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Market Dynamics in Maize Production in the North Region of Mozambique

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Abstract: In this article, a radiography of the agricultural sector is presented, specifically in the production of maize in the district of Malema, considering that the product is one of the most produced and consumed crops by the population in the province of Nampula. Low agriculture productivity is attributed to inadequate access to production technology and inputs and to “weak” markets for agricultural products, due to poor infrastructure and inadequate access of agricultural producers to financial services (example credit). In general, several documents analyze on how small-scale agriculture has lacks of conditions, and factors necessary for high productivity and income. In contrast, there is little information that gives an idea of the situation of agricultural maize production and existing agricultural markets and how this production and these markets are changing in Mozambique today. There is, for example, a complete absence of references to large-scale investments in agriculture currently agreed with domestic and foreign trading companies. Due to this omission, the author presents a partial analysis of the current context, and, therefore, it is not well explained how the greater investment can be directed to obtain greater use of productive technology and better access to the market, among small-scale producers. It seeks to analyze in more detail the situation “diagnosis” that is intended to be made on agriculture, specifically in the maize crop, and as a way to identify the specific aspects that can be considered starting points to work in the government intervention, in order to achieve the goals and increase agricultural productivity.

Key words: Maize, production system, family sector, Mozambique.

1. Introduction

Maize (*Zea mays* L.) is the most important agricultural crop in Mozambique, covering about 1/3 of the total cultivated area in the country [1, 2]. This crop can be considered a basic food crop as well as an income crop, being produced in the North region (in Nampula, Niassa and Cabo Delgado provinces) mainly for the subsistence of families [2, 3]. Most maize production is consumed locally, although some of the maize produced in northern Mozambique is exported and imports from South Africa meet some of the local demand in the south [4].

More than 80% of the total cultivated land area is used for rain-fed production of staple food crops, where maize, cassava and beans occupy about 60% of the total cultivated area [5]. The data from the Agrarian Survey Work (Trabalho de Inquerito Agrário: TIA) 2007 [6], show that in the northern region of the country in the 2006/2007 campaign, the income obtained for maize is estimated at around 950 kg/ha, with a greater concentration of production in rain-fedsystem. However, in the irrigation system, average is estimated at around 700 kg/ha.

Integrated value-adding chains for agricultural products are still at an incipient stage due to several problems, but there is space for the establishment of small and medium scale processing operations for agricultural products, as shown by recent investments in maize processing structures and other crops [4].

Crop productivity has remained low because of the weak adoption of modern production technologies

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(only 5%-10% of farmers use improved seeds, 5% use fertilizers, average fertilizer use is 5.3 kg/ha, and 10% use animal traction), limited access to financial incentives, and poor access to markets for product placement and value chains [4].

From this perspective, food security is stable, considering the availability of the main products, especially maize in the interior districts of Nampula and Cabo Delgado provinces. In coastal districts, in addition to the availability of cassava, there is fishing and cashew production, which helps with family income.

The present study analyzes the agricultural sector, specifically in the production and commercialization of maize in Malema district. It addresses the reasons that lead farmers in this region to continually invest in maize production, even with production levels that fluctuate significantly, and identifies specific aspects that can be considered starting points for working government intervention, in order to achieve the goals, and increase in agricultural productivity in the specific crop.

2. Materials and Method

A literature review was initially carried out, followed by fieldwork in the Malema district. The choice of this district for conducting the study is due to the relative importance of maize production in this district, as well as the fact that the Malema district in terms of ranking is one of the first places in terms of agricultural production in Nampula province.

However, in the district of Malema, farmers from two maize production systems (irrigation and rain-fed) use the instruments of the Rapid Participatory Diagnosis.A total of three “Focus Group Discussion (FGD)” were carried out, one with rain-fed farmers and two with irrigated farmers (Table 1).

Therefore, for the irrigation system, farmers who grew maize in a monoculture system, were selected and they were divided into two more or less homogeneous subgroups, based on the amount of inputs used in the production process. The groups were designated as being, low-input-use farmers group and medium-input-use farmers group.

