.3 (22.5)	270 (279)	334 (302)	796 (690)	462 (411)	47% (29)
Caterers (Confectioneries) (n = 7)	3 months	14%	5.8 (3.5)	99 (81)	105 (82)	367 (420)	262 (342)	52% (32)
Restaurant operators (n = 8)	3 months	13%	5.4 (4.4)	66 (51)	63 (51)	153 (172)	90 (126)	35% (58)
Point of Sale (POS) operators (n = 8)	3 months	0%	0.9 (0.5)	3 (1)	138 (153)	241 (298)	104 (147)	33% (16)
Node 2: Gari, fufu, HQCF and confectioneries (n = 73)	3 months	.	32.8 (104.6)	190.2 (418.8)	222.1 (498.9)	589.5 (1453.3)	367.5 (964.6)	49% (25)
Node 3: Restaurant and POS (n = 16)	3 months	.	3.1 (3.8)	32.2 (46.2)	100.2 (116.7)	197.0 (239.7)	96.8 (132.6)	34% (41)

*(): standard deviation; Exchange rate at the time of the survey: US $1 = N200 (May, 2015)

Figure 1: Firm ownership by gender and business type

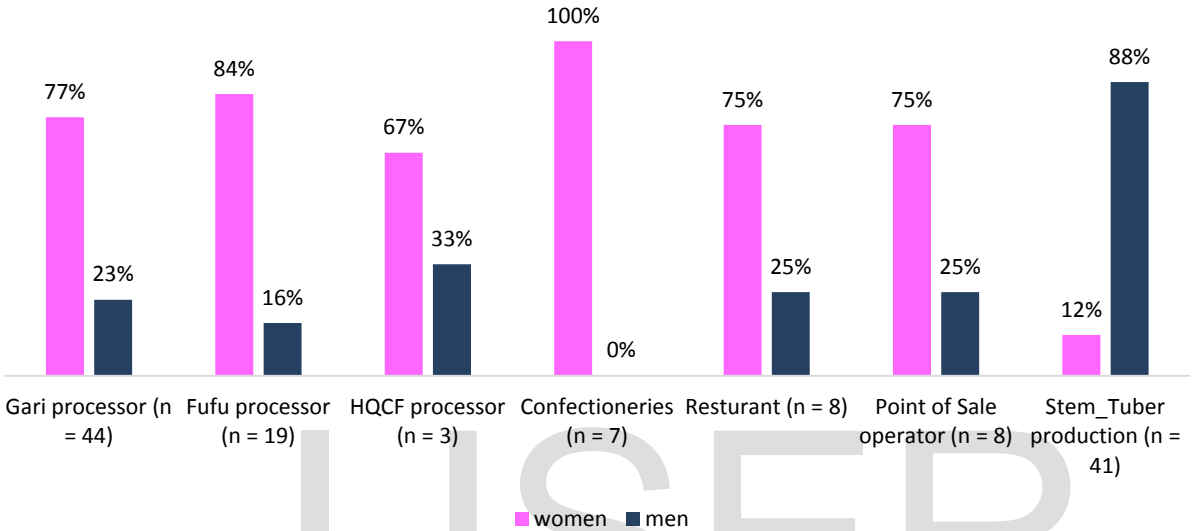


Figure 2a: Share of vitamin A cassava in total cassava trade volume by business type

