# Analysis of maize production and yield in Mozambique (2000-2018): trends, challenges and opportunities for improvement

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## Abstract

This paper assesses the trends of production and yield of maize sector in Mozambique discusses the challenges and opportunities for enhancing both production and productivity in the country considering the key interventions that have been undertaken by all stakeholders. We use data from national agricultural surveys carried out from 2002 to 2015. Other data sources including FAOSTAT are considered especially for the comparison between Mozambique and other neighboring countries. The analysis confirms that the maize sub-sector is dominated by smallholder farmers who rely less on external inputs and technologies such as improved seeds, chemical fertilizers, pesticides and irrigation. We also find that the upward variation of total area allocated to maize is largely explained by the opening of new maize plots rather than expansion of maize cropped area by the cultivating households. We also find that Mozambique has struggled to meet domestic and regional maize targets to which it has committed. In the meanwhile, there is a large gap between average yield in Mozambique and neighboring countries is large and, more importantly, it has been growing over the years. The challenges faced by maize farmers include unbalanced pattern of investment in the agricultural sector in Mozambique, weak evidence-based development planning, low quality seeds, lack of rural storage facilities and road infrastructure, difficulty of integration of maize smallholder farmers in the value chain and low access to agricultural credit. Agriculture development policy that directly addresses these constraints can improve maize productivity to the benefit of many.

**Key Words:** Agricultural productivity, Agricultural policy, Smallholders, Maize, Africa

## Acronyms and Abbreviations

| | |
|---|---|
| AU | African Union |
| CAADP | Comprehensive Africa Agriculture Development Program |
| CSA | Agricultural Services Centers |
| DCA | Development Credit Authority |
| DCA | The Development Credit Authority (DCA) |
| DUS | Uniformity and Stability |
| ERV | Green Revolution Strategy |
| FAOSTAT | The Food and Agriculture Organization Corporate Statistical Database |
| FAW | Fall Armyworm |
| FDA | Mozambique's Agricultural Development Fund |
| GDP | Gross Domestic Product |
| GoM | *Governo de Moçambique*, Government of Mozambique |
| IAI | *Inquérito Agrícola Integrado*, Integrated Agricultural Survey |
| IIAM | *Instituto de Investigacão Agrária de Moçambique,* National Agricultural Research Institute of Mozambique |
| IMF | International Monetary Fund |
| INE | Instituto Nacional de Estatísticas, National Institute of Statistics |
| IRRIGA | Small-Scale Irrigation and Market Access Project |
| MAFAP | Monitoring African Food And Agricultural Policies |
| MASA | Ministry of Agriculture and Food Security |
| NAMP | National Agricultural Mechanization Program |
| PAPA | Action Plan for food production |
| PEDSA | Strategic Plan for the Development of the Agriculture Sector |
| PFCS | Program for Strengthening of Seed Chain |
| PFCS | Program for Strengthening of the Seed Chain |
| PNF | National Fertilizer Strategy |
| PNISA | National Agricultural Investment Plan |
| PNMA | National Agricultural Mechanisation Programme |
| PQG | Plano Quinquenal do Governo, Government Five Year Plans |
| PROAGRI | National Program for Agricultural Development in Mozambique |
| PROIRRI | Sustainable Irrigation Development Project |
| RGF | Fertilizer Management Regulation |
| SADC | Southern African Development Community |
| SIDA | Swedish International Development Cooperation Agency |
| SSA | Sub-Saharan Africa |
| TIA | *Trabalho de Inquérito Agrícola*, Agriculture Field Surveys |
| USAID | United States Agency for International Development |
| VCU | Value for Cultivation and Use |
| WB | World Bank |

# Table of contents

## List of tables



## List of figures

## 1. Introduction

In Mozambique, agriculture has essentially been based on poorly resourced farmers over the past decades and is the mainstay of the economy. The agriculture sector is the main source of livelihoods in Mozambique, especially in rural areas, and is expected to remain so for decades to come. It accounted for about 24.7% of the GDP in 2016, and employed around 72% of the labor force in 2014 (IOF, 2014-2015), while also contributing around 7.2% of the total export earnings in 2014 (INE, 2016). According to IMF (Fox et al., 2013), this has been the trend in Sub-Saharan Africa (SSA) countries, where the share of the sector in total employment was 81% in 2010, making it a critical component of programs that seek to reduce poverty and attain food security in those countries including Mozambique.

In general, Mozambique is rich in natural endowments well suited for agriculture given its favorable climate and soil conditions. It has a total of about 36 million hectares of arable land but only about 13% is currently being exploited. Smallholders are the pillar of the predominant farming system, with crop production accounting for about 75% of the sector's value-added (World Bank, 2015). Food crops account for 90% of total crop production and maize is the most important cereal and the second main food crop grown. However, food production system including maize production faces a huge set of challenges driven by structural constraints and farmers' socio-economic aspects.

In order to overcome such challenges, the Government of Mozambique has developed several policies and Strategic Plan for the Development of the Agriculture Sector 2011 – 2020 (PEDSA)[1], which aim to increase agricultural productivity of maize and other priority crops. PEDSA is fully aligned with Government Five Year Plan (PQG) and the Comprehensive Africa Agriculture Development Program (CAADP) priorities, details the sector objectives and broad targets, while an investment plan (PNISA) translates these objectives into specific programs, indicators and budgets. In addition to PEDSA/PNISA, more recently, the Government of Mozambique committed in 2014 at the African Union (AU) Summit in Malabo to doubling (100% increase) agricultural yield within 10 years (2015-2025). Those targets under Malabo Declaration are expected to be met through several interventions including establishment of Agricultural Service Centers (CSAs), operationalization of inclusive Public-Private-Partnerships for commodity value chains with strong linkage to smallholders, and construction of silos as well as construction of bridges and roads.

In this paper, we assess the trends of production and yield of maize in Mozambique and build on the findings to discuss the challenges and opportunities for enhancing both production and productivity in the country considering all interventions that have been undertaken. In fact, there is a bulk of studies looking at trends, challenges and opportunities of maize sub-sector (e.g. Prasanna, 2015; Badu-Apraku & Fakorede, 2017; and Ekpa et al., 2019). However, all of them are

[1] Referred to by its Portuguese acronym PEDSA – *Plano Estratégico para o Desenvolvimento do Sector Agrário 2011-2020.*

regional and none has addressed the maize productivity and production together and use the findings to discuss the challenges and opportunities of the sub-sector. Moreover, to our knowledge, this is the first country- and crop-specific study that addresses the issue.

More specifically, this paper presents an analysis of maize production and yield in Mozambique by addressing three questions as follows: (i) what has been the trend in production and yield of maize in Mozambique; (ii) What are the factors explaining the levels of production and yield; and (iii) what are the challenges and opportunities of maize sub-sector given the current status. The paper is organized as follows. First, we present an overview of Mozambique's agricultural sector with emphasis on maize sub-sector. Second, we describe the data and methodology used for the study. Third, describe and discuss the trends in maize production and yield in Mozambique. Next, we discuss the challenges of the maize sub-sector and identify some opportunities for improvement of performance of the sub-sector. Finally, the paper presents a summary of results and recommendations policy implications.

## 2. Overview of sector and (maize) sub-sector policies and programs in Mozambique

In the constitution of Mozambique, agriculture is the basis of national development. To attain agricultural sector goals, the government of Mozambique developed and implemented several agricultural policies, strategies and plans during the post-independence years to boost the sector performance. The policies in place discuss issues in a broader sense, targeting issues related to maize and other crops production and commercialization. These include among others the Strategic Development Plan for the Agricultural Sector (PEDSA) 2011to 2020, which is the main guiding document for the development of the agricultural sector, with the aim to transform the agricultural sector from predominantly subsistence to a more competitive and market-oriented production through value chain integration. The National Investment Plan for the Agricultural Sector (PNISA) 2014 to 2018 which was developed to operationalize the actions to achieve the CAADP (Comprehensive Africa Agriculture Development Program) and PEDSA objectives.

The National Program for Agricultural Development in Mozambique (PROAGRI), the 2007 Green Revolution Strategy (ERV) and the 2008 Action Plan for food production (PAPA) 2008 to 2011 are among others that preceded PEDSA aimed to increase agricultural performance of selected food crops including maize.

Neither policies in place nor the over-due ones are specific to the maize sub-sector to orient and support production and commercialization of the maize in the country. For example, PNISA document has a subprogram that targets among other food crops, maize production by offering a differentiate technology package compounded by improved seed and fertilizer to smallholder farmers to increase their production and productivity.

As was mentioned above, smallholder farmers are the pillar for agricultural production and are at the center of Mozambique’s agricultural development policies and programs. Mozambique is among the few southern African countries that the government has very little involvement in maize input market and does not intervene in maize output market (Sitko et al., 2017). The following, are brief description of relevant policies, strategies and programs used by the government of Mozambique (GoM) in recent years affecting food crops production. Mozambique neither has policy nor law for fertilizer. Improved inputs such as seeds and fertilizers are priority investment areas in the PNISA. PEDSA outlines priority actions to increase seed and fertilizer use.

In the case of fertilizer sector, there is only two regulatory instruments namely Fertilizer Management Regulation (RGF) aimed to ensure fertilizer quality in the country, and National Fertilizer Strategy (PNF) 2012 to 2016, aimed to establish a framework to help improve the quantity and quality of fertilizer available to producers. The strategy is based on the Abuja Declaration target of increasing use of fertilizer to 50kg/ha. The lack of fertilizer policy has negatively affected the agricultural performance in many ways including discourage private sector investments. The main policy instrument guiding the seed sector is PEDSA through the Program for Strengthening of the Seed Chain (PFCS), aims to strengthen the entire seed value chain and the Comprehensive Seed Regulation (Decree 12/2013) which focus mainly on certified, improved commercial seed varieties. The sector has also legislative documents, (i) Seed Act (Decree 41/1994), (ii) the plant variety protection decree (Decree 26/2014) for breeders' rights is not yet operational, (iv) the Ministerial Directive (Diploma Ministerial 51/2012) intend to relax the variety release process and allow for provisional release of varieties before the DUS and VCU tests were conducted (Mabaya et al., 2017). Further, PNISA, outlines activities related to developing locally adapted varieties, as well as local seed production in order to increasing access to improved and certified seed.

