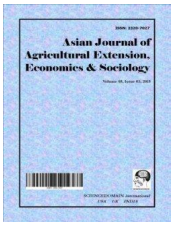

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Economic Analysis of Gari Processing Systems in Sierra Leone

Osman Nabay[1*], Abdul R. Conteh[1], Alusaine E. Samura[1], Mathew L. S. Gboku[1], Martin Koroma[1], Fallah S. Kassoh[1], Keiwoma M. Yila[1], James B. A. Whyte[1,2], Daniel S. Fornah[1], Isata Kamanda[1], Dan D. Quee[1] and Festus B. Massaquoi[1]

[1]Sierra Leone Agricultural Research Institute (SLARI), Sierra Leone.
[2]International Institute of Tropical Agriculture (IITA), Sierra Leone.

Authors' contributions

This work was carried out in collaboration between all authors. Authors ON, JBAW and MLSG designed the study. Authors ON, KMY, FSK and DDQ performed the statistical analysis and interpretation of the results. Authors ARC, DSF, ON and FBM wrote the protocol of the study. Authors ON, AES, MK and IK wrote the first draft of the manuscript. All authors were involved in managing the literature searches. All authors also read and approved the final manuscript.

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ABSTRACT

This study assess the performance and efficiencies of existing (4) gari production systems (profitability and marketing margins as well as the strengths, weakness, opportunities and constraints) in Sierra Leone. The Policy Analysis Matrix (PAM) was used for the analysis. Multistage random sampling was used to select study samples. Information was collected using a structured questionnaire from a total of 108 gari processors in 24 chiefdoms. Data collected included cost return and socioeconomic variables. The PAM was based on 50 Kg of fresh cassava storage roots and Leone (SSL) as money to evaluate costs and revenues. The analysis indicates that only three (3) cassava gari production systems (2, 3 & 4) present a Domestic Resource Cost Ratio of less than 1 (DRC < 1) and Cost-Benefit Ratio (CBR) also less than 1 (CBR within 0.64 to 0.96). Cassava gari

**Corresponding author: E-mail: nabayosman@yahoo.com;*

production activity which uses systems 2, 3 and 4 was economically profitable for gari processing. Discounting potential revenue from cassava gari production systems that use at least mechanical equipment have higher comparative and competitive advantages. PAM for cassava gari production systems at 30% interest rate only system 4 remains profitable and thus have a comparative and competitive advantage which was the most mechanized system. It can be concluded that among the four gari production systems identified, system 4 was the most profitable with higher competitive and comparative advantage. This implies that policies for mechanizing gari production must be enacted for profitable and sustainable gari production in Sierra Leone.

Keywords: Competitiveness; cost-benefit ratio; domestic resource cost ratio; efficiencies; cassava gari production systems.

1. INTRODUCTION

Gari is a product derived from cassava which is an important food crop in the tropics, accounting for 33% of all staple foods produced in sub-Saharan Africa [1]. In terms of food supply (kcal/ capita/ day) in Sierra Leone, cassava was second to rice and contributed 251, 227 235, 253, 265 in 2007, 2008, 2009, 2010, and 2011 respectively [2]. Cassava cultivation and promotion has been part of government strategy under the agenda for prosperity through the smallholder's commercialization programme (SCP) [3].

In Sierra Leone, the importance of gari was noticed during the civil war (from 1991 to 2002) and since then, it has become one of the Sierra Leonean staples. Since cassava is grown country wide most farmers quickly tend to process fresh storage root into gari to avoid loss as a result of pests and post physiological deterioration after harvest and theft [4]. In the agricultural sector in general, the value-chain framework has been conceived as one of the strategies to bring more efficiency in the development of cassava products [5]. Assessing the various processing systems and the range of activities that are required to bring a product from its conception, through its design, sourcing of raw materials and intermediate inputs, marketing and distribution, to the final consumer has been recommended [5].

According to [6], gari processing is expanding in Sierra Leone with a great opportunity to feed into rising gari market share in West Africa and the Mano River Union countries in particular. Sierra Leone has shown remarkable success in gari processing at both domestic and commercial scales, although to varying degrees. The introduction of equipment for most processing activities has eased the labor-intensiveness of the trade work, releasing time for women into other income-generating activities and allowing them to attend to family responsibilities as a result of direct involvement by Governments. Nevertheless, most gari processors still use local equipment to manually produce gari [6] due to limited or no access to mechanize equipment for processing especially in most remote part of the country.