Meanwhile, in the rain-fed system, farmers who had extensive experience in maize cultivation were selected for the survey, and due to the high homogeneity among farmers (they grow maize in intercropping), they were organized into a single group and to estimate the proportion of the cultivated area occupied by maize, the technique of “beans game” was used, which is a technique developed by the Ministry of Agriculture and used in Agricultural Survey Works (ASWs) to estimate the area occupied by intercropped crops.

Then, separate views were carried out with each constituted group, and three previously prepared worksheets were used as interview guides, the first of which allowed the collection of information on the agricultural calendar of the crop, that is, the activities and their sequence in terms of consecutive days for maize production, from land preparation, harvesting and/or marketing. The second spreadsheet made it possible to collect information on the technical coefficients, that is, the type and quantity of inputs allocated to the production of the crop and their respective prices. The last worksheet focused on demographic aspects, welfare indicators, sources of income, gender aspects and experience in growing the maize crop.

Based on the information above, production systems were characterized, based on cultivation patterns, crop rotation, types of germplasm used (traditional or improved seed), activity calendar, type and quantity of inputs, water management practices, pests, diseases and weeds and the income obtained.

Then, the budgets for the cultivation of maize in the cultivation systems under study were elaborated as well as their profitability analysis, in order to find out according to the returns of family labor in the production process.

However, only variable costs were taken into account for the purposes of analysis in the present study, due to the difficulty of indicating the value of all fixed costs (example: irrigation water, production instruments, etc.) supported by the interviewed producers.

Table 1 Number of maize producers participating in the survey.

Date of the FGD	Location of the survey	Participants	Total number of farmers	Men	Women
15/01/2021	Nataleia	Dryland maize producers	23	8	15
16/01/2021	Nataleia	Irrigated corn producers (low use of inputs)	23	11	12
16/01/2021	Nataleia	Irrigated corn producers (average use of inputs)	20	8	12

Furthermore, an analysis of the cost and benefit of producing 1 kg of maize and the cost of acquiring the same amount of the product on the market was carried out, in order to try to find a financial reason for the continuous production of maize by rain-fed farmers. Cunguara *et al* [7] carried out a study that analyzes the participation of households in income-generating activities in the north and south of Mozambique and concluded that there are few alternatives for income-generating activities such as employment, which leads farmers even further tocontinue maize cultivation, even if the profitability of this practice is still low.

Finally, a sensitivity analysis was carried out to determine the technological options developed by the investigation that could improve the profitability of the maize crop. Thus, the effect of the possible reduction in the price of fertilizers, the effect of the use of improved seed by rain-fed producers and the effect of the use of the Matuba variety in the production process were analyzed. The choice of the Matuba variety for the sensitivity analysis is due to the fact that this is the most widespread improved variety of maize among producers in the country, although there are other varieties recently released under the Drought Tolerance Maize for Africa (DTMA) project, being that their poor dissemination is the factor that contributed to their non-inclusion in this study.

3. Results and Discussion

3.1 Pest, Disease and Weed Management Practices

Table 2 shows that in the identified maize production systems, weed control is done manually, and for pest management, irrigated farmers resort to the use of conventional pesticides, mainly methamidophos, which is an effective insecticide.

However, farmers with medium use of inputs apply 0.4 L/ha of insecticide, and during the crop cycle, spraying is done 3 times. This amount is relatively higher than the 0.24 L/ha of insecticide that is applied twice by low-input farmers during the crop cycle. On the other hand, rain-fed farmers do not adopt any practices to mitigate the effect of pests and diseases on their fields.

To justify this practice, irrigated farmers mentioned that the fact that their production is market-oriented leads them to invest some financial resources to purchase pesticides that are used to combat pests and diseases in order to reduce the risk of loss of production, as well as improve product quality (appearance) by eliminating any visible symptoms of disease. In Mozambique the use of fertilizers and pesticides on a largescale is very low, only 4.5% of farmers use pesticides on their fields and most of them use exclusively for cash crop [5, 8].

The continued implementation of policies aimed at promoting the use of pesticides and fertilizers among maize farmers through the use of registration books (vouchers) that would allow producers to have access to these agricultural inputs at the beginning of the agricultural season. Since agriculture is mostly rain-fed, voucher promotion should take place in areas where the response to chemical fertilizer application has already been documented [9].

