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Do agricultural research and rural extension organizations satisfy households' agricultural demands? Evidence from maize growers in Sussundenga district, Mozambique

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This paper compares the supply and demand of agricultural technologies related to maize crop in Sussundenga district, Mozambique. The field work was carried out in February and March 2018 and comprises of a survey of 140 households' maize growers, interviews with 15 agricultural technicians and six focus group meetings (four with maize growers and two with agricultural technicians). Data analysis was done using Bardin's content analysis and descriptive statistics. The results reveal that agricultural research and rural extension focus more on supplying technologies related to maize production. But farmers have holistic expectations that go beyond production technologies to include the entire marketing chain. It makes the technical support provided with little use to maize growers. Besides it, there are also farmers' unanswered demands and the supply of non-demanded technologies. It means that there is a mismatch between supply and demand of maize farming technologies. Agricultural research and rural extension organizations are suggested to supply not only agricultural technologies that maximize crop yield, but also services that help households improve their ability to store agricultural products and to sell it when prices are high. These actions have the potential to improve agricultural market performance and make the agricultural technologies more useful to maize growers.

Key words: agricultural market, agricultural technologies, maize farming, mismatch, rural households, unanswered demands.

INTRODUCTION

Agriculture is an important activity for economic development and poverty reduction in developing countries (Aref, 2011). In Mozambique, although the contribution of agriculture to Gross Domestic Product (GDP) is only 25%, this activity employs about 80% of economically active people (Ministry of Agriculture and Food Security-MASA, 2015). The fact that agriculture is a source of employment for a large proportion of the

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Mozambican population, but it contributes little to GDP, reveals its low productivity. For example, maize yield[1], the most widely cultivated crop in Mozambique is about 1.2 tons per hectare (ton/ha), lower than the average of African continent (1.8 ton/ha) (Dias, 2013). The potential yield of maize in some regions of Mozambique is about 5-8 ton/ha (IIAM and FAEF, 2010), meaning that the current national maize yield is only 15-24% of its potential. Cunguara et al. (2013) point out that the low adoption of technologies contributes significantly to the low agricultural productivity in Mozambique.

Increasing agricultural productivity is an important strategy for curtailing poverty in Mozambique (Arndt et al., 2012). Agricultural research and rural extension organizations play a crucial role in sourcing information to farmers about available technologies, allowing for modernization which can increase agricultural productivity, contributing to improve their living standards (Amungwa, 2018). Although there is a considerable number of institutions (public, Non-Governmental Organizations–NGOs[2] and private) providing advisory services to farmers in Mozambique (Gemo et al., 2005; Cunguara and Thompson, 2018), the national agricultural performance remains low.

According to Maulu et al. (2021), the relevance of rural extension programs in agriculture is largely dependent on their ability to meet farmers' needs since they are the stakeholders at the grassroots. Improving agricultural performance requires provision of agricultural technologies and compatible information with farmers' needs and realities (Oladele and Fawole, 2007). However, Snapp et al. (2003) state that in many developing countries, research and extension institutions face difficulties in providing services that are compatible with farmers' needs and circumstances. This reveals the need to analyse the congruence between demand and supply of agricultural technologies. Thus, the aim of this study is to compare the supply and demand of maize crop technologies in Sussundenga district. The research questions of this study are: (1) what are the main technologies and services offered by agricultural research and rural extension to maize growers in Sussundenga? and (2) what are the main agricultural technological demands of local maize growers? In one side, this study can help in identifying the gaps between supply and demand of maize farming technologies in Sussundenga and in another side it can help in the definition of public, private sector and NGOs intervention strategies to provide services and technologies that contribute significantly for improvement of agriculture Sussundenga district and in other regions of Mozambique. Sussundenga was chosen because this district is situated in Agro Ecology Region 4, a region with high maize production in the country (Walker et al., 2006). Besides it, Sussundenga is one of the districts with high intensity of rural extension activities in Mozambique (Gemo and Chilonda, 2013).

METHODOLOGY

Study area

The present study is a result of field work carried out in February and March 2018 in Sussundenga district, Mozambique. The district has an area of 7100 km^2 and is situated in central region of Manica Province. Estimates indicate that the population of the district is about 171000 inhabitants (National Statistics Bureau-INE, 2018). Agriculture is the main activity practiced by the local households, where the main crops are maize, beans, vegetables and fruits (MAE, 2014).