Although PNISA does not clearly recognize input subsidies as means for increase agricultural performance, the GoM through MASA in partnership with international organizations and donors launched in 2009 the input subsidy program aims at increasing maize and other food crops production and productivity. The program targets mostly small-and-medium scale farmers and subsidizes around 70% of the seed and fertilizer's retail price. In areas affected by emergency situations eligible farmers receive agricultural inputs free of charge from government or development partners with aim to restore agricultural production and afterward increase crops yield. In Mozambique the subsidy program is very small scheme in term of number of beneficiary farmers. During the 2009/10 cropping season the program reached 0.4% of total small-scale maize farmers, costing only 1.2% of agricultural budget (Jayne and Rashid 2013). Between 2015 and 2017, 0.6% of total small-and-medium scale farmers benefited from the subsidy program. The budget allocated to the subsidy program, the selection of target areas, including the inclusion criteria to be eligible may justify the number of farmers reached by the program. According to Mosca and Abbas (2016), a large portion of subsidy goes to medium-and-large farmers, as they can meet the selection criteria such as "having financial capacity to purchase subsidized inputs".

Mozambique adopted in 2010 the National Strategy for Irrigation, followed by establishing the National Irrigation Institute. The World Bank (WB) have been working with the GoM and other donors to improve the access and use of irrigation schemes by the smallholder farmers. Recently, the WB funded two irrigation projects namely, Sustainable Irrigation Development Project (PROIRRI) and Small-Scale Irrigation and Market Access Project (IRRIGA) aimed to support the expansion and development of irrigation to increase agricultural production of smallholder farmers and market access. Currently, irrigation schemes largely benefit large-scale farmers. Between 2014 and 2015 the percentage of maize smallholder farmers using irrigation schemes went from 1% to 1.1%. The country has scarce and outdated irrigation infrastructure used by smallholder farmers.

PEDSA outlines the need for more accessible credit. Nonetheless, the strategy has no clear activities which specifically focus on promoting access to credit to the small-scale farmers. Indeed, many programs intended to improve access to finance in agriculture seems to neglect smallholder farmers in favor of emergent and commercial farmers. In 2013 the GoM approved the Financial Sector Development Strategy (2013-2022) to further development of the financial sector and benefit the majority of households and business. The Development Credit Authority (DCA) is guaranteed by funds from USAID and SIDA to finance loans to medium-large scale farm agribusiness.

National Agricultural Mechanization Program (NAMP) has been implemented since 2015. The program is operationalized through network of Agriculture Service Centers, Public Institutions and Individual Farmers scattered throughout the country. Lack of finance, small farm size and high land fragmentation are the major obstacles that limit the smallholder farmers to acquire this service.

In many cases, the strategies, programs developed and implemented are not always suited to the local context. This includes the promotion of input subsidies, irrigation schemes, access to finance, and mechanization which are all priorities for the GoM, and are not designed to tackle the needs of smallholder farmers' needs. Such program can only work for a restricted number of farmers, leaving the majority without support.

## 3. Methodology

The analyses presented in this research are based on multiple sources of data, with the main source being the repeated agricultural household surveys (TIA/IAI) collected by the Ministry of Agriculture and Food Security (MASA) in collaboration with the National Institute of Statistics (INE). TIA/IAI Data are nationally and provincially representative and are available for nine agricultural seasons from 2002 up to 2015. The sample sizes vary from year to year and have an increasing trend. For instance, the first round of TIA, in 2002, collected in the country randomly sampled 4,908 small and medium-size farmers whereas in 2015, about 7130 households were interviewed (Table 1).

Table 1. TIA/IAI sample sizes across years

| Year | Number of Surveyed Households |
|---|---|
| TIA 2002 | 4,908 |
| TIA 2003 | 4,935 |
| TIA 2005 | 6,149 |
| TIA 2006 | 6,248 |
| TIA 2007 | 6,075 |
| TIA 2008 | 5,968 |
| IAI 2012 | 6,744 |
| IAI 2014 | 6,134 |
| IAI 2015 | 7,130 |

Source: MASA 2002-2015

Amongst the information of interest to this paper, the survey instruments contain information on: (i) HH demographics; (ii) access to resources, membership to farmers' organizations and natural disasters; (iii) income from economic activities on and off-farm; (iv) characteristics of land, including ownership and access to irrigation; (v) inputs, outputs, and sales of maize and other agricultural commodities; (vi) village-level information on infrastructure and other aspects. Additionally, in years for which MASA does not have data, the research relies on FAOSTAT data. Provincial population data collected by INE are also used in this report. Data analysis was carried out at aggregate level using descriptive statistics for the SADC region. Analyses at provincial level are also carried out.

This study further uses qualitative data collected through key informant survey in September 2019 aimed at further grasping the interventions in maize sub-sector as well as challenges and opportunities to enhance productivity and production of the crop in Mozambique. The survey involved fifteen (15) key informants including maize breeders, researchers and policymakers (see Table 13 in the appendices). After sending a list of questions through e-mail to all key informants, they were given a choice to be interviewed face-to-face or by responding by e-mail. The list of questions asked to specialists includes: (i) strategies/programs implemented to improve maize sub-sector over the last decade; (ii) lessons learned from all past and ongoing interventions; (iii) challenges faced by smallholder farmers to achieve maize yield of 2 ton/ha; and (iv) means to mitigate the challenges. The gathered information was analyzed using thematic approach which seeks to identify patterns of themes.

# 4. Analysis of trends in maize production

## 4.1. Overview of the Maize Value Chain in Mozambique

Maize is consumed by a great majority of Mozambicans. With the rapid growth of urban population in Mozambique and many other Sub-Saharan Africa countries, maize demand is expected to continue rising as a result of increase in demand for fresh produce, meat and dairy products. Another issue that is expected to contribute for the increase of demand for maize is its use as local raw materials for beer brewing. Maize is grown by more than 70% of farming households who are mostly smallholder farmers, and accounts for major cropping area compared to other food crops. Maize is produced in all regions and the southern is often considered to produce less than consumed. Later, we estimate the national, regional and provincial self-sufficiency in maize and explain more about the crop distribution across the provinces.

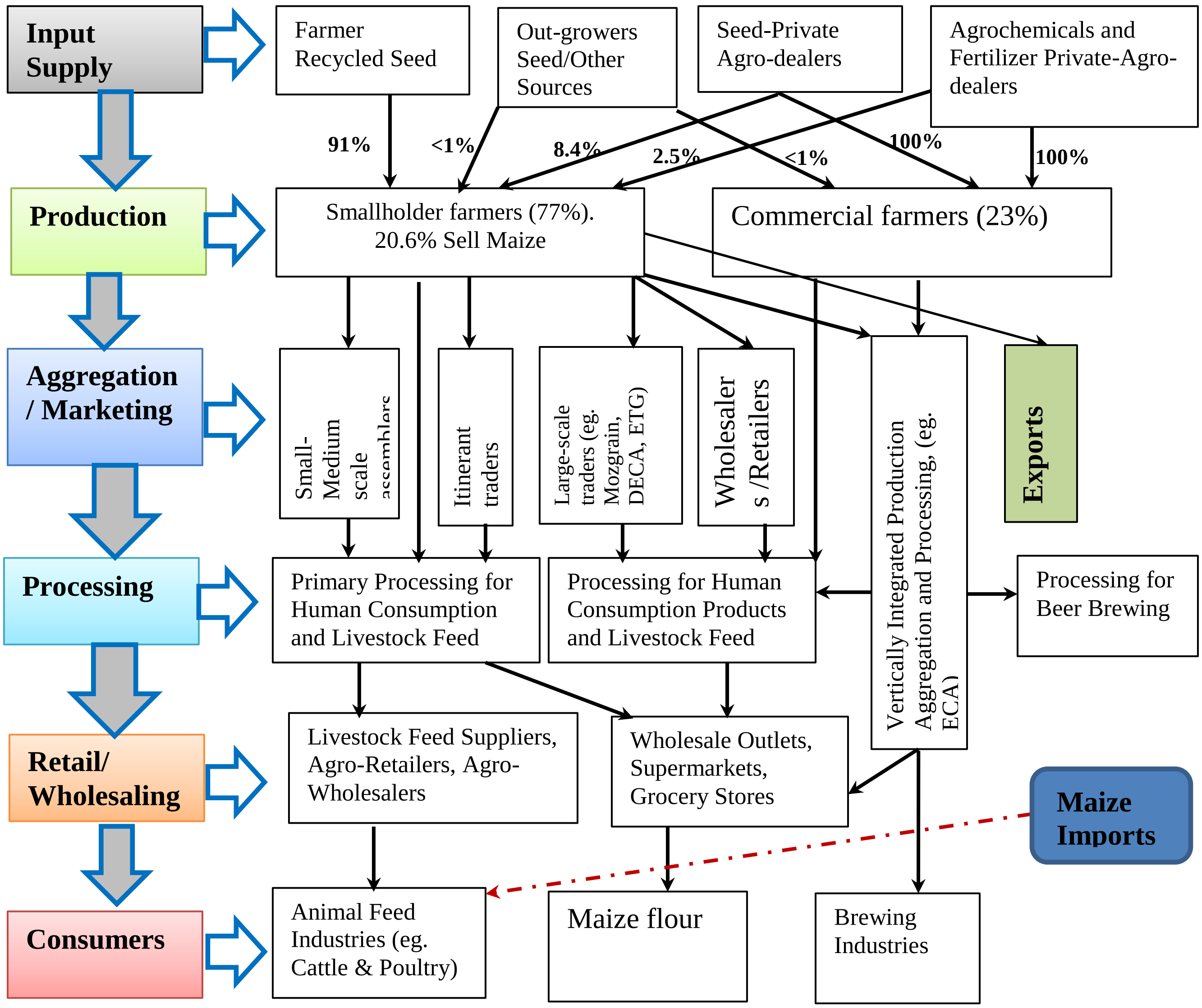
Maize value chain is encompassed by production, aggregation/marketing and processing stages. Maize is characterized by poor input supply especially for smallholder farmers. For instance, seed supply consists of two systems: formal and informal. According to FAO (1998), the latter is described as a system where farmers produce, obtain, maintain and distribute seeds from one cropping season to the following one. Formal sector, which is still incipient, includes breeding and evaluation of improved varieties as well as producing and selling certified seed varieties to farmers (Mabaya et al., 2017).

