Economics of Smallholder Sorghum and Maize Production Systems in Botswana: a Comparative Analysis

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Abstract

Sorghum and maize, the predominant crops of smallholder farmers in Botswana, compete for the same limited resources of the farmers. Unfortunately very little is known about their relative economic efficiency. Using farm-level data on 60 randomly selected smallholder farmers, this study provides a comparative economic analysis for the two enterprises. The results of the analysis reveal higher productivity for both land and labour employed among maize farms than those of sorghum; it was, respectively, 59 and 38% more for maize.

1 Introduction

Arable farming in Botswana is dominated by resource-poor smallholder farmers who utilize more than 60% of the total arable land in the country (MINISTRY OF AGRICULTURE, BOTSWANA, 1991). As in many African countries, the main resources of the smallholder farmers in Botswana are land, family labour and draught animals. However, in recent years, the use of tractor farm technology is increasing (PANIN AND MAHABILE, 1996). The smallholder farmers, whose farming system is subsistence in nature, produce the bulk of the nation's total domestic food output (MINISTRY OF AGRICULTURE, BOTSWANA, 1991). Mixed cropping is still a popular cropping pattern systems among the farmers despite early focus of research and extension to stimulate them to adopt monocropping (LIGHTFOOD AND TAYLER, 1987). Sorghum and maize, in terms of acreage, are the predominant crops of the subsistence farmers in Botswana. These two crops together accounts for about 85% of the total acreage of all crops cultivated in a particular year and they also compete for the same limited resources of the subsistence farmers. Both sorghum and maize varieties grown by the farmers have been found to be drought resistant and therefore suitable to the harsh climatic condition prevailing in the country (DAR, 1988a; 1988b; REEDS, 1986).

Despite their competition for the farmers' limited available resources, very little is known in the country about their relative economic performance. A better understanding of this

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would indeed help the farmers to employ their resources more efficiently. In line with the need for efficient allocation of limited resources among competing enterprises, this study undertakes a comparative economic analysis of these two major crop enterprises (sorghum and maize) of smallholder farmers in the country with respect to use of resources, output and productivity. It is hoped that the information derived from the study will be useful to the smallholder farmers in the planning of their farming activities regarding optimal use of their limited farm resources. The specific objectives of the study are: (i) to quantify the physical inputs and outputs of sorghum and maize enterprises of the smallholder farmers in the study area as well as their related costs and returns, and (ii) to compare the productivity of fixed resources used for the production of sorghum and maize.

2 Materials and Methods

2.1 Data and study area

The data used in this study come from a random sample of Botswana's smallholder farmers crop production activities for the 1995-96 agricultural year. The sample comprised 60 households selected from two villages in Barolong district. A structured questionnaire was used to obtain the data through personal interviews. Detailed information on various aspects of the farm-household was collected. This included the household's demographic characteristics, farm size, cropping patterns, crops output, labour and non-labour inputs and respective input and output prices. During the interviews, the main respondents were always a head of a household. However, assistance was, at times, sought in answering some questions from other household members.

The study area is located in the south-eastern part of Botswana, sharing a common border with the Republic of South Africa. The two selected villages from the area are about 40 km apart from each other. The area's economy is mainly based on farming activities. More than 90% of households in the area are engaged in agriculture. The average annual rainfall in the area is about 400-500 mm, exceeding the overall country's average of 350 mm. The sampled households were relatively large in size with an average of 8.5 persons per household. Eighty percent of the households were under the leadership of males even though females had a share of 51% household members' composition. In terms of age distribution, the households had more adults (about 68%) than children (32%), contrasting the findings of similar studies elsewhere in Africa where there is a predominance of children (i.e., PANIN AND DE HAEN, 1988). The average age of the heads of households was 54.3 years, indicating that most of them were fairly old. Illiteracy still prevailed in the study area; more than 50% of surveyed household members had not completed six years of formal schooling. These results confirm the findings of other studies on smallholder farmers in Botswana (PANIN et al., 1993; PANIN, 1995; PANIN, et al., 1996).