Sampling and data collection

Data used in this study were collected through a structured questionnaire made to 140 households maize growers. The interviewed households belong to the four Administrative Posts of the district, where 55 were from Sussundenga Headquarters, 53 from Dombe, 21 from Muoha and 11 from Rotanda.

In addition to the questionnaire made to households, it also interviewed 15 agricultural technicians[3] belonging to four organizations that provide agricultural services advices to farmers in Sussundenga. In 2018, these four organizations, namely District Economic Activities Service (SDAE[4] in Portuguese), Agrarian Station of Sussundenga (EAS in Portuguese), National Cooperative Business Association and Cooperative League of United States of America (NCBA-CLUSA) and Food and Agriculture Organization of the United Nations (FAO) had 19, 5, 2 and 1 technicians working directly on maize crop with farmers, respectively. The sample is composed of seven technicians from SDAE, five from EAS, two from NCBA-CLUSA and one from FAO.

The information that was gathered from farmers allowed the author to characterize their households and to discern their main technological and information needs, from the agricultural input market to maize commercialization. Data collected from the technicians are related to the main technologies or information that their organizations provide to maize growers. Data of supply and demand of maize farming technologies were grouped in three categories: maize production issues, maize storage and market issues (agricultural input market and maize commercialization).

In addition to the questionnaires, six meetings were held, four with farmers and two with technicians, using the focus group technique. Since many local farmers do not speak Portuguese language and the researcher does not speak *matewe*, the local language, we asked one member of them to translate our questions to local language and to translate farmer's answers to Portuguese. The number of participants in the focus groups ranged from five to eight. In the focus groups with farmers and agricultural technicians,

[1] Maize is the most cultivated in terms of number of farmers growing it and in terms of area dedicated to grow it. According to MASA (2015), in 2015, maize crop was cultivated by 72.5% of household's farmers in Mozambique and occupied more than 30% of cultivated area.

[2] Between 2016 and 2017, in addition to the public sector, there were 20 NGOs, national and international, working with rural extension in Mozambique (Cunguara and Thompson, 2018).

[3] In this study, the expression "technician" is used to designate the collaborator from either the public or private institutions/NGOs responsible for sharing agricultural knowledge/technologies or that one who does any work related to the agriculture field.

[4] Besides rural extension activities, SDAE is responsible for other activities as issuing licenses for natural resources exploitation, fishing, tourism, trading and industry.

Table 1. Characteristics of households' maize growers in Sussundenga.

Variable	Percent
Sex of household head	
Male	82.9
Female	17.1
Age of household head (years)	
Missing	3.6
Between 19 and 40	46.4
Between 41 and 60	40.7
More than 60	9.3
Educational level of household head (years of formal school)	
Missing	5.0
Less than 7	47.1
7 or more	47.9
Household size (number of people)	
1 or 2	4.3
3 or 4	27.1
5 or more	68.6
Practice of off-farm activity in the household	
Yes	82.1
No	17.9
Membership of farmers' groups	
Yes	28.6
No	71.4

Source: Field data (2018). N = 140.

we collected data regarding to the main problems faced by local maize farmers. We used the same technique to collect information of services that research and extension supply to farmers in Sussundenga.

Data analysis

Data collected in individual interviews were analysed using descriptive statistics (percentage), which allowed the construction of frequency tables. *Bardin*'s content analysis is a technique used to analyse data collected from focus groups meetings. According to Godoy (1995), in content analysis from *Bardin*'s perspective, the researcher seeks to understand the characteristics, structures or models present in the interviewees' answers. Content analysis has three phases, namely: pre-analysis, material exploration and treatment and interpretation of results (Bardin, 2011; Silva and Fossá, 2015). The *ipsis verbis* transcript of focus group interviews was the first step of pre-analysis phase. After transcription, the author made a fluctuating reading of the interviews. This exercise allowed the construction of categories of analysis suited to the objectives of the research.