The government should engage in the implementation of policies aimed at reducing the cost of acquiring inorganic pesticides and fertilizers and other inputs, through the improvement of the input marketing network, which includes the improvement of access roads. As an example, countries such as Kenya were able to double the amount of chemical pesticides and fertilizers used in 10 years by reducing the average distance from the household to the place of purchase of inputs, from 7.4 km to 3.2 km during that period [10]. In Malawi, the use of fertilizer has been promoted through subsidy programs and policies that have increased access from about 30% of farmers [11]. Crawford *et al*. [12] also emphasize the role of improved transport infrastructure in the adoption of chemical fertilizers.

3.2 Phytosanitary Status

The phytosanitary situation in Nampula province and specifically in Malema district was characterized by the occurrence of pests and diseases, such as the corn funnel caterpillar (*Spodoptera frugiperda*), the elegant grasshopper (*Zonocerus elegans*) and the field mouse (*Praomys natalensis*). These pests eat the leaves of the maize plant, reducing the photosynthetic area, and consequently grain production [13]. In Mozambique, including in Nampula Province, funnel caterpillar (*Spodoptera frugiperda*) was first detected in 2017 and is one of the pests that has caused major damage to maize crops [14], it can reduce production by between 34%and 52%. And to control them, physiological insecticides are recommended, which act only on the physiology of the insect [13].

The tomato caterpillar (*Tuta absoluta*), the cabbage moth (*Plutella xylostella*), the aphids (*Brevicoryne brassicae*) were also pests, attacking corn, sorghum, cassava, beans and various vegetables. Following the outbreak of the described pests, pesticides were distributed to the affected districts, with a total of 400 L allocated. Stem borer (*Diatraea saccharalis*) and beetle were also reported to occur in the months of February to March 2019 in maize crops and also in sorghum, millet, rice and beans in the districts of Malema, having been controlled with the use of pesticides allocated to the districts, with no record of loss of areas.

3.3 Production System Comparison

Maize is cultivated in an intercropping system, mainly with cowpea and pumpkin. The maize produced is for family subsistence, the labor used in the production process is all family owned and the local seed is the only input used, and therefore the only cost supported by the producers. The activities that consume most of the workforce are farming and weeding, which require 33.3 and 18.8 d/ha respectively for their execution.

In the 2019/2020 agricultural season, the yield obtained for maize was 593 kg/ha and the production of this cereal in this system was not profitable, and the cost of producing corn grain was relatively higher than the cost of purchasing the same product in the local market. However, farmers continue to invest in maize production, and among the various factors are habits and customs, low purchasing power and guarantee of food and nutritional security for households, such as those that contribute to the continuation of this practice. The use of own production seed conserved from one campaign to another would make this production system profitable in relation to the acquisition of seed in the local market. The use of seed of the Matuba variety by farmers in this system can be a technological option with a great impact on the profitability of maize production in this system, even without the full use of the technological package recommended to accompany the variety and with yields in the order of 500kg/ha and a price of 40 Mt/kg for the acquisition of the seed of the variety.

The maize production used is mainly in monoculture system, using agricultural inputs such as improved seed, inorganic fertilizers and pesticides, and production is market-oriented. Maize production is carried out in two campaigns and crop rotation is used as a soil management technique and pest and disease management. In this system, the production process predominantly uses hired labour, and the activities of furrow alignment, simultaneous weeding and mounding and fertilization followed by mounding are the ones that require the most time to be carried out, with 15.6, 23.4 and 12.5 d/ha, respectively. In an area with the same soil and climatic conditions, the yieldsobtained depend on the level obtained depend on the level of use of the inputs, and in this system, yields vary between 926 and 1,275 kg/ha of maize grain.

Table 2 Pest, disease and weed management practices.

Characteristics	Production systems		
	Drought	Irrigation	
		Low use of inputs	Average use of input
Pests and diseases	None	Application of insecticides (methamidophos)	Application of insecticides (methamidophos)
Amount of pesticides	0	0.24 L/ha	0.4 L/ha
Weeds	Hand draw	Hand draw	Hand draw

Table 3 Cost for maize production in rainfed and irrigated systems 2019/2020.