2.2 Method of analysis

The main analytical tool used to compare the productivity of resources engaged in sorghum and maize enterprises of the smallholder farmers is gross margin analysis. However, t-test analysis was performed on respective yields and resources utilised under the maize and sorghum enterprises to ascertain the significance of mean differences between the two. The two resources whose productivity is being compared are land and family labour (homogenised into man-equivalent hours). Implicit in the use of gross margin analysis to assess resource productivity are the assumptions that: (i) the resource whose productivity is being estimated is the only one that is in "fixed supply"; (ii) all other resources are in variable supply which can be increased or diminished at a known per-unit cost (i.e. price) which accurately reflects the value of its marginal product (opportunity cost); (iii) the farmer does in fact vary the input of these other resources so as to combine them in an economically optimum way with each other and with the fixed resource. Thus in estimating the productivity of "land" we need to know the price of family labour, and similarly the price of "land" in estimating the productivity of family labour.

Gross margins are computed by deducting variable costs from the gross value of production, in both cases expressed per unit of fixed resource, e.g. per hectare or per man-equivalent hour. Variable costs considered in this paper include those of seed, fertilizer, non-family labour and draught power. All the variable resources have known market prices, and for convenience we subsequently refer to them as "cash" costs. However, not all the resources involved in the crop production have easily ascertainable market prices. Family labour and land are the ones most concerned here and we refer to them subsequently as "non-cash" costs although they are sometimes traded for cash. For family labour, we can value it at the local wage rate of P0.50 per hour. Land, on the other hand, is more difficult to value because officially there is no market for it in the rural areas and renting is also totally against the culture of the people. Nevertheless, we can use the shadow price of P25.00 for land obtained with a linear programming model specified for smallholder farmers in an adjacent district by Panin (1993). The crop outputs were valued using the respective market prices of each crop that prevailed at the time of investigation. The latter was P0.32/kg for sorghum and P0.44/kg for maize. Agricultural commodity prices are established every year by the Botswana Agricultural Marketing Board (BAMB).

3   Results

3.1 Land use systems of sample households

Table 1 presents an overview of the land use systems of the sample households. The data reveal an average cultivated area of 10.39 ha which by average standards of smallholder farmers in the country is relatively large. The average cultivated area reported for most smallholder farmers from other parts in the country ranges between 5.4- 8.1 ha

(PANIN, 1993; PANIN, et al.,1996). As seen from the cropping patterns, the dominant cropping system is mono-cropping, accounting for about 87% of total cultivated area. Sorghum and maize emerged as the predominant sole crops, occupying respectively 60.3 and 20.5% of the total cultivated area. Only three mixed-cropping patterns were identified namely: sorghum and maize, maize and cowpeas, and sorghum and cowpeas. Their total share of 13% of total cultivated area suggests that mixed-cropping is not popular in the study area.

3.2   Yield, resource use and gross margin analysis of sorghum and maize enterprises

This section uses data from farmers' plots planted with only sorghum and maize as sole crops. In all, 96 individual plots were recorded of which 53 were allocated to sorghum and 43 to maize production. The average plot size of sorghum enterprise was 6.82 ha compared with 3.05 ha for maize (Table 2). The mean difference was statistically significant (P<0.001). This clearly indicates that sorghum is the most preferred crop of the people. The preference by farmers to grow more sorghum than maize may be due to the fact that sorghum is relatively more tolerant than maize to the harsh climatic conditions prevailing in Botswana. By any standard, per hectare use of labour and seed were very low among the two enterprises. Also low was the level of crop productivity, however, it was slightly higher (261 kg/ha) for sorghum than maize (229 kg/ha). None of the mean differences were statistically significant. As seen in the table, the most labour demanding operation in both sorghum and maize enterprises is harvesting, requiring respectively 44 and 46 hr/ha. These results also confirm the conclusion made by Panin (1993) that harvest labour requirement is one of the main constraints on increased crop production of smallholder farmers in Botswana.