In the production stage, smallholder farmers are the main actors producing around 80% of total maize and the difference is produced by commercial farmers. Aggregation/marketing is done by traders – local small-and-medium-scale assemblers, itinerant traders, large scale traders, wholesale traders and retailers. Processing stage is executed by hammer millers, medium and large scale millers. Processed maize is used for human consumption, animal feed and for breweries. Figure 1 displays the maize value chain in Mozambique. In general, the structure of maize value chain is characterized by the missing linkage between the major actors. Moreover, there is lack of coalitions that represents the maize value chain players capable of advocating for state support to the maize sector as well as to address issues pertaining to maize value chain and strengthen the linkage between downstream actors and farmers.

Majority of smallholder farmers are not integrated in the maize value chain. These actors are resource poor and face multiple constraints in the agricultural production which could be minimized if they were part integral of the maize value chain. Those few integrated farmers are in aggregation schemes either with formal or informal contract with agro-processors, large millers and traders that supply seed and other improved inputs on credit and at harvest time farmers sell the production output and payback the advanced improved input costs. Beside these markets, smallholder farmers also sell maize to small-medium scale assemblers, traders and itinerant traders. Sometimes assemblers who are usually local residents or from neighboring communities sell maize bought from smallholder farmers to medium-scale traders and itinerant traders in their settled buying points and sometimes export to neighboring countries such as Malawi.

Itinerant traders are usually female traders from southern Mozambique which buy maize from surplus regions, transport through trucks to sell in maize deficit provinces. Large scale traders (ex. Mozgrain in Nampula province) are capitalized actors and movement large volumes of maize to supply millers, animal feed producers and poultry and cattle producers. An exception among millers is ECA miller in Manica province, which buy almost 100% of the maize directly from smallholder farmers and process into maize grits to supply to two breweries in southern Mozambique and other maize is processed in maize meal to sell to retailers and wholesalers markets, while the maize bran by-product export to South Africa market. Processors – process maize for direct human consumption and for animal feed (example: CIM, HIGEST, NOVOS HORIZONTES). A significant quantity of maize processed by most of Mozambican industries is imported mainly from South Africa because local farmers cannot satisfy the demand in terms of quantity and quality standards.

Figure 1. Value Chain Map – Maize



## 4.2. Production and productivity levels

Yield, which is used as a proxy for productivity, was calculated at the household level by (i) estimating total production which is equal to the total quantity harvested in each year; (ii) dividing total production by the area total cropped area. This analysis is shown at provincial and national levels and for 2002 until 2015. Table 2 depicts the distribution of maize cropped area in hectares across provinces for every year. It shows fluctuations in total land size allocated to maize over years. For instance, while about 2.1 million hectares of land were allocated to maize in 2014, the number decreased dramatically (by over 25%) in 2015. Those fluctuations are largely explained by expected amount and distribution of rainfall as well as pest and disease challenges (FAO, 2000). Overall, the results show that maize is largely grown in central Mozambique, more specifically in Manica, Tete and Zambezia provinces. While the north shows modest amount of land cultivated to maize, the south lags behind the other regions, with Gaza province being an exception for some years.

Table 2. Total Maize cropped area (ha) in Mozambique (2002-2015)

| Province | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2002 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 150,173 | 198,416 | 153,566 | 177,376 | 196,522 | 153,984 | 128,434 | 117,081 |
| CABO DELGADO | 106,777 | 142,103 | 137,721 | 137,994 | 135,135 | 109,108 | 202,955 | 163,984 |
| NAMPULA | 107,482 | 177,567 | 170,463 | 144,640 | 210,400 | 139,552 | 155,855 | 175,690 |
| ZAMBEZIA | 251,619 | 345,728 | 280,937 | 269,301 | 326,647 | 268,062 | 353,060 | 295,854 |
| TETE | 271,200 | 319,784 | 264,258 | 239,555 | 303,532 | 261,130 | 308,538 | 269,769 |
| MANICA | 238,479 | 224,156 | 225,944 | 286,224 | 265,926 | 255,780 | 336,637 | 198,072 |
| SOFALA | 128,866 | 119,006 | 142,996 | 119,557 | 205,685 | 191,256 | 221,140 | 113,634 |
| INHAMBANE | 105,161 | 108,268 | 106,984 | 111,250 | 118,300 | 54,173 | 62,345 | 56,331 |
| GAZA | 172,794 | 182,999 | 152,508 | 151,239 | 150,694 | 95,831 | 245,131 | 100,950 |
| MAPUTO | 43,994 | 33,953 | 28,514 | 27,226 | 51,554 | 36,473 | 135,146 | 79,161 |
| Total | 1,576,545 | 1,851,978 | 1,663,890 | 1,664,362 | 1,964,393 | 1,565,348 | 2,149,241 | 1,570,526 |

*Source: Authors computation using Data from National Agricultural Surveys*

In addition to total maize cropped area, we look at the variations in average cropped area. In general, the results show that national average area allocated to maize has been below 1 hectare over the past decade or so (Table 3). The average size of land cultivated to maize has a downward trend, which is consistent with findings from previous studies (e.g. Mosca and Abbas, 2016). Comparing the total cropped area presented in Table 2 and average cropped area, we find that the upward variation of the former is mostly explained by the opening of new maize holdings, i.e., entry of new households in maize cultivation rather than by expansion of maize cropped area by the cultivating households. On the other hand, downward change in total cropped area can be explained by reduction of land size cultivated to maize by one households as well as shifting from maize to other crops. Two additional takeaways from Table 2 and Table 3 are as follows. First, Manica is the only province where the households have consistently allocated over 1 hectare to maize over the past years. Second, despite the fact that Zambezia province is amongst the provinces with highest total land allocated to maize, it is composed of very small plots cultivated by each household. Land expansion in Zambezia may be limited given its population size.

Table 3. Average maize cropped area in Mozambique (2002-2015)

| Province | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2002 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 0.88 | 1.11 | 0.77 | 0.87 | 0.86 | 0.82 | 0.63 | 0.74 |
| CABO DELGADO | 0.40 | 0.49 | 0.49 | 0.46 | 0.46 | 0.37 | 0.47 | 0.44 |
| NAMPULA | 0.25 | 0.36 | 0.37 | 0.37 | 0.47 | 0.29 | 0.32 | 0.34 |
| ZAMBEZIA | 0.50 | 0.65 | 0.52 | 0.52 | 0.64 | 0.45 | 0.45 | 0.61 |
| TETE | 1.09 | 1.20 | 0.92 | 0.77 | 0.84 | 0.75 | 0.72 | 0.78 |
| MANICA | 1.15 | 1.07 | 0.97 | 1.08 | 1.06 | 0.94 | 0.97 | 1.09 |
| SOFALA | 0.84 | 0.74 | 0.85 | 0.73 | 0.91 | 0.83 | 0.79 | 0.66 |
| INHAMBANE | 0.53 | 0.53 | 0.55 | 0.48 | 0.53 | 0.33 | 0.40 | 0.37 |
| GAZA | 0.86 | 0.83 | 0.72 | 0.72 | 0.67 | 0.51 | 0.77 | 0.59 |
| MAPUTO | 0.62 | 0.51 | 0.44 | 0.40 | 0.56 | 0.29 | 0.71 | 0.29 |
| Total | 0.64 | 0.71 | 0.63 | 0.63 | 0.69 | 0.54 | 0.59 | 0.56 |

*Source: Authors computation using Data from National Agricultural Surveys*

Table 4 shows the maize production in tons for each province from 2002 to 2015. The results suggest a similar tendency as that observed in the total land size allocated to maize, i.e., total area allocated to maize is positively associated with total production of the crop. It is shown again that the central Mozambique has the highest production levels of maize and the southern lags behind the other regions. However, despite the association made between maize production and total land allocated to this crop, our estimation of maize production do not take into account the area of the crop. In what follows, we discuss productivity, which accounts for area, across provinces and at national level.

Table 4. Maize production (tons) levels in Mozambique 2012 - 2015, regardless of area

| Province | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 175,000 | 160,000 | 122,000 | 223,000 | 104,000 | 170,000 | 144,000 | 138,000 | 92,400 |
| CABO DELGADO | 85,700 | 93,100 | 80,400 | 105,000 | 85,700 | 76,100 | 68,400 | 115,342 | 93,800 |
| NAMPULA | 117,000 | 89,100 | 103,000 | 124,000 | 93,900 | 99,600 | 112,000 | 99,800 | 95,600 |
| ZAMBEZIA | 185,000 | 299,000 | 179,000 | 213,000 | 229,000 | 209,000 | 179,000 | 246,798 | 159,000 |
| TETE | 205,000 | 183,000 | 174,000 | 260,000 | 212,000 | 239,000 | 227,000 | 253,201 | 210,000 |
| MANICA | 163,000 | 172,000 | 162,000 | 204,000 | 212,000 | 187,000 | 228,000 | 210,880 | 148,000 |
| SOFALA | 76,100 | 104,000 | 52,700 | 102,000 | 96,800 | 105,000 | 118,000 | 146,853 | 87,100 |
| INHAMBANE | 18,500 | 16,700 | 18,000 | 32,500 | 29,000 | 36,900 | 20,600 | 19,291 | 12,200 |
| GAZA | 66,900 | 56,500 | 40,800 | 102,000 | 60,900 | 63,800 | 48,700 | 64,191 | 37,700 |
| MAPUTO | 21,800 | 7,622 | 10,400 | 29,300 | 10,900 | 26,600 | 24,800 | 63,048 | 64,500 |
| Total | 1,110,000 | 1,180,000 | 942,000 | 1,400,000 | 1,130,000 | 1,210,000 | 1,170,000 | 1,357,404 | 1,000,300 |

*Source: Authors computation using Data from National Agricultural Surveys*

Worth mentioning that yield was calculated at the household level. Thus, the average yield of maize that is reported in Table 5 was not obtained by dividing the average of the total production of maize in tons shown in Table 4 by the total area allocated to maize in hectares shown in Table 2. Doing so would reduce the degrees of freedom. Overall, the results show that maize yields in Mozambique has been fluctuating around 1,000 kg/ha over the past decade. Such fluctuation is also observed at provincial level, i.e., none of the provinces shows a consistent trend in its yield. The yield observed during the interval analyzed here is less than a quarter of potential of most varieties distributed along agro-ecological zones.[2]

[2] For instance, Tsangano and Sussuma varieties (OPV) are expected to have yields of 3.5-8.2 ton/ha and 3-6 ton/ha, respectively; Olipa and Hluvukane varieties (hybrid) are expected to achieve yields of 3-10 and 3-7 ton/ha, respectively.