Detailed studies have been done in examining the conduct of gari production, determining the factors affecting gari production and its cost and returns associated which most results indicate processing cassava storage roots into gari is profitable [7,8,9,10,11]. Notwithstanding, not much in trying to examine the various existing production systems.

Improving the existing gari processing systems and its nutritional quality in Sierra Leone will require detail analysis of the current production systems and the involvement of a variety of scientists and developers in a chain of interventions from the roots to the plate of the consumers. Preliminary information on the profitability of the gari enterprise is paramount in designing strategies for promoting gari commercialization and consumption. Therefore, the key objectives of this study was to; assess the performance and efficiencies of existing gari production systems; determine the profitability and marketing margins for the gari production systems and identify their major opportunities and constraints and suggest possible recommendations in order to improve its competitiveness in support of stakeholder livelihoods and economic development of the country.

2. METHODOLOGY

2.1 Study Area

Sierra Leone is on the West Coast of Africa between 6° 55' N and 10° 00' N. The Republic of Guinea borders it on the North and North-East,

and the Republic of Liberia borders it on the East and South-East. On the West and South-West, the Atlantic Ocean extends approximately 340 km. The country covers a total land area of 72,325 km^2. Nearly 75% of the total land area is arable. Approximately 56% of the land is below 150 m above sea level. Upland and lowland ecologies make up 78% and 22% respectively of the arable land area.

Administratively, Sierra Leone is divided into four regions: Eastern, Northern, Southern and Western Regions. Each region is divided into districts of unequal sizes. Each district is divided into chiefdoms, which in turn are divided into sections. Sierra Leone has a tropical climate called the tropical monsoon climate which was also described as a transitional climate, that is a continually wet tropical rainforest and a tropical savannah climate [12]. There are two prominent seasons determining our agricultural cycle: the rainy season which runs from May to November and the dry season from December to May. The average temperature is 28°C (82.4°F) and varies from 28°C (82.4°F) to 41°C (105.8°F) during the year [13,14]. Average rainfall is highest at the coast, 3000–5000 mm per year; moving inland this decreases and at the eastern border of the country, the average rainfall is 2000-2500 mm [15].

The agricultural sector is the backbone of Sierra Leone's economy comprising of food crops, tree crops, and fishery, livestock, and forestry sub-sectors. Nearly two-thirds of our population depends on the sector for its household livelihood [16,17,18]. The crops sub-sector contributes the highest towards the agricultural GDP with 33% in 2010 [19]. Most farmers produce a wide range of rain fed food and tree crops, predominantly using the slash-and-burn or shifting cultivation farming system [17].

The study covers the cross-section of the country covering twenty-four chiefdoms out of the 166 in Sierra Leone [20].

2.2 Sampling Technique

Sample selection was done in two (2) stages for cassava processors module. The first stage was the selection of the chiefdoms in a district and the second stage was the selection of the processors from the selected chiefdoms.

To allocate the sample sizes to districts, proportional random sampling was used in allocating a maximum of two (2) chiefdoms per district and then employed simple random sampling to have the selected chiefdoms. To select a maximum of five (5) processors per chiefdom, enumerators first identified the available processor in each of the selected chiefdoms and then randomly selected at most five processors using the random number table. The processor modules were then administered to the selected respondents.

A maximum of 5 processors' questionnaires were to be administered in twenty four chiefdoms for a total of 120 processors according to the sample calculated but only 48 processors interviewed questionnaire was completed during the survey. Due to the small sample size of processors received, supplementary data collection was emanated to increase the sample size. Sixty (60) gari processors were added to make a total sample of 108 respondents. Proportional sampling was also employed to allocate the total number of respondent by region. Twenty (20) respondents were allocated by region with the exclusion of the western region.

2.3 Data Collection

Information was collected using the structured questionnaire, personal interviews and enumerators' field observation. Data collected included cost and return variables and other socioeconomic data. The processor's modules were individual questionnaires. The sample for the Survey was designed to provide estimates of indicators at the national, regions and districts levels, and for urban and rural areas.