In the focus groups meetings, the analysed categories were: a) the main difficulties faced by farmers in maize production (such as access and availability of agricultural input market), b) farmer's instructions needs regard modern technologies and good agricultural practices (sowing data, sowing density, and pest control), c) maize storage and d) maize prices in the local market. In the exploration phase, the collected material is fragmented into record units. It consists of taking the interview paragraphs as records units (Silva and Fossá, 2015). According to the same authors, at this stage, the keywords which allow the elaboration of a summary to carry out a categorization are identified. Finally, the treatment and interpretation phase of the results consisted of the analysis of the gross results in order to validate them. In this phase, we made a comparative analysis of the contents of the focus group interview summaries with individual interviews'. It should be noted that in this study, the focus group meetings aimed to capture the general perception of farmers and agricultural technicians about technological demands of maize producers in Sussundenga. Since data from focus group meetings represents the general opinion of participants, we used them to help in the validation of the information collected in individual interviews with farmers and technicians.

RESULTS AND DISCUSSION

Profile of households' maize growers

The field data reveal that the majority of the households' maize growers are male-headed (Table 1). The predominance of male-headed households is consistent

with INE (2015). The document mentions that, the majority of households in Mozambique is male headed. Significant proportion of household heads (46.4%) is between 19 and 40 years old. This implies that from the point of view of age, a considerable proportion of the households is headed by prime-age adults.

Table 1 shows that 47.1% of the household heads have less than seven years of schooling, suggesting high illiteracy levels in Sussundenga district. Farmers' education level affects adoption of agricultural technologies and their participation in agricultural commercialization (Kafle, 2010; Tafesse et al., 2020). Thus, farmers' education level is an important characteristic to be taken into account by agricultural research and rural extension institutions.

Regarding to households size, 68.6% of households are composed of five or more members. The results are consistent with data from INE (2015). According to this source, the central region of Mozambique, in particular the provinces of Sofala and Manica, is one of the region with the largest number of households composed of more than five members.

The majority of the households (82.1%) are engaged in off-farm activities. It is understood as good, since the practice of off-farm activities is crucial to increase household's income, especially in regions like Sussundenga where poverty is high and agriculture is mostly dependent on climatic conditions. In fact, the field data reveal that besides agriculture, local households practice a range of activities both inside and outside the domestic nucleus. Among these activities, they sell several products (including agricultural products), work in public and private organizations, and work in mini-industry, just to mention a few.

Finally, Table 1 also shows that 26.4% of households have at least one person who is a member of farmers' groups. These groups are not only formal farmers' associations but also other type of organizations, as farmer fields schools (FFS). Groups as farmers' associations constitute capillarity so that, agricultural research and rural extension institutions can use them to reach more farmers (Martey et al., 2014).

Supply and demand of agricultural technologies related to maize crop

The analysis of relationship between demand and supply of agricultural technology related to maize crop in Mozambique is crucial, since the role of agricultural research and rural extension is to help farmers solving their problems by co-generation and supply of agricultural technologies that meet rural households' needs. But, demanded technologies must be appropriate, affordable and technically feasible if they aim to play a significant role in increasing production and yield and improving farmers' livelihoods (Agitew et al., 2018). Besides it, technologies must be profitable to be easily adopted and help farmers improve their livelihoods (Souza Filho et al., 2011; Cunguara and Darnhofer, 2011). The official documents of the Government of Mozambique mention that agricultural and rural extension institutions aim to help rural household to reduce poverty by providing them technologies that increase agricultural production and productivity (IIAM, 2007; MINAG, 2010, 2007). These documents recognize that the optimal functioning of the agricultural market can encourage households to produce agricultural surpluses, which can later sell it, thus creating the possibility of increasing their incomes and improving livelihoods. The relationship between supply and demand of technologies related to maize crop in Sussundenga is illustrated in Table 2. It is important to mention that the services provided to farmers by agricultural research and rural extension are free of charges.

Table 2 illustrates that local organizations provide mainly technologies related to maize production. Household's maize growers do not demand only technologies related to maize production, but also strategies and actions aimed at improving the functioning of the agricultural market in the district. It means that households have holistic expectations that go beyond maize production technologies to entire maize value chain which include aspects like product storage, agricultural input market and product commercialization. As it can be seen in Table 2, the supply of services related to improve maize market is insignificant. In this respect the great mismatch lies between the institutions and of maize growers' expectations.

Households' farmers demands presented in Table 2 are aligned with the main constraints on maize farming in Mozambique. According to MASA (2015), Dias (2013), Uaiene et al. (2009) and Roxburgh and Rodriguez (2016), maize farming in the country is constrained by use of low yield genetic material, high pest incidence, input and product market failures and inadequate maize farming practices. In response to farmers' needs, rural extension and research organizations dedicate a significant portion of their work providing technologies related to agronomic issues (improved maize varieties, sowing density and control of maize pests and diseases).