Given that we include before and after 2007/8, which was when the world food prices increased dramatically including that of maize, we check if farmers responded to high price expectations. While one could expect improvements in yield following food price spike, our data show a national yield of 1 ton/ha, 1.2 ton/ha and 1.2 ton/ha in 2009, 2010 and 2011, respectively.[3] Surprisingly, the slight improvements in yield from one year to another is not a result of technological advancement. There is no evidence of improvement in the use of external inputs such as improved seeds, fertilizers, animal traction and irrigation (see appendices).[4] This is consistent with findings of previous studies (e.g. Cunguara and Kelly, 2013; FAO, 2000) which indicate that variation in maize production in Mozambique is mostly explained by variations in rainfall patterns across cropping seasons rather production intensification or adoption of better cropping practices.

Table 5. Maize yield (Kg/ha) levels in Mozambique 2012 – 2015

| Province | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2002 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 1,343 | 865 | 1,962 | 731 | 1,053 | 1,273 | 1,261 | 1,036 |
| CABO DELGADO | 1,009 | 721 | 942 | 751 | 803 | 813 | 920 | 833 |
| NAMPULA | 1,545 | 752 | 897 | 732 | 667 | 1,010 | 1,102 | 868 |
| ZAMBEZIA | 1,537 | 805 | 1,088 | 1,186 | 893 | 798 | 883 | 819 |
| TETE | 868 | 674 | 1,256 | 1,078 | 982 | 1,072 | 1,264 | 1,015 |
| MANICA | 1,005 | 958 | 1,233 | 1,028 | 814 | 1,457 | 989 | 1,285 |
| SOFALA | 885 | 745 | 981 | 1,015 | 691 | 1,147 | 1,061 | 1,115 |
| INHAMBANE | 539 | 330 | 398 | 362 | 455 | 632 | 1,026 | 404 |
| GAZA | 464 | 333 | 710 | 590 | 584 | 927 | 1,199 | 739 |
| MAPUTO | 1,424 | 429 | 1,464 | 569 | 809 | 2,265 | 2,183 | 1,673 |
| Total | 1,138 | 698 | 1,053 | 863 | 788 | 1,049 | 1,109 | 974 |

*Source: Authors computation using Data from National Agricultural Surveys*

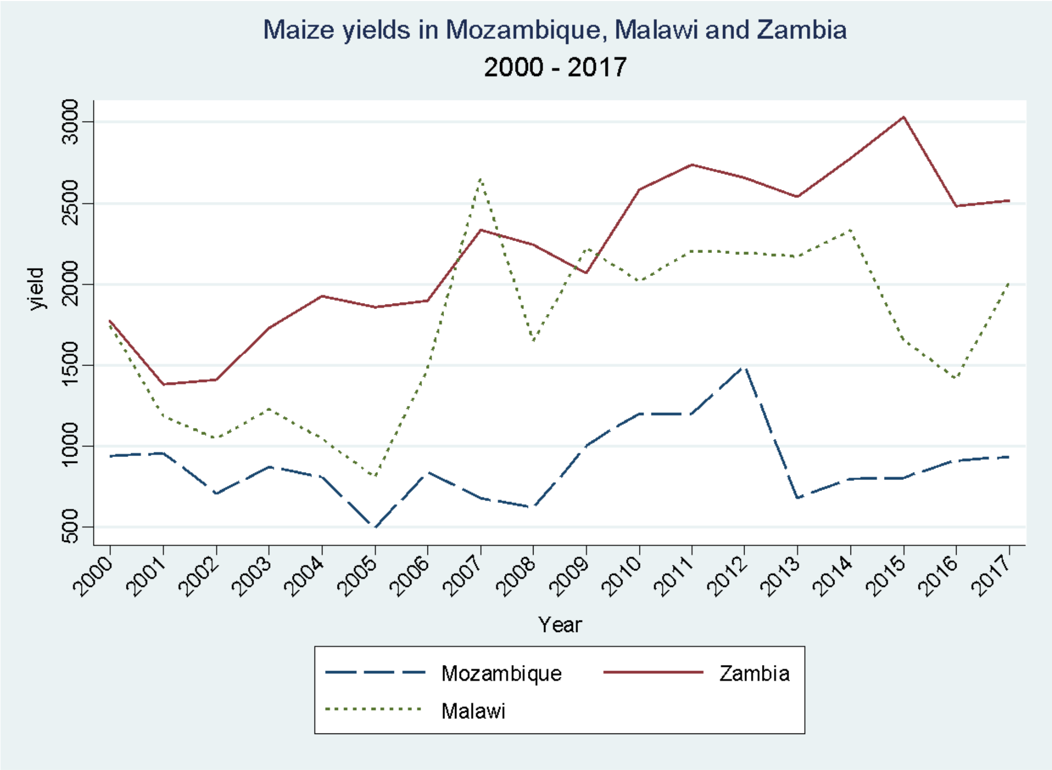
Certainly, low adoption of modern technologies has been identified as one of the main reasons for the disappointing performance of the Mozambican agricultural sector, particularly on maize sub-sector (Woohdouse, 2012; Jack, 2013, Wossen et al., 2017, and Chandio and Yuansheng, 2018). Other reasons behind the poor performance of maize sub-sector are summarized as follows. First, the missing linkage of smallholders to the value chain as well as lack of organization and innovation of maize value chain (Swinnen and Kuijpers, 2017); Second, lack of adequate policy support for maize and other crops (Tschirley and Abdula, 2007; MAFAP, 2014; and Sitko et al., 2017). Further, given its location and geography, Mozambique is amongst three countries in Africa most vulnerable to climate changes. This vulnerability is confirmed with droughts (recent case of El Niño in 2015/2016 agricultural cropping season), floods, and more recently, tropical cyclones (Dineo, Idai and Kenneth) as well as the spread of pests such as Fall Armyworm (FAW). These hazards and the outbreak of pests and diseases are expected to increase in the future (IPCC, 2018), and discourage more smallholder farmers from adopting improved technologies.

[3] Given that national agricultural survey was not conducted between from in 2009, 2010 and 2011, we use FAOSTAT estimates.
[4] This considers the percentage of households using each external input regardless of the crop.

### 4.2.1. How “well” is Mozambique doing with respect to maize sub-sector?

In this study, we have shown that maize productivity has been considerably stagnant at lower yields. Here, we compare maize yield observed in Mozambique to that observed in selected neighboring countries namely Malawi and Zambia. Those two countries are chosen for comparison due to their similarities with Mozambique from socio-economic and climate viewpoint. The results show that maize productivity (yield) is significantly below regional levels. Data from FAOSTAT (2019) show that maize yield in Mozambique (0.8 ton/ha) in 2017 was less than half of that observed in Malawi (2.0 ton/ha) and almost a third of the yield in Zambia (2.5 ton/ha). Overall, we find that the gap between average yield in Mozambique and neighboring countries is large and, more importantly, it has been growing over the years (Figure 2).

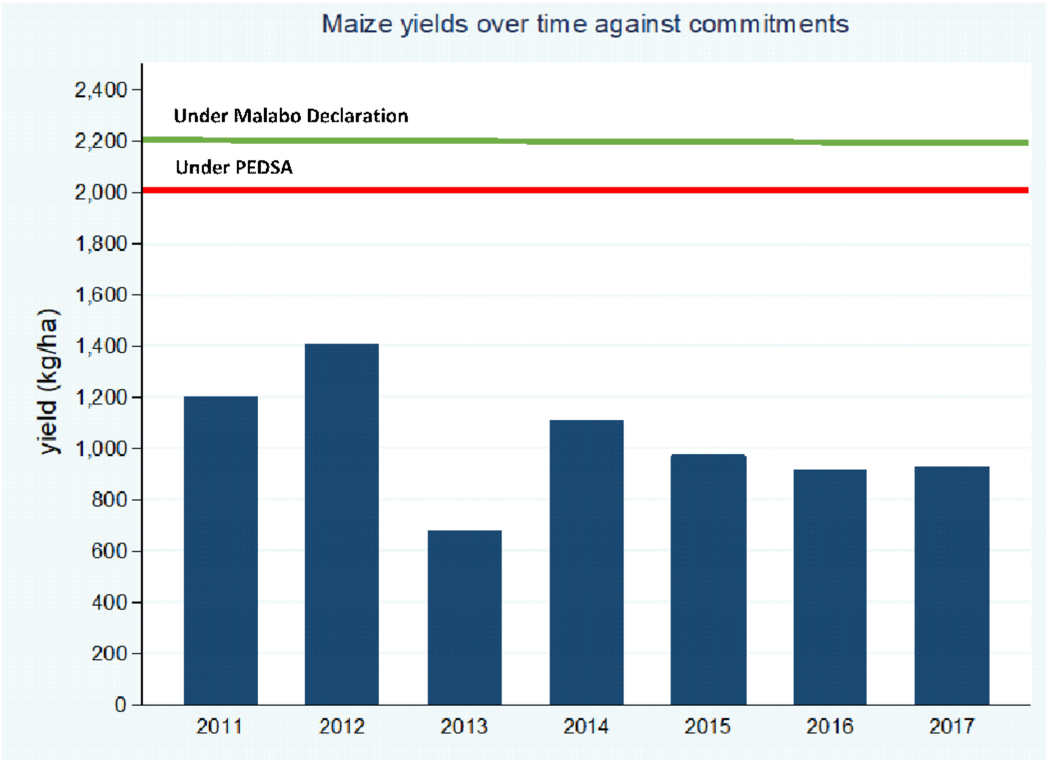
Figure 2. Comparison of maize yields of Mozambique and selected neighboring countries: 2000-2017




*Source: Authors using data from FAOSTAT (2019) and national agricultural surveys*

We also check how Mozambique is doing in meeting the targets to which it has committed. Under PEDSA/PNISA, the target is to achieve a yield of 2 ton/ha by 2020 (Figure 3). However, the trends show that the country is still very far from achieving such target. In fact, this recognized in the evaluation of PNISA as it is shown that interventions in maize sub-sector resulted in an increase of maize yield to only 1.1 ton/ha using maize improved seeds against an established target 2 ton/ha. In the meanwhile, the GoM committed do doubling agricultural yields of many crops including maize under Malabo Declaration. Three years after such commitment, no improvement in maize yield has been observed. In fact, the results show it has decreased since 2014.