2.4 Database Design

The data entry template was designed in the Census and Survey Processing Software (CSPro 6.3) for all the questionnaires. The captured data were then exported into STATA, Statistical Package for Social Scientist (IBM SPSS Statistics 21), SAS 9.4 and Microsoft Excel 2010 as databases.

2.5 Data Analysis/Analytical Technique

Combinations of qualitative and quantitative analytical methods were used to analyse the data collected from the study. Different packages were used to analyse the various objectives such as SAS 9.4, IBM SPSS Statistics 21 and Microsoft Excel 2010.

Table 1. Policy analysis matrix

Budgets	Revenue	Costs		Net
		Tradable goods	Domestic factors	Profit
Budget at market price	$A = P_f \cdot Q$	$B = P_t \cdot Q_t$	$C = P_n \cdot Q_n$	D(1) = A-B-C
Budget at social price	$E = P_e \cdot Q$	$F = P_i \cdot Q_i$	$G = P_d \cdot Q_d$	H(2) = E-F-G
Divergences	I(3) = A-E	J(4) = B-F	K(5) = C-G	L(6) = I-J-K

Note. A, B, and C: Represents products at market price; (P, Q): The vector of quantities representing production activities; (P_t.Q_t): Tradable inputs (Import-Export); (P_n.Q_n): Non-tradable (domestic factors). These are elements which go into the financial analysis of the budget; E, F, and G: Represent those elements which are considered during the economic analysis of the budget; I, J, K, and L: Represent the difference between the financial budget and the economic budget (A-E, B-F, C-G, D-H); it measures policy-induced transfers that come into play due to policy-induced market failures or distortions

Objective one and two, A "Policy Analysis Matrix" (PAM) framework was used, to assess private (Financial) efficiency, social (Economic) efficiency, and the divergence between the gari processing systems. This PAM analyse the direct and indirect effects (negative or positive) of current policies. It also considers the effect of the cassava processing environment on processors productivity by exploring the potential effects of various proposed policy interventions. Domestic Resource Cost Ratio (DRCR) and Cost-Benefit Ratio (CBR) were used to assess the efficiencies and competitiveness of gari processing systems. Detailed calculations of the PAM can be found at the article published on Assessing the Efficiencies and Competitiveness of the Fresh Cassava Storage Root Production Systems in Sierra Leone [21].

For objective 3, Kendall's coefficient of concordance was employed to identify cassava gari processors major opportunities and constrains (SWOT analysis).

3. RESULTS

3.1 Performance and Competitiveness of Cassava Gari Production Systems

The determinants for measuring performance and competitiveness of cassava gari production was based on Policy Analysis Matrix (PAM) for cassava gari processing system using a Scenario without loan and interest on the capital and Sensitivity analysis with a loan from the bank at 30% of interest rate. Existing gari processing systems were examined from which indicators of the policy analysis matrix (PAM) for the gari systems were determined on the basis of 50 kg of fresh cassava roots. The processing costs was categorised as labour cost (peeling, washing, grating etc.) and inputs cost (cassava fresh roots, knives, bags etc.) are fixed by the service providers on the basis of 50 kg of fresh cassava root. The output for gari production systems from the data analysed ranges from 13.75 - 14.70 kg by processing 50 Kg fresh cassava roots. Production costs and revenues are in Leone.

3.1.1 Existing gari processing systems

Eight (08) potential gari production systems (from full manual to partial mechanization processing) were identified from the literature. According to the survey, only four (04) systems were used by processors in Sierra Leone. System 1 (Manual_peeling + manual_washing + manual_grating+ manual_pressing + manual_sieving + manual_roasting) which is the least mechanized accounted for 16.0% among processors while system 4 the (Manual_peeling + manual_washing + mechanical_grating+ mechanical_pressing + manual_sieving + mechanical_roasting) the most mechanized system accounted for 10.4% of the processors sampled. The application of mechanical grating as the only mechanized stage, (System 2) accounted for the highest percentage of respondent (44.3%) while system 3 (mechanical grating and pressing) accounted for 29.2% of the respondent (Table 2).

3.1.2 Policy analysis matrix (PAM) for cassava gari processing system

Scenario without loan and interest on the capital.