Most of the agricultural technologies supplied and demanded in Sussundenga are related to the use of inputs that the main source is the market. Although some NGOs and SDAEs usually distribute some improved seeds and chemical pesticides[11] to local farmers, the main source of these inputs is the market. Thus, if there is an interest in the government and society that maize farming in the district change in order to be practiced as an economic activity, it is crucial to take into account the functioning of the agricultural market. From this perspective, issues related to market functioning, such as its structure and the power of the different players in dealing or pricing of inputs and maize, should be guiding

[11] The application of chemical pesticides is the most widespread pest control technology recommended to farmers.

Table 2. Supply and demand of technologies addressing maize crop in Sussundenga.

Technologies or information	Demand (% of farmers)	Supply	
		Rural extension (% of extension agents)	Research (% of researchers)
Maize pest and disease control in the field[a]	77.1	26.7	0.0
Storage pest control[b]	59.3	13.3	0.0
Maize improved varieties[a]	35.7	13.3	40.0
Sowing density[a]	35.0	40.0	0.0
Funding strategies[c]	32.9	6.7	0.0
Maize price improvement strategies[c]	26.4	6.7	0.0
Adaptation to rain irregularity[a]	19.3	0.0	0.0
Agricultural input market issues[c]	14.3	6.7	0.0
Animal traction tillage or use of tractors[a]	5.00	0.0	0.0
Growing seeds of improved varieties[c]	0.00	6.7	6.7
Fertilizer application[a]	2.90	20.0	0.0
Irrigation[a]	2.90	6.7	0.0
Erosion control and permanent land cover[a]	0.00	13.3	0.0

Source: Field data (2018). N=140 for farmers and N=15 for agricultural researchers and extension agents. [a]Maize production issues. [b]Maize storage. [c]Issues regarding the agricultural input or maize market.

the supply of technologies to households' maize growers. Technologies offered to farmers in the district (e.g. improved seeds, pesticides and chemical fertilizers) have potential to increase maize production and yield. According to data collected in the field, whenever maize farming is made without these inputs, its yield is very low (about 0.6 ton/ha). However, using the above mentioned technologies, yield can increase up to about 2.0 ton/ha in conditions of rain fed. It means that yield obtained by famers in Sussundenga is very low compared to its potential. According to IIAM and FAEF (2010), in Agro Ecology Region 4, where Sussundenga is situated, maize farming can reach the yield of 8 ton/ha if it is made with high using of level of inputs (fertilizer application, improved seeds and irrigation).

However, households consider that the price of agricultural inputs is high while that of maize is low. It configures an unfavourable environment to maize production from the perspective of the use of inputs acquired in the market. According to field data, 50 kilograms of Urea or NPK fertilizer cost about 2500 Meticais[15] (MT) equivalent to 33.35 USD, the litre of insecticide-800.00 MT (10.65 USD) and the kilogram of maize certified seeds-250.00 MT (3.35 USD). Mudema et al. (2012)[16] estimate that growing one hectare of maize costs 10647.50 MT, including the use of the above mentioned inputs, the payment of contracted and household labour and the machinery rental used in tillage. With the production of two tonnes, the expected revenue is 13400.00 MT[17]. Therefore, under these conditions, farmer earns about of 2752.50 MT. This margin is very low if one takes into account that one would have to wait four or five months to earn this amount of money. It is crucial to mention that neither the current study, nor that one of Mudema et al. (2012) took into account the price of land. Many rural households in Mozambique practice agriculture in their own land. That is why land price was not taken in account in this study.

The low price of maize in Sussundenga market is one of the main factors responsible for the low revenue. While a farmer in Sussundenga receives an average of 6.70 MT per kilogram of maize, in Maputo about 1100 km from Sussundenga, the main consumer market of agricultural products, that cereal costs an average of 17.15 MT (a difference of 250%). A huge difference between maize prices in the surplus regions (central and northern Mozambique) and the south of the country is in to certain extent due to market failures, partly caused by poor access routes that drive up transaction costs (Dias, 2013).

The improvement of roads, which is supposed to have an effect on reducing transaction costs, has high potential in reducing the differences between the price received by farmers and the one paid by maize final consumers. Under the current conditions, due to high information

[15] Metical-MT (in singular) or Meticais in plural is the official currency of Mozambique.