Figure 3. Maize yields over time against commitments




*Source: Authors using data from FAOSTAT (2019) and national agricultural surveys*

## 4.3. Self-sufficiency in maize

Using FAOSTAT estimation of annual per capita maize consumption in 2015 and population data from INE, consumption data for 2015 is computed by multiplying the per capita consumption of maize (54.56 kg) by the total population. The estimate of maize deficits or surpluses is obtained from the difference between production and consumption or a ratio between production and consumption needs. A province is considered to have a surplus if the ratio exceeds 100% or the difference between production and consumption is positive whereas a deficit is for those whose ratio is below 100% or difference between production and consumption needs is negative. The results are presented in Table 6.

The results revealed that only Tete and Manica produce more than their consumption needs whereas Niassa province is very close to 100%. The relative high production levels in these areas may be related to favorable weather and agro-ecological conditions. Moreover, especially for Manica province, there are few smallholder farmers who are integrated into the business models of companies such as *Empresa de Comercialização Agrícola* (ECA) and Export Trading Group (ETG). Nevertheless, when considering regional level, we find that the overwhelming "self-sufficiency" of Manica and Tete is not translated into regional self-sufficiency mainly due low self-sufficiency observed in Zambezia as a result of its high population. Surprisingly, while the northern produces more than double of what is produced in southern, it has higher deficit as it has almost double the population in southern. Considering all three regions together, we find that the country is not self-sufficient in maize as it just produces 79% of its consumption needs.

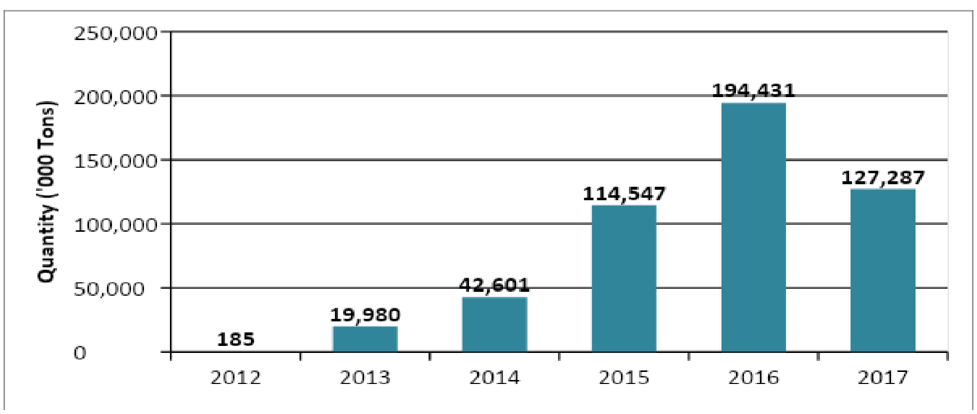
Table 6. Self-sufficiency in maize in 2015

| Province | Production (tons) | Population projection | Consumption needs (tons)[a] | Production / consumption in % | Self sufficiency (tons) |
|---|---|---|---|---|---|
| NIASSA | 92,400 | 1,722,148 | 93,960 | 98 | -1,560 |
| CABO DELGADO | 93,800 | 1,893,156 | 103,291 | 91 | -9,491 |
| NAMPULA | 95,600 | 5,008,793 | 273,280 | 35 | -177,680 |
| Northern | 281,800 | 8,624,097 | 470,531 | 75 | -188,731 |
| ZAMBEZIA | 159,000 | 4,802,365 | 262,017 | 61 | -103,017 |
| TETE | 210,000 | 2,517,444 | 137,352 | 153 | 72,648 |
| MANICA | 148,000 | 1,933,522 | 105,493 | 140 | 42,507 |
| SOFALA | 87,100 | 2,048,676 | 111,776 | 78 | -24,676 |
| Central | 604,100 | 11,302,007 | 616,638 | 108 | -12,538 |
| INHAMBANE | 12,200 | 1,499,479 | 81,812 | 15 | -69,612 |
| GAZA | 37,700 | 1,416,810 | 77,301 | 49 | -39,601 |
| MAPUTO | 64,500 | 1,709,058 | 93,246 | 69 | -28,746 |
| Southern | 114,400 | 4,625,347 | 252,359 | 44 | -137,959 |
| Total | 1,000,300 | 24,551,451 | 1,339,527 | 79 | -339,227 |

(a) per capita consumption of 54.56 kg provided by FAOSTAT
*Source: authors using IAI's 2015 and INE population projected population for 2015*

Long distances coupled with unreliable supply, poor phytosanitary quality of maize and high transport costs limit movement of domestic maize from surplus provinces in deficit provinces, especially in the south (MAFAP 2014) which has resulted in imports mainly from South Africa. Figure 4 indicates a very significant increase in imports from 2012 to 2016. In 2013 the country imported only 19.980 million tons of maize whereas in 2016, the amount of maize imports was ten (10) times the amount observed in 2013.

Figure 4.Maize Imports 2012-2017 (in Tons)




*Source: Ministry of Industry and Trade, July 2019*

## 5. Challenges in maize production and opportunities for improvement

### 5.1. Challenges in maize production

*(i) Pattern of investment in the agricultural sector (including maize sub-sector) Mozambique*

There have been incoherence between public expenditure on agriculture and potential of the regions in Mozambique (Cassamo, Mosca and Arafat, 2013; Cunguara et al., 2013). Cassamo, Mosca and Arafat (2013) show that the southern Mozambique has absorbed most investment. Yet, south region has the lowest population and least number of agricultural explorations. According to the Agricultural Census (CAP) conducted in 2010 the south accounts for only 15% and 17% of the total number of farm households and cultivated area respectively. Mosca and Abbas (2016) indicate inequalities between different types of farmers (small, medium and large scale farmers) resulting from prioritization of medium and large scale farmers by most interventions seeking agricultural and rural development.

In the meanwhile, maize is largely grown by small scale farmers and those are often characterized by low profitability and competitiveness (Mosca, 2012). Hanlon and Smart (2013) show that maize is not profitable for small commercial farmers in Mozambique. In fact, such low profitability and competitiveness result from several factors including low use and access to productive technologies and, most importantly, their integration in non-competitive markets and low prioritization of this type of farmers by public interventions. Data show that only a quarter of the total public expenditure on agriculture has been on services benefiting smallholder farmers (Cassamo, Mosca and Arafat, 2013).

Nevertheless, if improved technologies are used, maize can certainly be profitable. Di Mateo (2016) in his paper on investment in agriculture, where he also looks at investors' engagement in the cultivation and/or sourcing of commodities, has pointed out that maize is the commodity with the highest proportion of investors (27%) engagement, followed by soya with 23% of investors. Given high use of input and mechanization by most investors, they have been able to realize maize yield of 3.86 ton/ha which is four times higher than the national average of 0.96 ton/ha, giving marginal profit.

*(ii) Weak evidence-based development planning*

Evidence-based development planning is still far from becoming a norm within the context of Mozambique. There are two evidences supporting this assert. First, very low investment devoted to research in the agricultural sector including maize subsector in Mozambique. Research and extension, which have great potential to enhance production and productivity, have received limited resources when compared to expenditure in other sectors.

Second, weak delivering of official agricultural statistics. There are multiple sources of agricultural statistics commonly used in Mozambique. First, Census of Agriculture and Livestock (CAP) which is conducted every 10 years by INE with collaboration with MASA. Second, the national agricultural surveys *(Inquérito Agrário Integrado-IAI/Trabalho de Inqérito Agrícola-TIA)* conducted by MASA and the main source of agricultural statistics. Surveys use universally accepted methodology but information is not regularly available. For instance, as of August 2019, the data collected in 2017 were not publicly available.

Third, forecasts of crop production are regularly available through the Early Warning System (Aviso Prévio). Those forecasts are estimated using a methodology different than the one used for IAI/TIA. In the meanwhile, FAO provides through its database (FAOSTAT) information on several indicators at national level on year base. Having multiple sources of information *per se* is not of a concern. The concern comes from the fact that those sources of information often show huge discrepancies in their estimates (Kiregyera et al., 2008).[5] The inconsistencies in agricultural data from different sources make planning more difficult.

*(iii) Low access (to) and use of appropriate agro-chemicals, particularly fertilizers*

As mentioned earlier in this report, variations in maize production levels in Mozambique has been driven by changes in the cropped area rather than in intensification. Data indicate that, overall, no more than 5% of smallholder farmers used inorganic fertilizers over the past years in Mozambique. Additionally, those who use inorganic fertilizers have application rates very lower than those observed in neighboring countries. For instance, the amount of fertilizer applied per hectare in Malawi and Zambia is, respectively, about 5 and 6 times greater than that applied in Mozambique (Figure 5). Both Malawi and Zambia have had very well-established input subsidy programs.