Items	Production system		
	Irrigation		Rainfed
	Medium use of inputs	Low use of inputs	
Average income (kg/ha)	2,500.00	1,875.00	293.00
Price of the product (Mt/kg)	10.00	10.00	5.00
Production value (income*price) (Mt/ha)	25,000.00	18,750.00	1,465.00
Production costs (Mt/ha)			
Input costs (Mt/ha)	11,115.00	4,083.50	3,098.15
Machinery costs (Mt/ha)	2,820.00	2,820.00	0.00
Hired labor costs (Mt/ha)	7,420.00	3,744.00	0.00
Total variable costs (∑production costs) (Mt/ha)	21,355.00	10,647.50	3,098.15
Profit (total production value-total variable costs) (Mt/ha)	3,645.00	8,102.50	-1,513.15

The analysis of the cost structure (Table 3) showed that in the maize production systems analysed, farmers allocate most of their monetary resources to the acquisition of inputs, with the particularity that in the rain-fed the input costs are those that are only supported by this group of farmers. It can be seen that in the irrigation system both groups of farmers allocate the same proportion of the total cost of maize production in hiring labour, despite the differences in their financial capacities. However, the costs of renting machinery are the ones that make the smallest contribution to the overall structure of production costs, which suggests that even in irrigated systems, the mechanization of agriculture is still deficient.

In terms of profitability, 2019/2020 agricultural season shows that the returns to family labour for low-input farmers were around 209.91 Mt/ha and about 125.69 Mt/ha for medium-input farmers. Meanwhile, in the rain-fed system, there are negative returns (-13.95 Mt/ha) in relation to the use of a member of the household in the production process. When the price of maize is decided by the market conditions a large surplus farmers may sometimes have to sell their maize for less than the cost of production [15]. Taking into account that in this system most of the costs borne by producers come from inorganic fertilizers, the implementation of policies aimed at reducing the costs of inorganic fertilizers will benefit more irrigated farmers, with greater emphasis on those with medium use of inputs.

In Table 3, it can be seen that by marketing maize grain at a price of 5.00 Mt/kg and cobs at a price of

10.00 Mt/kg, the production value in the irrigation system is about 15 times higher than production value obtained in the rain-fed system. In a study in Malawi a sensitivity analysis was conducted including two maize price scenarios, an average of 0.21 $/kg and a high price of 0.45 $/kg for a farmer who can get by storing maize for six months or more [11]. However, the profit obtained by rain-fed farmers in this study was negative, and the behaviour observed for this financial indicator may have been derived from the low level of agronomic income obtained by rain-fed farmers, which did not compensate for the costs incurred during the production process. However, the possible occurrence of irregular rains and other risk factors may have contributed to low yields in the rain-fed production system at the time in question.Negative margin profits make life difficult for farmers because according to Ministério da Agricultura (MINAG) [5], the sale of agricultural products is the most important source for rural households in central and northern Mozambique. When the price of maize is decided by the market conditions a large surplus farmers may sometimes have to sell their maize for less than the cost of production.

The production costs of maize under irrigation are offset when the cob marketing price drops to 4.30 Mt/kg and 1.50 Mt/kg for low- and medium-input farmers, respectively. However, production costs in this system are compensated when maize yield is increased by about 302.63 kg/ha.

In terms of the number of harvests carried out per year, it is observed that irrigated farmers carry out at least two harvests during the year, unlike rain-fed farmers who practice only one harvest in the same period. This result is associated with the availability of water by irrigated farmers, unlike rain-fed farmers who depend solely on rainfall. Regarding means of production, particularly water, the use of irrigation infrastructures is concentrated in the central and southern zones, where rainfall is irregular, and is almost non-existent in northern Mozambique [5]. According to the Food and Agriculture Organization (FAO) [4], in Mozambique rain-fed agriculture is predominant and is practised on less than 10% of arable land, under dryland conditions (only 3% of arable land is irrigated), and largely in areas prone to frequent floods and droughts.

4. Conclusions

The study concludes that in Malema district maize production systems and weed control are done manually. For pest management (funnel caterpillar, elegant grasshopper and field mouse), irrigated farmers, resort to the use of conventional pesticides. Rain-fed agriculture is predominant and the yield obtained for maize, 2019/2020 season, was 593 kg/ha and the production of this cereal in this system was not profitable.

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