[16] This study was carried out in South of Mozambique where yield is lower than in Centre and North of the country. We consider that is important because it give us a figure of maize production expenditures.

[17]For the calculation of revenue, it was considered 6.70 MT as the price of kilo of maize because in the last 12 months of fieldwork (between April 2017 and March 2018), this was the average value that local farmers received for sale of this cereal. The data used to calculate maize prices is provided by the Agricultural Market Information System (SIMA). More information at http://www.masa.gov.mz/sima/

asymmetry between farmers and retailers, the retailer has a lot of power in determining the price to be paid to the farmer. According to Souza Filho et al. (2011) and Jack (2013), the fact that inputs allow an increase of agricultural production and productivity is not an enough condition for its adoption by farmers.

The authors' argument is that, farmers, especially smallholders, would not be willing to make high investments in agricultural inputs in situations where markets are insecure. In markets with many failures, the lack of economies of scale, inadequate conditions of packaging, poor storage and transportations make it difficult for farmers to gain direct access to consumer markets, forcing them to accept the low prices determined by retailers (Souza Filho et al., 2011). Cunguara and Darnhofer (2011) argue that access to market and technologies' profitability are crucial elements that can encourage farmers to adopt agricultural technologies and boost their incomes.

Some interviewees showed their displeasure about the low maize price as well as the scarcity of options for selling this product at the price considered satisfactory, which forces them to sell it under this condition. In addition to the precariousness of road connecting central and southern Mozambique, the reduced bargaining power of farmers to negotiate maize and inputs prices[18] the high speculative purchasing power of traders and retailers, farmers' inability to store maize and sell it when price is high, contribute to low profitability of that cereal in Sussundenga market. Because of famers' inability to store maize, they usually sell it right after the harvest when prices are extremely low and purchase back the same product during the lean season.

Field data indicate that in central Mozambique there are companies that purchase significant quantities of maize to their production. For example, "Cervejas de Moçambique" in Bárue district, 150 km from Sussundenga, "Deca" Company in Chimoio City -40 km and "Abílio Antunes" Poultry in Gondola district- 60 km, acquire significant quantities of maize produced in central region of Mozambique. However, according to the technicians interviewed, these companies pay low prices. Because of low maize prices and the high agricultural input prices, many maize growers consider that, it is not economically favourable to use such agricultural inputs. In our analysis, some options like the creation of an environment that will drive up the maize price received by farmers and the increasing of farmer's bargaining power to negotiate the maize price can improve the profitability of agricultural inputs and encourage farmers to adopt agricultural inputs, increasing maize production and productivity.

The technicians interviewed in this study recognize that the current local agricultural market does not encourage the adoption of agricultural inputs because there is no guarantee of a favourable price for the product. However, the same technicians continue recommending farmers to use these inputs. It highlights the difficulty of research and rural extension in supplying technologies that really take into account local market characteristics. This finding reveals that the institutions' main concern is to recommend technologies that maximize maize yields without thinking about the entire maize value chain. One possible reason for this little consideration of market aspects is that the agricultural research and rural extension guiding documents (*eg*, MINAG, 2007, 2010), and the speeches of politicians guide technicians to work towards helping rural households to increase agricultural production. The logic of this orientation is that agricultural technologies allow increasing production and consequently increasing of rural households' income. Agricultural technologies are relevant to improve production and productivity, but if the agricultural value chain is not well structured and organized, the role of those technologies in improving farmers' well-being will remain insignificant.

In addition to issues related to production and market technologies, about 60% of farmers demand pest control technologies for stored maize, particularly regarding weevil infestations (*Sitophilus zeamais*). In response to this question, FAO and other organizations implemented *Gorongosa*[21]-type silo construction project in Sussundenga district. However, evidence from the field shows that those silos are still seldom used. Interviews with technicians and farmers reveal that famers consider that the initial investments needed to build the *Gorongosa* silo are high, which in addition to the need to thresh maize before storage[22], reduce their interest in using it. Another factor that also contributes to the low use of *Gorongosa* silo is the perception that the maize price is low, which may influence households' lack of interest in investing in building this type of silos. This is a vicious cycle that needs to be broken because the storage of maize allows farmers to sell it when the price is high. Therefore, it would improve the profitability of maize production. In this research, we did not make a cost-benefit analysis of using *Gorongosa* silos, but FANRPAN (2017) did it for metal silos. The author points out that even to smallholder farmers it is profitable to invest in metal silo building. The experience of metal silos suggests that *Gorongosa* silos are also profitable. It is important to mention that *Gorongosa* silos are more affordable than metal silos and grain can stay for more than 8 months (FANRPAN, 2017). But in order to have