Table 3 indicates that the Domestic Resource Cost ratios (DRC) of the systems 1, 2, 3 and 4 were 1.48, 0.956, 0.77 and 0.64 respectively. Systems 2, 3 and 4 have a DRC of less than 1 and thus have comparative and competitive advantage. The Cost Benefits Ratios (CBR) of the systems 1, 2, 3 and 4 were 1.41, 0.96, 0.77 and 0.64 respectively. The CBR which indicate the profitability of the activity were less than 1 (0.96, 0.77 and 0.64) for the same 3 systems. Any cassava gari production activity which uses systems 2, 3, and 4 was economically profitable for gari processing.

Table 2. Existing gari production systems in Sierra Leone

Potential systems	% of Processors
1. Manual_peeling + manual_washing + manual_grating+ manual_pressing + manual_sieving + manual_roasting	16.0
2. Manual_peeling + manual_washing + mechanical_grating+ manual_pressing + manual_sieving + manual_roasting	44.3
3. Manual_peeling + manual_washing + mechanical_grating+ mechanical_pressing + manual_sieving + manual_roasting	29.2
4. Manual_peeling + manual_washing + mechanical_grating+ mechanical_pressing + manual_sieving + mechanical_roasting	10.4

NB: The number of processors who responded to the question is 106
Source: Data survey, 2013 and 2016

3.1.3 Policy analysis matrix (PAM) for Cassava gari processing system

Sensitivity analysis with loan from the bank at 30% of interest rate.

In addition to the normal situation, a scenario where the processor gets a bank loan with 30% interest rate fixed by the bank to finance its activity was assessed. The Domestic Resource Cost ratios (DRC) of the systems 1, 2, 3 and 4 were 2.049, 1.296, 1.007 and 0.807 respectively. Systems 1, 2 and 3 had a DRC of greater than 1 which indicates no comparative and competitive advantage. Systems 4 have a DRC less than 1 and thus have a comparative and competitive advantage. The Cost Benefits Ratios (CBR) of the systems 1, 2, 3 and 4 were 1.84, 1.25, 1.01 and 0.83 respectively. The CBR which indicate the profitability of the activity were less than 1 (0.83) for systems 4 only. System 1, 2 and 3 have a CBR greater than 1. This indicates that gari production activity which uses the systems (4) which was the most mechanized system was economically profitable for processors even with interest rate of capital of 30% (Table 4).

3.2 Profitability and Gross Margins for Gari Production Systems

All gari processing systems are financially profitable with profits of 2,975, 11,850, 19,300 and 27,550 Leones per 50 kg of fresh cassava processed, respectively (Table 5). The economic or social profits are negative for the system 1 (-9630) which is essentially based on manual processing operations and positive for systems 2, 3 and 4 with economic profits 1185, 8845 and 17135 respectively. The profitability coefficient for systems 2, 3 and 4 is positive (10.0, 2.18 and 1.61) respectively and that of system 1 is negative (-0.36). System 2 shows the highest ratio D/H with a value of 10 against 2.18 and 1.61 for the systems 3 and 4 respectively.

3.3 SWOT Analysis for gari Processors

The Kendall's coefficient of concordance indicates a very low degree of agreement among the gari processors vis-à-vis ranking of strengths (0.07), weaknesses (0.091), opportunities (0.027) and threats (0.023) even though P-values in the test statistics are highly significant even at 1% for the strengths, weakness, opportunities and threats (Table 6).

4. DISCUSSION

Gari processing capacities in Sub Saharan Africa is relatively low. In Ghana, monthly processing levels were approximately 6000 kg, 4000 kg and 3000 kg of cassava as reported by [11]. Although profitability and market margins analysis for the gari production systems show that, all gari processing systems are financially profitable which confirms that gari processing enterprises are profitable and very lucrative business venture [7,8,9,10] but the profit margins for systems 1, 2 and 3 were low. Gari production can be profitable when operations are fully mechanized. This is in agreement with regional effort in adding value to cassava through improved gari processing methods from mechanical peelers, roaster, graters, siever and pressers [6].