Table 1: Land use systems of sample households, Barolong district, Botswana, 1995/96

Cropping Pattern	Average Area (ha) (N=60)	Percentage share
Mono-cropping		
sorghum	6.27	60.3
maize	2.13	20.5
cowpeas	0.59	5.7
Sub-Total (a)	**8.99**	**86.5**
Mixed Cropping		
sorghum and maize	0.67	6.4
maize and cowpeas	0.48	4.6
sorghum and cowpeas	0.25	2.4
Sub-Total (b)	**1.40**	**13.4**
Total area (a+b)	**10.39**	**99.9**

Table 2: Yield and resource use by sorghum and maize enterprises, Barolong district, Botswana, 1995/96

Variable	Crop Enterprise	
	Sorghum (n=53)[a]	Maize (n=43)
Area (ha)	6.82 (3.70)[b]	3.05 * (2.01)
Total yield (kg ha⁻¹)	261.08 (183.17)	229.13 (172.26)
Labour (hr ha⁻¹) total labour ploughing/pl anting weeding harvesting	80.46 (31.34) 5.12 (7.06) 30.91 (9.45) 44.44 (26.85)	81.32 (31.92) 5.30 (7.02) 30.47 (7.99) 45.55 (32.35)
Seed (kg ha⁻¹)	8.02 (1.59)	8.23 (0.65)

[a] n=number of plots planted with respective crops. *= significant mean difference at 1% level.
[b] Figures in parentheses are standard deviations.

Table 3: Gross Margin Analysis for Sorghum and Maize Production by smallholder farmers, Barolong district, Botswana, 1995/96

Variable	Sorghum	Maize
Use of fixed resource (Unit) Land (ha) Family labour (me-hr ha⁻¹)	1 77.64	1 79.70
Value of grain production (Pula ha⁻¹)	83.55	100.82
Variable costs (Pula ha⁻¹) Cash costs Seed Fertilizer Non family labour Draught power	2.57 1.59 1.41 15.50	3.62 3.41 0.81 15.50
Non-cash costs[1] Family labour Land	38.82 25.00	39.85 25.00
Gross margin per fixed resource Land (Pula ha⁻¹) Family labour (Pula me-hr*)	23.66 0.48	37.63 0.66

[1]In calculating gross margins per unit of land, the cost of land is excluded while the cost of labour is included in the calculations. Similarly, in calculating the gross margins per of family labour, the cost of land is included and the cost of family labour excluded from the calculations.

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Table 3 presents the gross margin analysis for sorghum and maize enterprises. The per hectare gross value of production as expected was extremely low for both enterprises. It amounted to about P81.00 and P101.00, respectively, for sorghum and maize enterprises. Since crop productivity was slightly higher for sorghum than maize (Table 2) and at the same time the levels of inputs used were almost the same for the two enterprises, the higher gross value of production for maize can only be attributed to the difference in the respective market prices for maize and sorghum. As indicated earlier, the market price of maize (P0.44/kg) was about 38% more than that of sorghum (P0.32/kg).

As can be seen from Table 3, the single most important variable input is draught power. This accounts for about 19% of the total value of production for sorghum and 15.4% for maize. It is worth mentioning that during the year of study, farmers' fields up to six hectares were ploughed free under a government ploughing scheme. Most of the farmers with farm size more than the six hectares used draught animals to plough the extra land. It is the average cost of this extra land that is included in the analysis. The values of the other variable inputs are so low depicting a typical characteristic of many traditional farming systems in Africa where the use of cash inputs is insignificant.

As is evident from Table 3, the gross margins expressed per unit of fixed resource used, either per hectare of land or an hour of a family labour input, are surprisingly low for both enterprises. Nevertheless, they were higher for maize than sorghum. The return on a hectare of land for maize production amounted to P37.63 against P23.66 for sorghum, providing an increase of 59% over that of sorghum. With regard to an hour of a family labour, sorghum production produced a return of P0.48 whereas maize had P0.66. Here, the increase in return over sorghum was about 38%. While the return on family labour accruing from maize production exceeds the rural wage rate of P0.50 (the opportunity cost of labour) by 32%, similar returns from sorghum reduce it by 4%. This suggests that under the existing farming conditions, family labour would be more efficiently utilized when allocated to the production of maize than to either sorghum production or any alternative jobs in the rural area.

4   Summary

Although sorghum and maize, the predominant crops of smallholder farmers in Botswana, compete for the same limited resources of the farmers, very little is known about their relative economic efficiency. The results presented in this paper for smallholder farmers in Barolong district reveal significant mean differences in areas planted with sorghum and maize but not in their respective crop productivities. Area allocated to sorgum production was more than twice of that of maize. However, in monetary terms, the returns to land and family labour were higher for maize production than sorghum, indicating that under the current land use system maize production is, economically, more profitable than sorghum.

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