[18] This issue is linked in some way to the extremely small scale of production. This characteristic means that farmers have no power to negotiate prices, which forces them to obey by the conditions imposed by the few traders who wish to purchase the product. Field data show that maize plots average 4.3 hectares and most are less than 5 hectares, which difficulties the economies of scale.

[21] Gorongosa barn enables the grain quality to be maintained as long as all the rules of its use are observed.

[22] Before being put into the *Gorongosa* barn, maize must be threshed. However, farmers understand that threshing requires is a lot of work, which discourages them from using the barn.

profit of using silos, farmers would have to sell maize in the lean season. This must be a huge challenge to smallholder farmers since they tend to sell agricultural products immediately after harvest. On the other hand, smallholder farmers may need money to buy certain goods for their immediate consumption. Another problem that may affect farmer's willing in building silos in Mozambican is the low access to credit. In our analysis, all these aspects affect the use of silos in Mozambique. Table 2 illustrates two other situations that also deserve to be mentioned. The first is the existence of farmers' demands that have not found answers from the organizations. For example, demands on strategies for adapting to rainfall irregularity, animal or tractor-tillage and maize irrigation were presented by 27.2% of the interviewed farmers, but these demands have not been answered (Table 2). These demands are crucial, as currently, agriculture faces new scenarios that threaten its performance. For instance, the issue of strategies for adapting to rainfall irregularities should deserve attention from the institutions because there is evidence that in recent years, rainfall has begun to fall more irregularly in Mozambique (Tadross, 2009). This situation threatens the maize production and other crops, given that in Sussundenga district agriculture is mainly rain fed.

The second and last situation is related to the existence of technologies offered by the agricultural research and rural extension with little or no farmers' demand, namely: fertilizer application, erosion control and mulching. According to MAE (2014) the district faces erosion problems. Thus, we perceive that erosion control technologies have got potential to help solving this problem. However, the fact that these technologies have not been demanded demonstrates that, probably, the issue of soil conservation is not yet perceived as a problem by farmers interviewed in the current study. From the perspective of Pinto (2008), technologies offered under these conditions hardly find acceptance by potential users. It challenges research and rural extension institutions to illustrate to local farmers that the issue of soil erosion is a real problem that can compromise agricultural production. Chemical fertilizer application has the potential to mitigate soil depletion considering that, according to technicians; maize farming is mostly made without application of this input. One possible reason for the low use of this input is because it is one of the most expensive inputs in maize production in Mozambique (Mudema et al., 2012).

Possibilities and limitations of agricultural research and rural extension interventions

Rural extension and agricultural research organizations are relevant actors as source of agricultural technologies. But acting in isolation will not solve the problems faced by farmers. For example, according to MINAG (2007), Extension Master Plan 2007-2016 defined that one of the objectives of rural extension is to facilitate the link among farmers, input suppliers and agricultural product traders[23]. However, it is considered that, it is very difficult to achieve this goal in regions characterized by small scale production, low local agricultural products' demand and very poor access routes. Another issue is that the direct participation of public institutions in input markets or in the provision of agrarian financing, for example, can lead to much discussion because the perception is that it is a private sector role. Recent experience of a public funding program for economic activities in Mozambique has raised a number of questions because of lack of transparency in projects selection, high borrower defaults and poor results (Orre and Forquilha, 2012).

Although there are limitations on the agrarian market in Sussundenga district, it is crucial to highlight two FAO's projects aimed at improving access to agricultural inputs. The first project is offering *e-vouchers* to farmers in order to have access to subsidized inputs in local *agrodealers.* Depending on the package, local farmers pay only 25 or 40% of the real cost of agricultural inputs and FAO covers the remaining value (Nagasawa, 2017). It is recognized that the project improves agricultural inputs access to farmers, but it does not solve the other component of the problem: the low price of maize. Apart from these issues, there is no certainty about its continuity since it depends on international aid. Another project offers farmer training in maize seed production. If this project succeeds, farmers can reduce their market dependence on this input, as well as creating possibility of selling part of the product, which would be another source of household's income.