In the meanwhile, those using inorganic fertilizers are still very far from meeting domestic and regional targets. Data show a fertilizer application rate of 5.7 kg per hectare which about 5 and 10 times lower than that expected under PEDSA and Abuja Declaration[6], respectively (Figure 5). The scenario is even worse in case of smallholder farmers growing maize. Less than 2.7% has applied fertilizers in the crop plots with an average fertilizer application rate of about less than 5 kg of Nitrogen per hectare (Table 13). Further, fertilizers being used are often not adequate as they do not appropriately account for soil type and/or local needs. For instance, the composition of fertilizers immediately available in local market is NPK (12-24-12) and this often does not account for nutrients already in the soil. Farmers use the same combination regardless of the amount of nutrients needed to correct soil fertility. Moreover, NPK (12-24-12) is said not bring much of a yield increase (Bento et al., 2015). This problem can be overcome mapping nutrient deficiencies in order to develop a prescribed blend for each area.

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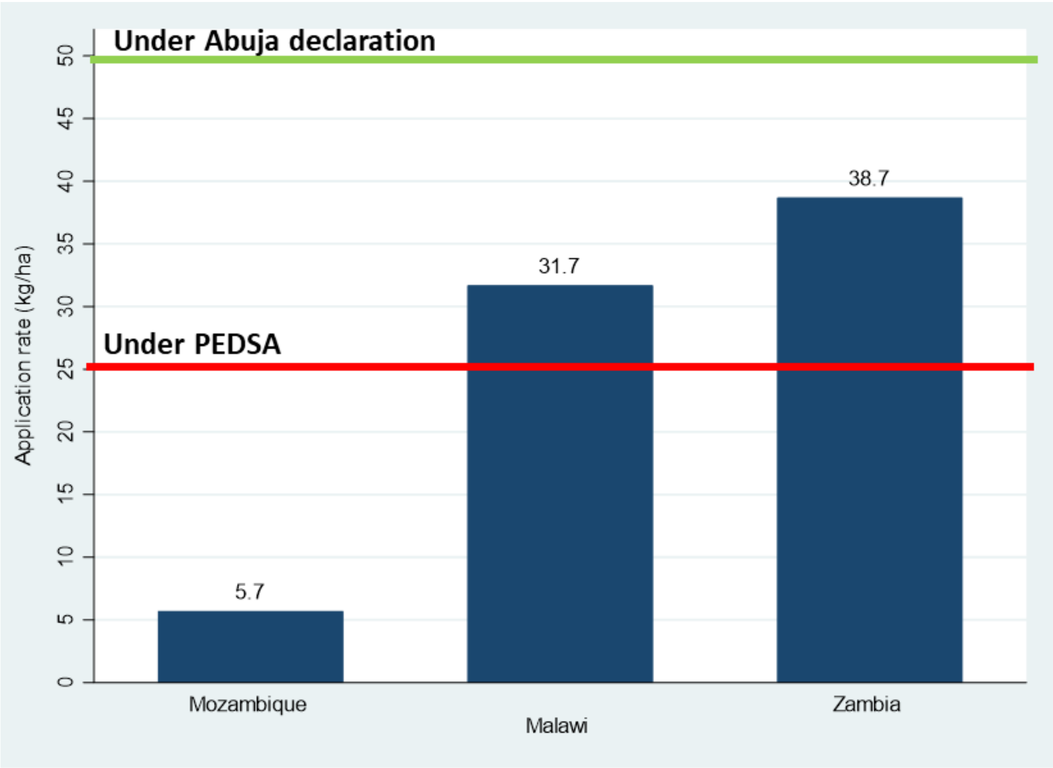
[5] Note that those discrepancies result from the use of different methods of data collection and indicator estimation.

[6] In 2006, the AU Member States resolved, in a summit, to increase fertilizer use from 8.0 kilograms to 50.0 kilograms of nutrients per hectare by 2015.

The low level of intensification can be explained by missing or incomplete input markets, unreliable input supply chains as well as high input prices. The latter is often said to be the case for maize especially for small scale commercial farmers. Farmers may have access to inputs and be unable to use them due to lack of knowledge. Extension has great potential to overcome the lack of knowledge. However, access to public extension by smallholder farmers is still very low, with a downward trend. While about 15% of smallholder farmers received visits from extension agents in 2005, this percentage dropped dramatically in 2015 with only 5% receiving extension visits.

Figure 5. Application rate of maize in Mozambique and neighboring countries




*Source: FAOSTAT (2019)*

*(iv) Quality seeds*

Maize is the crop with highest number of varieties released by IIAM since independence. 22 of 164 varieties released by the institution are of maize, followed by sweet potato (20) and bean (19). Great majority of those varieties were released after 2011 mainly due to a ministerial directive No. 51/2012 which simplifies the varieties release process. This is consistent with the number of plant breeders belonging to the institution, where about 35% (7 specialists) of them are maize breeders, followed by rice with 3 plant breeders. However, as mentioned earlier, the seed formal system is still emerging in Mozambique. Data show very limited use produced in formal system (improved/certified).

One of the major concerns in seed sector is the quality of seed even for those acquiring in formal system as often local supplies of good quality seed are not yet reliable in Mozambique and seed supply remains heavily dependent on imports (Woohdouse, 2012). This is a result of weak inspection of seed production by Country's Seed Authority. Mabaya et al. (2017) mentioned in their paper that the country's Seed Authority (NSA) has only 25 licensed seed inspectors whose services have been considered inadequate by most seed companies interviewed. Seed inspection activities are constrained by limited access to financial resources and transport.

*(v) Rural storage facilities and road infrastructure*

Limited availability of adequate rural storage facilities increase post-harvest losses hence, contributing to lower grain maize quality. Amaral et al. (2014) found that an overwhelming majority of smallholder farmers lack proper storage facilities. Their study showed that 37% of maize is lost along the value chain. In addition, maize produced by smallholder farmers tend to have a low phytosanitary quality caused mainly by poor crop husbandry and harvesting practices. This, however, push the demand side particularly, maize processors based in the south opt for imports regardless local surplus in the center and north.

In the meanwhile, remoteness compounded by poor road infrastructure makes it difficult for farmers in areas with surplus to transport their produce to those areas in deficit. Mosca and Abbas (2013) found that for the southern, which is the region with the lowest production-consumption ratio, importing maize from South Africa and other countries is often cheaper than buying maize produced in the north of the country. As road connectivity is mixed and distances are long, marketing costs are high, i.e., raise of farm-gate input prices and lower output prices. in short, this works against high-yielding technologies strategies that rely on purchased inputs.

*(vi) Difficulty of integration of maize smallholder farmers in the value chain*

Great majority of smallholder farmers operate as independent growers that sell individually to the markets participation levels of smallholder farmers in the maize value chain is very low. Based on key informant interviews, contract farming was mentioned as scheme link farmers in the value chain, thus, enhance production and productivity of maize in Mozambique. Indeed, contract farming benefits arise from its resolution of imperfections in inputs, output, credit, and insurance markets through the reduction of exposure to market risk, uncertainty, and transactions costs (Bijman, 2008; Oya, 2012). Specifically, under contract farming, farmers use production as collateral and benefit from an advanced set of agricultural services, inputs, and technical assistance to which they would otherwise not have access to. This enables farmers to benefit from economies of scale or scope.

Despite all its advantages, CF is not a *panacea*. While several scholars point to the challenges experienced in its implementation (e.g. Barret et al., 2012; Bellemare, 2010, 2015), its most severe drawback is the difficulty in enforcing contract terms, which becomes more accentuated for oral contracts and weak legal institutions, as is the case in Mozambique and other neighboring countries.

Production or side-selling appear as the main sources of opportunism from farmers, which is described as a situation where contracted farmers evade payment for services and inputs they have received from the buying firm (Bellemare, 2010; Bellemare, 2015). Typically, farmers sell their produce on local markets at higher prices, claiming it as loss to the buyer. This behavior, which has enormous potential to reduce the chances of a buying firm to initiate contract farming, may arise when there exists an immediate market for the product, and for product that is easy to store and transport as it is the case of maize (Guo et al., 2005 and Swinnen et al., 2010).

*(vii) Low access to agricultural credit*

Access to formal agricultural credit has been a big challenge, particularly for smallholder farmers in Mozambique. Less than 3% farmers had access to formal credit during the period spanning from 2008 to 2015. It is almost impossible to access credit from commercial banks due to issues of collateral and high interest rates. These pre-conditions, screen out almost all smallholder farmers to qualify for a loan. What is more, agricultural loans are often short-term with fixed repayment periods, which does not suit annual cropping, particularly when loan release is not in line with growing cycles of crops.

## 5.2. Opportunities for improvement of maize production

In-kind credit could be one alternative to address the quality seed issue. Under in-kind credit, farmers would receive a certain amount of seeds and, in return, they would be required to give back a certain amount of grain taken after harvesting. The main difference between the in-kind credit and contract farming is that, under contract farming, farmers must sell their production to the miller/buyer after harvesting and price is often determined prior to production whereas under the in-kind credit scheme, farmers would be expected to sell their surplus to the millers/buyers but there would be no obligation in place. Indeed, farmers would be obliged to pay back the seeds as agreed upon when they received the seeds.

For the success of the models like in-kind credit, it is important to ensure farmers' bargaining power is improved. There are several instruments that can be employed for its increase. One is collective action, which is often seen as a solution when farm profits are stagnant partly due to the economic power of farmers (Bosc et al. 2002; Levins, 2002). The literature (e.g., Svensson and Yanagizawa, 2009) documented improved prices paid to farmers when they are horizontally integrated. Another instrument to enhance the bargaining power of small-scale farmers is an improvement in the access to pricing information. Several studies (e.g., Svensson and Yanagizawa, 2009; Courtois and Subervie, 2015) show that the dissemination of price information strongly improved farmers' bargaining power and, ultimately, increased prices and final receipts. The *Bolsa* *de Mercadoria de Moçambique* and Instituto de Cereais de Moçambique, whose aim is to link smallholder farmers with marketing with fair prices, can also play an important role in that regard.