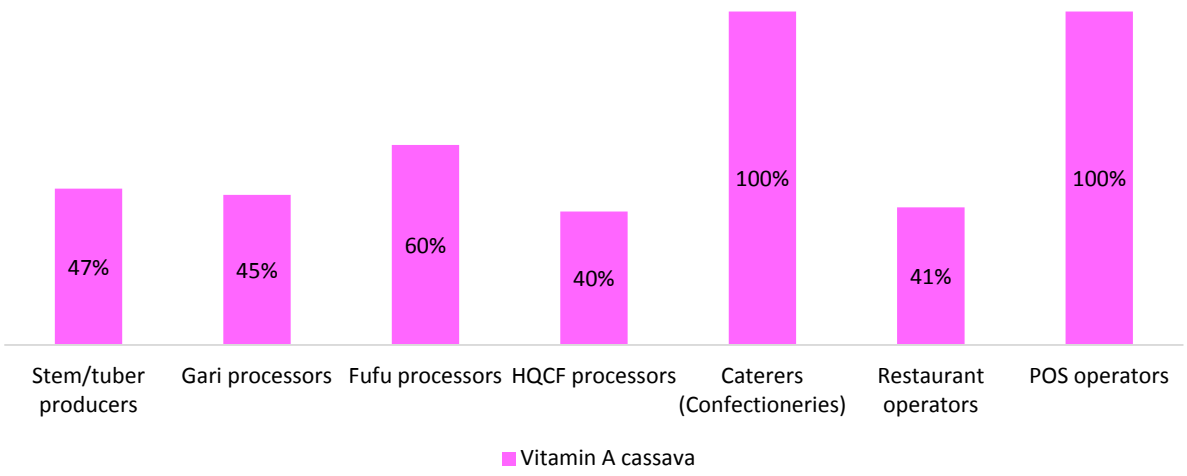


Figure 2b: Share of vitamin A cassava in total cassava trade volume by scale of investment

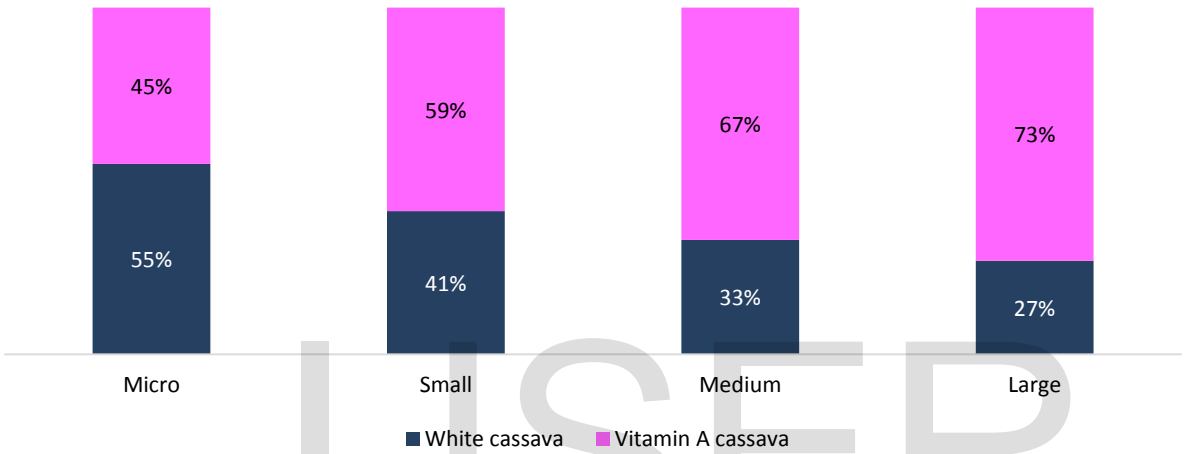
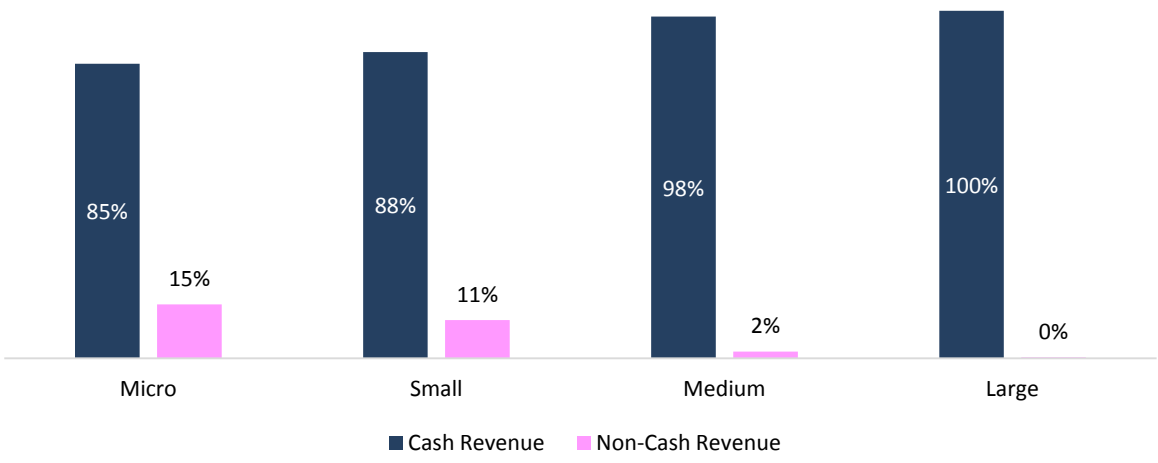