The results of this paper confirm previous studies, that mentioned that agricultural research and rural extension organizations face difficulties to provide technologies and recommendations that take into account farmer's realities and needs (Agitew et al,. 2018; Snapp et al., 2003). But it is crucial necessary to mention that there are many factors determining the success of the activities of these organizations. According to Van den Ban and Hawkins (1996) and Taye (2013), the effectiveness of rural extension depends on other factors that are beyond the control of these institutions. Taye (2013) points out that market, transport, funding provision and collaboration between rural extension and research aspects influence the performance of extension activities. In the same point of view, Alves et al. (2016) mention that, in some cases, the diagnosis that the problem of technologies is derived from the fact that institutions work with unsuitable extension methods is a misconception. According to the authors, the main problem with many agrarian technologies is that, ideally, they require a free environment or with low market failures to make them profitable, especially for smallholder farmers. By distorting prices paid and/or received by farmers, market

[23] It is understood that this action is an attempt of the public sector to improve the connection of these three actors.

imperfections affect the profitability of the technology, which makes its adoption unattractive. It is noticeable here the difficulty of issuing judgment the agricultural research and rural extension institutions functioning.

Given the reality Sussundenga district, agricultural research and rural extension can help reduce market failures by providing farmers with information on maize prices in main consumer markets whenever helping to set up and consolidate farming associations. It has the potential to make farmers achieve economies of scale in maize and agricultural input market. Farmer's associations are relevant instrument for improving farmer's well-being in developing countries, either through its potential contribution to markets access or by strengthening information dissemination among them (Sitoe and Sitole, 2019).

Since most technologies offered to maize growers depend on the market, and currently agricultural market does not encourage farmers to adopt it, agricultural research and rural extension can develop and supply another set of technologies that are less dependent on the input market, for example organic fertilization, crop rotation and intercropping and use of botanical pesticides for maize pest control. It is worth mentioning that according to data obtained in the field, some of these technologies have been supplied to farmers, but their use is still incipient. As argued by Maulu et al. (2021), extension program delivery methodologies should constantly be adjusted to meet farmers' needs in their particular environmental and socio-economic settings. This is the main challenge that needs to be taken in account by agricultural research and rural extension programs in order to help famers boost the development of their households through agricultural activity. In order to stimulate farmers to invest in *Gorongosa* silos, agricultural research ought to conduct economic researches to demonstrate that it is profitable to use this technology.

Conclusion

This study aimed to compare supply and demand of agricultural technologies related to maize crop in Sussundenga. The results reveal the existence of some disconnections between households and rural extension/agricultural research organizations.

Households' maize growers have expectations that go beyond agricultural technologies regarding maize production. Besides it, they demand strategies to improve agricultural market performance, but extension and agricultural research organizations do not seem to supply enough solutions to meet this maize grower's demand. There are also unanswered demands and the supply of little or non-demanded technologies.

The supply of high priced input technologies in a situation where agricultural market is insecure is a misconception in terms of the rationality of an economic activity. It suggests that agricultural research and rural extension organizations should rethink the way they work in order to help rural households refrain from poverty through farming.

The recommendation for these institutions is to expand the range of technological options to other production systems that are less dependent on market inputs. The strengthening of farmer's associations is also suggested because it may increase their power to negotiate the maize prices and agricultural inputs through economies of scale. Agricultural funding, research and rural extension organizations are suggested to help farmers breaking the vicious cycle of non-use of *Gorongosa* silos as they are useful for farmers to store maize and sell it when the price is high. It can rouse the interest of farmers to adopt high-productivity agricultural technologies.

The recommendation for the public authorities is to improve access roads, especially the road linking south to other regions of the country. This is a condition that may arouse the interest of the private sector to invest in efficient transportation system and storage infrastructure, which would help to reduce the different price received by the producer and the one paid by the final consumer, benefiting the farmer.

The existence of demand for maize in the Mozambican market justifies the need for efforts to be made by different actors so that farmers of high agricultural potential regions, like Sussundenga, take advantage of this scenario by creating conditions that will increase their production and yield and therefore income and improving living conditions.

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CONFLICT OF INTERESTS

The author has not declared any conflict of interest.

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