The PAM analysis for Scenario without loan and interest on the capital point out that, the more the system is mechanized the more profitable and competitive it is. The lower DRC and CBR values of system 4 indicate that it is the most profitable system for gari production compared to systems 2 & 3. The scenario where the processor gets a bank loan with 30% interest rate further revealed that profitability and competitiveness can only be attained under system 4 for gari production. This implies that, processors can borrow money to purchase machines for some of the processing operations such as milling, pressing and roasting, etc. In this case, the economy of scale

Table 3. Policy analysis matrix for cassava gari system processing 50 kg of fresh storage roots

No	Cassava gari systems	Indicators of competitiveness and policy effect						
		CBR	DRC	NPC	NPCI	EPC	PC	SRP
		CBR= (F+G)/E	DRC= G/(E-F)	NPC= A/E	NPCI= B/F	EPC= (A-B)/(E-F)	PC = D/H	SRP = L/E
1	Manual_peeling + manual_washing + manual_grating + _manual_pressing + manual_sieving + manual_roasting	1.41	1.488	0.882	1.18	0.828	-0.36	0.539
2	Manual_peeling + manual_washing + mechanical_grating + manual_pressing + manual_sieving + manual_roasting	0.96	0.956	0.909	1.18	0.874	10	0.335
3	Manual_peeling + manual_washing + mechanical_grating+ mechanical_pressing + manual_sieving + manual_roasting	0.77	0.77	0.926	1.18	0.9	2.18	0.267
4	Manual_peeling + manual_washing + mechanical_grating + mechanical_pressing + manual_sieving + mechanical_roasting	0.64	0.64	0.938	1.18	0.917	1.61	0.221

Source: Data survey, 2013 and 2016

Table 4. PAM for cassava Gari systems with Simulation of interest rate of capital of 30%

No	Cassava gari systems	Indicators of competitiveness and policy effect						
		CBR	DRC	NPC	NPCI	EPC	PC	SRP
		CBR= (F+G)/E	DRC= G/(E-F)	NPC= A/E	NPCI= B/F	EPC= (A-B)/(E-F)	PC = D/H	SRP = L/E
1	Manual_peeling + manual_washing + manual_grating + _manual_pressing + manual_sieving + manual_roasting	1.84	2.049	0.882	1.18	0.807	0.12	0.736
2	Manual_peeling + manual_washing + mechanical_grating + manual_pressing + manual_sieving + manual_roasting	**1.25**	**1.296**	0.909	1.18	0.862	-0.84	0.463
3	Manual_peeling + manual_washing + mechanical_grating+ mechanical_pressing + manual_sieving + manual_roasting	**1.01**	**1.007**	0.926	1.18	0.891	-57.7	0.369
4	Manual_peeling + manual_washing + mechanical_grating + mechanical_pressing + manual_sieving + mechanical_roasting	**0.83**	**0.807**	0.938	1.18	0.911	2.77	0.307

Source: Data survey, 2013 and 2016

Table 5. Profitability and margins for gari production systems

Systems	Market				Economic				Divergences				
	A	B	C	D	E	F	G	H	I	J	K	L	PC
	$A=P_f.Q$	$B=P_t.Q_t$	$C=P_n.Q_n$	D=A-B-C (SLL)	$E=P_e.Q$	$F=P_i.Q_i$	$G=P_d.Q_d$	H=E-F-G (SLL)	I= A-E	J=B-F	K= C-G	L=I-J-K	PC = D/H
	Market Revenues	Costs (Imported)	Costs (domestic factors)	Profits (SLL)	Econ. Revenues	Costs (imported)	Costs (Domestic Factors)	Profits (SLL)	Div. Rev (market rev_ economic rev.)	Div. Cost imported.	Div. Cost domestic factor	Div. Profit	Profitability Coef.
S1	20625	4300	13350	**2975**	23375	3655	29350	**-9630**	-2750	645	-16000	12665	- 0.36
S2	28900	4300	12750	**11850**	31790	3655	26950	**1185**	-2890	645	-14200	10725	**10.00**
S3	36250	4300	12650	**19300**	39150	3655	26650	**8845**	-2900	645	-14000	10515	**2.18**
S4	44100	4300	12250	**27550**	47040	3655	26250	**17135**	-2940	645	-14000	10475	**1.61**