Figure 3: Share of cash and non-cash revenue in total revenue



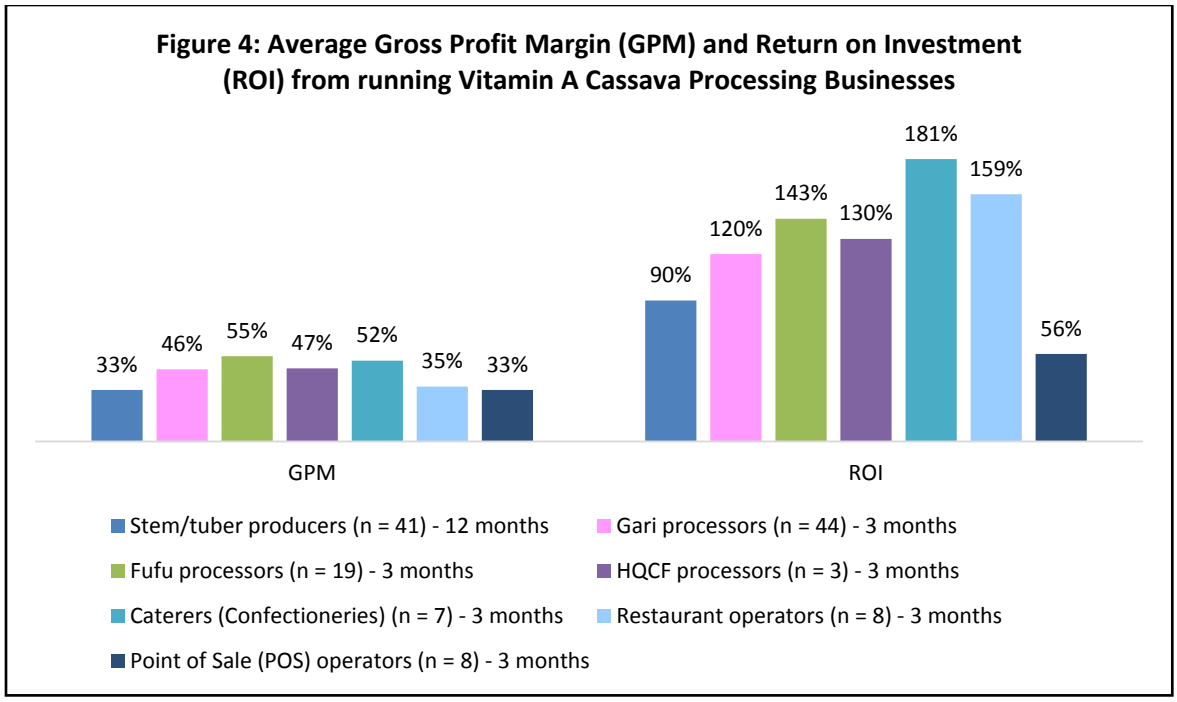


Figure 4: Average Gross Profit Margin (GPM) and Return on Investment (ROI) from running Vitamin A Cassava Processing Businesses
33%
46%
55%
47%
52%
35%
33%
90%
120%
143%
130%
181%
159%
56%
GPM
ROI
Stem/tuber producers (n = 41) - 12 months
Gari processors (n = 44) - 3 months
Fufu processors (n = 19) - 3 months
HQCF processors (n = 3) - 3 months
Caterers (Confectioneries) (n = 7) - 3 months
Restaurant operators (n = 8) - 3 months
Point of Sale (POS) operators (n = 8) - 3 months