Moreover, instruments such collective action, where a group of smallholder farmers are oriented to achieve a common objective may also functioning to reduce transaction costs. This requires coordinated action by producers and buyers. This can be through aggregation models - example: Self-monitoring clubs employed by ECA miller, Formal/informal associations used by ETG, both in Manica province, Establishment of buying points, and Establishment of network of traders. Regardless of its advantages, these schemes are not countrywide implemented. Most of them are restricted in few areas. Government should take action in order to scaling-up as it proven to contribute for crop production and productivity.

Increase access and improve reliability of inputs (seeds and fertilizers) has potential to improve maize production performance. Establishment of village-based agro-dealers network should be considered as they may work in the grassroot level and widen their outreach of both extension services and quality inputs supply at fair prices. Establishing this approach implies costs, therefore, government and development partners can play an important role in that regard.

Experiences from countries such as Zambia and Malawi whose implemented inputs subsidy program to improve agricultural performance have witnessed considerable increase in crop yield when compared with years without input subsidy program (Sitko et al. 2017). GoM should devote part of agricultural budget to similar programs for maize taken the advantage of maize being priority crop for several donors. By doing so, the government has to ensure that the subsidy program is for intended beneficiaries who, without subsidies, would not use essential inputs. Issues of access and affordability should be kept in mind when formulating input subsidy policy. Agricultural inputs should be priced within the reach of the majority of rural farmers.

The input subsidies should be used as a means to reduce attendant effects of market failures. It should be productive, therefore, be market responsive. It should be used to develop competitive private-sector-led input markets, and complement commercial sale outlets. It should be limited in duration. Fertilizer subsidy may induce use of other improved technologies and inputs, therefore, the demand for improved inputs should be enhanced through the promotion of complementary practices such as training of farmers about the inputs to be used, irrigation, among others.

Northern Mozambique is rich in natural gas and phosphate, the main raw material for the manufacture of fertilizer. Currently, Mozambique rely on imports to satisfy its fertilizer's demand. Zandamela (2014) reported interest of fertilizer's companies in establishing a fertilizer industry in Mozambique, however, lack of fertilizer law and policy discourage private sector investment. This becomes imperative for the government to develop domestic capacity for fertilizer production. By doing so, fertilizer price would reduce, thus nullifying the need for further subsidies. Domestic sale prices would perhaps stabilize since it is not subject to the variation of international supply and demand. Problem with fertilizer quality, arbitrage, and timeliness of fertilizer distribution would also be overcome. Thus, increase fertilizer and other improved inputs use and hence, improve maize production and productivity.

Several scholars have found positive relationship between access to agricultural credit agricultural productivity. Farmers may be unable to adopt new technology that improve maize productivity due to missing or inefficient credit markets. Thus, loan terms should be flexible, taking into consideration the target business and its related risk. Moreover, it should be timed financed. For example, Beaman et al. (2014) reported that in Mali, credit with repayment scheduled after harvest (i.e., not immediately after loan disbursal in weekly or monthly payments) increased farm-level investment and revenue. Another success experience was reported in Duflo et al. (2011) study conducted in Kenya, where free delivery of fertilizer right after harvest increased fertilizer use more than a 50% price subsidy. Before pilot these opportunities for increasing inputs use and hence improve maize production, the GoM should strengthen its agricultural credit guarantee scheme in order to ensure the confidence of commercial banks.

Post-harvest losses and low phytosanitary issues are challenges that worsen the unreliable supply of maize grain and the quality sought. The GoM has constructed metal silos of less than 100,000 metric tons capacity, however in few parts of the country, (in Tete province). Lack of funds limited the expansion of storage facilities in other parts of the country. Proper storage could reduce losses and increase the quality of grain to supply domestic industries, who currently source maize grain mainly from South Africa. One option to expand storage capacity is promotion of private ownership and operation of silos. This may relax the financial burden on the government.

Across all experts and key informants interviewed there is a shared view that the current weak performance of maize production and productivity can be reverted with active participation of the private sector. Currently the participation level of private sector in maize production to help overcome constraints and enhance farmers’ access to productive inputs and market is very low. Since most of the private sector companies are resource constrained, particularly of finance resources. One option to leverage their resources and let them facilitate inputs transfer is by offering government finance for private-sector-led input transfer programs that could otherwise not be financed. This is achieved through public-private partnerships involving grants loans. This modality has advantage of de-risking investments. One similar and success case is the ECA millers, which was established with loan from AgDevCo, a development cooperative which uses public funds mainly from DfID. As an equity partner they share the risk of the investment in ECA millers and Phoenix Seed Company. Alternatively, government and NGOs could directly assist suppliers in improving access to inputs in hope of increasing market demand in collaboration with the private sector.

# 6. Conclusion

This paper assesses the trends of production and yield of maize sector in Mozambique and use findings to discuss the challenges and opportunities for enhancing both production and productivity in the country considering all interventions that have been undertaken by all stakeholder. We use data from national agricultural surveys carried out from 2002 to 2015. Other data sources including FAOSTAT are considered especially for the comparison between Mozambique and other neighboring countries. The analysis confirms that maize sub-sector is dominated by smallholder farmers who rely less external inputs and technologies such as improved seeds, chemical fertilizers, pesticides and irrigation. There have been huge fluctuations in area allocated to maize, production and yield over years and such suggest that the expected amount and distribution of rainfall as well as incidence of pests and diseases are still very critical in the decision to cultivate maize in a given cropping season. We also find upward variation of total area allocated to maize as largely explained by the opening of new maize holdings rather than expansion of maize cropped area by the cultivating households. All provinces other than Manica province have registered an average area allocated to maize below 1 hectare.

There is no specific policy for maize sub-sector. Lack of fertilizer law and policy undermines the inflow of investment in domestic fertilizer industry. The GoM has little involvement in maize input market. Apparently, smallholder farmers are at the center of Mozambique's agricultural development policies and programs. However, the eligibility criteria considered in such policies and programs are not realistic enough as they often end up ruling those farmers out.

The yield levels observed over the years covered by this study indicate that the country lags behind some neighboring countries with similar conditions such as Malawi and Zambia. Despite all efforts being made by different stakeholders of the maize sub-sector, the country is still very from meeting both regional (e.g. Malabo Declaration) and domestic commitments (e.g. PNISA). The challenges faced maize farmers include unbalanced pattern of investment in the agricultural sector in Mozambique, weak evidence-based development planning, low quality seeds, lack of rural storage facilities and road infrastructure, difficulty of integration of maize smallholder farmers in the value chain and low access to agricultural credit.

The study identified opportunities for improvement of maize sub-sector in which can be used to overcome the identified challenges faced by maize smallholder farmers. We begin by suggesting a rather simplified and flexible version of contract farming in which farmers would mainly receive seeds on a timely basis and in return they would have to give back a certain amount of grain with an option of selling their surplus if they find price fair. Also, foster collective action through aggregation models and establishment of village-based agro-dealers network are recommended as to reduce transaction costs faced by smallholder farmers. Further, and when possible, implement inputs subsidy program which has to be limited in duration and market responsive.

Make loan terms flexible, taking into consideration the target business and its attendant risks is great opportunity for smallholder farmers to access agricultural credit and use for the designated purpose. Therefore, this step should be preceded by strengthening agricultural credit guarantee scheme in order to ensure the confidence of banks. Additionally, the study brings to the GoM the need of increase and scaling up the involvement of private sector companies through public private partnerships involving grants loans in order to both de-risking investments and overcome constraints and enhance farmers access to productive inputs and market.

Taken together, all of this suggests that an opportunity of improving smallholder farmers maize production and productivity is a sound one, especially when combined with policies that tackle the needs of smallholder farmers. However, the task of implementing, disseminating, and scaling-up the full set of inputs and services needed for improvement of production and productivity represents a challenge to the government and development partners. Still, there is local success cases that show the improvement of maize yield.

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# Appendices

Table 7. Percentage of households using maize improved seeds 2005 - 2015 (%)

| Province | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 5.9 | 8.9 | 4.9 | 5.3 | 4.6 | 5.0 | 5.5 |
| CABO DELGADO | 0.9 | 2.1 | 2.7 | 3.9 | 6.9 | 1.5 | 3.4 |
| NAMPULA | 6.1 | 7.3 | 5.9 | 3.8 | 4.3 | 4.0 | 3.7 |
| ZAMBEZIA | 4.9 | 9.1 | 10.6 | 8.2 | 7.9 | 5.3 | 6.4 |
| TETE | 10.9 | 17.0 | 23.8 | 12.5 | 20.8 | 21.2 | 19.9 |
| MANICA | 9.8 | 17.9 | 20.1 | 29.1 | 11.3 | 12.2 | 19.6 |
| SOFALA | 4.8 | 8.6 | 7.5 | 13.8 | 11.0 | 8.4 | 7.1 |
| INHAMBANE | 3.9 | 3.4 | 4.9 | 3.1 | 3.5 | 4.5 | 2.7 |
| GAZA | 2.4 | 10.1 | 5.1 | 13.2 | 6.6 | 13.2 | 4.5 |
| MAPUTO | 11.0 | 12.5 | 13.6 | 16.3 | 6.9 | 6.9 | 1.2 |
| Total | 5.6 | 9.3 | 10.0 | 9.9 | 8.7 | 8.1 | 7.1 |

*Source: Authors' computation using Data from National Agricultural Surveys*

Table 8. Percentage of households who used chemical fertilizers in Mozambique (%)

| Province | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 7.5 | 11.6 | 17.7 | 15.0 | 7.1 | 9.8 | 8.3 | 10.5 | 10.9 |
| CABO DELGADO | 2.6 | 0.0 | 0.2 | 4.5 | 1.1 | 2.7 | 0.4 | 2.5 | 2.2 |
| NAMPULA | 3.3 | 0.3 | 2.8 | 2.8 | 2.2 | 2.6 | 1.9 | 1.7 | 1.2 |
| ZAMBEZIA | 0.7 | 0.7 | 0.0 | 1.6 | 1.1 | 0.4 | 0.1 | 0.1 | 0.6 |
| TETE | 15.1 | 12.1 | 16.5 | 17.7 | 21.0 | 14.7 | 10.0 | 21.6 | 24.1 |
| MANICA | 3.0 | 2.8 | 2.3 | 0.8 | 1.1 | 4.4 | 1.8 | 1.8 | 2.7 |
| SOFALA | 0.7 | 1.5 | 0.5 | 1.6 | 1.1 | 0.6 | 1.9 | 0.3 | 0.4 |
| INHAMBANE | 1.7 | 1.8 | 1.0 | 2.3 | 3.5 | 2.2 | 4.0 | 2.1 | 1.6 |
| GAZA | 5.1 | 2.1 | 3.9 | 2.3 | 1.7 | 3.6 | 1.6 | 3.6 | 5.2 |
| MAPUTO | 3.5 | 3.1 | 6.1 | 6.1 | 10.1 | 7.9 | 5.3 | 7.2 | 2.5 |
| Total | 3.7 | 2.5 | 3.8 | 4.6 | 4.0 | 4.0 | 2.6 | 4.6 | 5.0 |