Source: Data survey, 2013 and 2016

Table 6. SWOT analysis for gari processors

Strength	Freq. (%)	§Rank	Weakness	Freq. (%)	§Rank
* Strong knowledge and experience in gari processing	31.6	1	* Have limited access finance and credit facilities	24.8	1
Have access to labour for processing activities	19.2	2	* Use of local processing equipment	22.3	2
Produce own tubers	14.7	3	Inability to pay high transport fare	17.8	3
Have access to credit and finance	11.9	4	Have limited access to improved processing equipment	17.2	4
Have access to agricultural land for tuber production	11.3	5	Poor road network	4.5	5
Strong linkages with farmers	7.3	6	Produce small quantity of gari	3.8	6
Member of processing association	2.8	7	Lack of training on quality gari production	3.2	7
Have access to processing equipment	1.1	8	Have limited access to market	3.2	7
			Produce poor quality gari	3.2	7
Kendall's W	0.07		Kendall's W	0.091	
P – value	< 0.0001		P – value	< 0.0001	
Opportunity	**Freq. (%)**	**§Rank**	**Threat**	**Freq. (%)**	**§Rank**
* Availability of improved cassava varieties	28.9	1	* Increase in labour costs for farming activities	28.8	1
Strong linkages with VC actors	16.4	2	* High interests rates	26.9	2
High demand for gari in local markets	16.4	2	* High cost of improved processing equipment and inputs	24.0	3
Provision of training by NG0's	13.3	3	Inadequate supply of raw materials	11.5	4
Availability of improved processing technologies	10.9	4	Market diversity and competition with other food items	8.7	5
Strong government and donor support	9.4	4			
Availability processing centres	4.7	6			
Kendall's W	0.027		Kendall's W	0.023	
P – value	< 0.0001		P – value	0.0001	

Source: Field survey 2013

Freq.: Frequency count; §Rank: Kendall's ranking; Test statistics not significant (P > 0.05); Kendall's W: Kendall's coefficient of concordance

will also reduce the unit cost of gari while processing a significant quantity of fresh cassava.

The economic or social profits was negative for the system 1 which is essentially based on manual processing operations and positive for systems 2, 3 and 4. The system 1 cannot survive without assistance from the government. It wastes resources by producing social costs that exceed the costs of importing. Systems 2, 3 and 4 could have operated profitably without any policy transfers based on the social profit attained. The best choice for decision makers will be to enact new policies or provide private incentives that encourage full mechanization in the processing systems for gari production.

The strengths identified using the SWOT analysis suggests that a lot of training and capacity building efforts had been promoted by value addition projects in Sierra Leone such of the common fund for commodities (CFC) [6], unleashing the power of cassava in Africa (UPOCA) and the Dissemination of proven agricultural technologies in Africa (DONATA).

Generally, weakness identified in gari production in Sierra Leone include limited access to finance and credit facilities and the using of local processing equipment for gari production. This finding is in consonant with the processing constraints results of [7,9]; and the use of local varieties by [4] resulting to low productivity. [6] also outlines several other weaknesses in gari production which includes low level of mechanization and the lack of entrepreneurial skills and strategies. In this study the limited access to finance and credit facilities was more paramount. This indicates that opportunities such as access to improved materials and processing technology disseminated through government and NGO efforts has been taken advantage of by farmers and processors. System four which is the most mechanized system will ultimately address the issue of gari quality and quantity of gari production identified as weakness in the SWOT analysis.

5. CONCLUSION AND RECOMMENDA-TIONS

It can be concluded that among the four gari processing systems identified, system 4 (Manual_peeling + manual_washing + mechanical_grating + mechanical_pressing + manual_sieving + mechanical_roasting) was the most profitable. At 30% interest on the loan, system 4 was the only profitable enterprise which implies that policies for mechanizing gari production must be enacted for profitable and sustainable gari production in Sierra Leone.

According to [10], Economic returns to gari processing enterprise can further be enhanced if processors are able to adopt more labour saving methods like mechanizing operations. Therefore, the Government of Sierra Leone should facilitate access of processors to mechanical equipment. The gari production system using full manual processing is not competitive, neither profitable nor sustainable due to high cost of labour. For gari production, it is better for Sierra Leone to produce locally than importing it based on the economic profitability showed by system 2, 3 and 4.

The SWOT analysis indicates that the major strengths of gari producers are their strong knowledge and experience in gari processing, whilst limited access to finance and credit facilities and use of local processing equipment are their major weaknesses. Availability of improved cassava varieties for processing into gari was their major opportunities whilst increase in labour costs, high interests rates and the high cost of improved processing equipment and inputs were their major threats.

CONSENT

As per international standard or university standard written participants' consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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