*Source: Authors computation using Data from National Agricultural Surveys*

*Table 9*. Percentage of households who accessed to irrigation in Mozambique (%)

| Province | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 8.1 | 5.1 | 2.1 | 6.1 | 4.8 | 8.9 | 4.4 | 6.4 | 6.4 |
| CABO DELGADO | 3.5 | 0.8 | 1.6 | 2.0 | 2.1 | 2.0 | 2.7 | 2.2 | 1.5 |
| NAMPULA | 2.2 | 1.9 | 4.5 | 5.5 | 4.5 | 5.4 | 5.8 | 1.7 | 1.7 |
| ZAMBEZIA | 1.4 | 3.4 | 1.4 | 3.4 | 5.2 | 2.8 | 1.9 | 2.2 | 0.7 |
| TETE | 27.9 | 18.6 | 9.2 | 16.3 | 18.9 | 13.4 | 16.2 | 3.5 | 8.9 |
| MANICA | 22.3 | 4.6 | 3.2 | 9.2 | 24.4 | 11.3 | 13.7 | 6.5 | 2.9 |
| SOFALA | 5.6 | 4.9 | 4.2 | 4.1 | 8.5 | 10.8 | 6.5 | 0.6 | 1.6 |
| INHAMBANE | 29.5 | 9.6 | 14.2 | 20.1 | 17.4 | 22.3 | 17.9 | 6.9 | 9.9 |
| GAZA | 26.7 | 14.7 | 16.7 | 17.9 | 11.7 | 14.3 | 9.8 | 8.5 | 9.9 |
| MAPUTO | 24.4 | 17.3 | 23.2 | 19.0 | 19.5 | 16.5 | 20.5 | 17.3 | 4.4 |
| Total | 10.8 | 5.9 | 5.8 | 8.1 | 9.4 | 8.5 | 7.7 | 4.3 | 3.9 |

*Source: Authors computation using Data from National Agricultural Surveys*

Table 10. Percentage of households who used animal traction in Mozambique (%)

| Province | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 |
|---|---|---|---|---|---|---|---|---|
| NIASSA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| CABO DELGADO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| NAMPULA | 0.0 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 1.1 |
| ZAMBEZIA | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 |
| TETE | 35.2 | 31.2 | 17.4 | 38.7 | 32.3 | 20.8 | 11.5 | 19.4 |
| MANICA | 11.4 | 13.5 | 10.9 | 13.5 | 9.3 | 15.6 | 18.6 | 18.7 |
| SOFALA | 1.5 | 1.5 | 2.1 | 1.9 | 1.8 | 6.1 | 1.6 | 2.8 |
| INHAMBANE | 46.9 | 46.4 | 45.8 | 50.5 | 43.5 | 45.7 | 37.9 | 57.2 |
| GAZA | 44.4 | 49.4 | 36.5 | 52.2 | 52.8 | 44.6 | 36.3 | 67.6 |
| MAPUTO | 11.5 | 13.7 | 14.8 | 13.8 | 13.8 | 26.7 | 7.6 | 50.2 |
| Total | 11.2 | 11.2 | 9.3 | 12.4 | 11.5 | 10.9 | 7.2 | 15.5 |

*Source : Authors computation using Data from National Agricultural Surveys*

Table 11. Percentage of households who had access to credit for agricultural purpose (%)

| Province | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 7.0 | 9.1 | 6.6 | 5.8 | 1.7 | 2.5 | 4.0 | 1.9 |
| CABO DELGADO | 1.0 | 4.2 | 3.7 | 3.0 | 2.7 | 1.7 | 1.0 | 0.2 |
| NAMPULA | 3.5 | 5.4 | 1.9 | 4.2 | 2.7 | 4.4 | 1.0 | 0.4 |
| ZAMBEZIA | 0.9 | 0.4 | 1.5 | 2.3 | 1.0 | 1.5 | 1.0 | 0.5 |
| TETE | 9.3 | 7.7 | 6.2 | 13.6 | 5.2 | 1.6 | 1.0 | 2.4 |
| MANICA | 2.0 | 1.0 | 1.1 | 3.3 | 4.8 | 2.3 | 1.0 | 1.2 |
| SOFALA | 3.1 | 3.3 | 6.7 | 5.1 | 3.7 | 1.3 | 1.0 | 0.5 |
| INHAMBANE | 0.5 | 1.7 | 1.1 | 6.3 | 0.8 | 1.1 | 2.0 | 0.1 |
| GAZA | 3.1 | 1.9 | 2.7 | 3.7 | 2.4 | 0.8 | 1.0 | 0.5 |
| MAPUTO | 2.9 | 3.5 | 2.4 | 3.6 | 4.7 | 0.8 | 1.0 | 0.2 |
| Total | 2.9 | 3.5 | 2.9 | 4.7 | 2.6 | 2.0 | 1.0 | 0.6 |

*Source: Authors computation using Data from National Agricultural Surveys*

Table 12. Percentage of households who received extension visits (%)

| Province | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 | 2012 | 2014 | 2015 |
| NIASSA | 10.6 | 9.2 | 13.7 | 23.1 | 12.1 | 8.9 | 7.2 | 15.3 | 4.9 |
| CABO DELGADO | 18.7 | 14.2 | 15.6 | 11.4 | 5.8 | 6.8 | 6.3 | 5.0 | 10.3 |
| NAMPULA | 16.1 | 16.5 | 18.7 | 9.8 | 8.5 | 10.9 | 7.9 | 8.6 | 4.4 |
| ZAMBEZIA | 9.5 | 8.6 | 10.3 | 9.7 | 11.6 | 6.6 | 4.4 | 4.6 | 1.9 |
| TETE | 19.9 | 16.3 | 16.0 | 13.4 | 13.5 | 12.8 | 9.4 | 18.0 | 9.7 |
| MANICA | 14.9 | 8.9 | 11.6 | 14.9 | 10.9 | 7.5 | 3.4 | 11.2 | 5.3 |
| SOFALA | 19.8 | 24.0 | 21.1 | 16.9 | 14.4 | 10.2 | 10.2 | 9.0 | 4.6 |
| INHAMBANE | 4.6 | 9.9 | 7.8 | 6.6 | 7.4 | 4.6 | 7.7 | 8.9 | 4.1 |
| GAZA | 10.4 | 18.4 | 22.2 | 15.3 | 7.7 | 4.0 | 8.0 | 10.1 | 1.1 |
| MAPUTO | 11.0 | 14.5 | 11.0 | 9.8 | 19.9 | 6.8 | 4.1 | 11.3 | 0.7 |
| Total | 13.5 | 13.3 | 14.8 | 12.0 | 10.1 | 8.3 | 6.6 | 8.8 | 4.3 |

*Source: Authors computation using Data from National Agricultural Surveys*

Table 13. Percentage inorganic fertilizers use in maize plots (%)

| Province | 2014 | 2015 |
|---|---|---|
| NIASSA | 0.7 | 1.1 |
| CABO DELGADO | 0.2 | 0.0 |
| NAMPULA | 0.5 | 0.1 |
| ZAMBEZIA | 0.0 | 0.2 |
| TETE | 15.8 | 16.3 |
| MANICA | 1.4 | 2.3 |
| SOFALA | 0.0 | 0.4 |
| INHAMBANE | 0.0 | 0.1 |
| GAZA | 1.4 | 3.2 |
| MAPUTO PROVINCE | 3.0 | 0.8 |
| Total | 2.4 | 2.6 |

Table 14. List of Interviewees under key informant survey

| # | Institution/Organization | Name of the respondent | Contact/Address | Type |
|---|---|---|---|---|
| 1 | DAI/INOVA | Rafael Uaiene | ruaiene@gmail.com | Researcher and policymaker |
| 2 | DAI/INOVA | Raul Pitoro | raul_pitoro@ftf-inova.com | Socio-economic Researcher |
| 3 | AMOZFERT | Carlos Zandamela | carloszandamela@gmail.com | Plant breeder (researcher) |
| 4 | Feed the Future | Carlos Moamba | cmoamba@ftf-seedtrade.org | Researcher and policymaker |
| 5 | Independent consultant | Calisto Bias | calisto.bias@gmail.com | Plant breeder (researcher) |
| 6 | Independent consultant | Benedito Cunguara | cunguara@gmail.com | Socio-economic researcher |
| 7 | UEM | Helder zavale | hzavale@gmail.com | Socio-economic researcher |
| 8 | ECA Millers | Moses Muchayaya | agronomy@ecamoz.com | Maize aggregator |
| 9 | USAID | Paula Pimentel | ppimentel@usaid.gov | Researcher |
| 10 | Independent consultant | Gerrit Struyf | gerrit.struyf@gmail.com | Agronomist |
| 11 | IIAM | Pedro Fato | fatomagunge@gmail.com | Maize breeder (researcher) |
| 12 | ICM/BMM | | | |
| 13 | MASA | Eng. Hiten Jantilal | hiteno2@yahoo.com.br | Policymaker |
| 14 | MASA/DPCI | Dr. Aurelio Mate | aureliomate@gmail.com | Policymaker |
| 15 | IIAM | Pedro Silvestre Chaúque | chauquepedro@hotmail.co.uk | Researcher (plant breeder) |