Determinants of Maize Yields among Small-Scale Farmers in Mbinga District, Tanzania

Dickson Utonga

Abstract

Maize plays a significant role in food security strategies in the world. It is the world's most staple food crop to majority of communities since it provides cheap source of essential calories as compared to other sources of protein foods. It has the potential of being grown in a variety of agro-ecologies zones with varied yields per hectare. The main purpose of this study was to analyse the determinants of maize yields among small-scale farmers in Mbinga district, Ruvuma region, Tanzania. This cross-sectional study employed a multistage sampling method to select 120 farmers in the study area. Semi-structured questionnaires and key informant interviews were used for data collection. The data was analysed by descriptive statistics and multiple regression analysis (double-log model). The results indicate that farm size, amount of seed, fertilizer and labour were the significant determinants of maize yields among small-scale farmers in the district. The study recommends that; the government should ensure access to quality and affordable inputs to farmers by employing effective price control mechanisms on fertilisers and improved seeds which are imperative in improving the yields. Farmers should be capacitated on accessing affordable loans through financial inclusion programs and expand market access that can be reliable through the formation of farmers' associations. Farmers should be exposed to better farming techniques such as the rational application of inputs through effective provision extension services.

Key words: Maize, Yield, Small-scale, Farmers, Determinants, Inputs

1.0 Introduction

The implementation Sustainable Development Goals (SDGs) encounters a significant number of issues, among others, hunger, food insecurity and climate change (Xu et al., 2020; Dicks et al., 2019). In achieving the SDGs that are linked with poverty (Goal 1), hunger (Goal 2), Health (Goal 3) and climate change (Goal 13) requires, among other efforts, to ensure a wider scope and sustainable implementation of agro-policies and strategies (Xu et al., 2021). One of the strategies has been to ensure a worldwide improvement in agricultural production so as to slow down food insecurity (Dutta et al., 2020). This is backed by the Food and Agricultural Organization (FAO) et al., (2018) and the International Food Policy Research Institute (IFPRI) which recognise food security as a vital global concern of the 21st Century. Ensuring a sustainable global food security call for bridging the yield gaps variations for small-scale farms as main producers of major cereal crops in the developing world (Krupnik et al., 2015; Godfray et al., 2010). In this scenario, the cereal crops such as maize and wheat are extensively relied for attaining food security goals in the world.

Maize plays an essential role in the global food security as staple food crop for majority of people in Asia, Africa, and Latin America (Erenstein, 2010). It is rationally considered as a cheap source of essential calories as compared to fruits, vegetables and animal source of protein foods. It is considered as the world's most significant cereal crop that occupy about 14% of the global land planted with crops (FAO, 2020). On average, the global production of maize extents to 1,127 million tons annually (OECD/FAO, 2019). It has the potential of being grown in a variety of agro-ecologies zones with varied yields per hectare. It has relatively higher yields than other types of cereal crops which make it the most potential for farmers even in areas with high population pressure and a limited farm size (Shiferaw et al., 2011).

In the developing world, maize is the extensively grown cereal crop and a dietary staple however it is faced with substantial deficits causing demand for its import (Grote et al., 2021). The crop is grown on more than 40 million hectares of land in the sub-Saharan Africa (SSA) and over half of the countries grow maize as the primary cereal crop. This identifies it as one of the uppermost cereals to more than three-quarters of the SSA countries (FAO, 2021). The consumption of the crop per day is beyond 100 grams to more than half of the countries. Prasanna et al., (2021) projected that the SSA population will double over the next 30 years. The projection raises concerns over an increase in the demand of cereal crops by three-fold (van Ittersum et al., 2016). In the East African countries, Tanzania is the key producer of crop followed by Kenya and Uganda (Ntabakirabose, 2015). It has the strength of being grown in nearly all agro ecological zones of the country (USAID, 2010). As such, it is grown and consumed staple crop by most of the Tanzanian households. It is the most essential cereal crop in the country, contributing for almost 70% of the cereal production per annum (GoT, 2018). This makes it as the primary staple crop which serves as a superlative strategy for achieving food security among communities.

In Tanzania, the crop is predominantly produced to 80% by small-scale farmers who grow it mainly for subsistence (Wilson & Lewis, 2015). The production is actually accelerated by its potential in accounting about 31% of total food produced and 70% of entire cereal consumption countrywide with the per capita consumption standing at 128 kilograms annually and 35% of daily calories consumption (Suleiman & Rosentrater, 2015; Baha, et al., 2013; BEFS, 2013; Suleiman et al., 2013 Zorya et al., 2011). For that case the crop is considered as the high priority and the most important strategy for achieving household food security within the country (FAO, 2016; Homann-Kee et al., 2013). Thus, the subsector has the role to play in achieving food security to attaining high-quality livelihood among citizens as advocated in the Tanzania Development Vision (TDV) – 2025.

In the country, the crop's production is largely undertaken in the Southern Highlands regions (Rukwa, Ruvuma, Mbeya, Iringa and Njombe) which are principally characterized by small-scale farmers. Amongst the regions, Ruvuma contributes a significant share of maize yields in the grain basket of Tanzania. The region has the strength of possessing an area planted into maize of about 50% of the area occupied with annual crops (2007/08 National Sample Census of Agriculture [NSCA], 2012). By comparing to its area of crop plantations, the region has the opportunity to significantly boost its maize yields because of reliable and favourable weather with its proximity to the export markets such as Mozambique that turns out to be a significant opportunity for export market. Within the region, Mbinga district is among the potential producers of the crop due to its favourable climate and fertile soils which support maize farming in most of the areas. The district occupies the largest area 65,770 hectares which accommodate cereal plantations within the region (NSCA, 2012). This enlightens that it has a potential role in improving maize yields within the region that can ultimately contribute a sustainable to the regional grain basket.

Despite the importance it has both for food security achievement and the economic well-being, maize production and productivity among producing households is still low in the country that stands at 1.2 – 1.5 tonnes/ha compared to 1.8 tons/ha for SSA (DTMA, 2014; URT, 2015). In addition to that, its productivity is outlying from that of South Africa (SA) and the World average yields in general standing at 2.7 and 4.3 tonnes/ha correspondingly (Urassa, 2015). Countrywide, there have been instituted diverse sectorial initiatives to address this matter in the course of maize producing households. The initiatives include the National Strategy for Growth and Reduction of Poverty (NSGRP I and II), the introduction of District Agricultural Development Plans (DADPs), the

Agricultural Sector Development Programme (ASDP), the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), Japan Policy and Human Development (JPHD) and the Eastern Africa Agricultural Productivity Programme (EAAPP). They aimed, among other goals, at transforming agriculture which promotes yields, livelihood and economic growth. However, despite these efforts in place, maize production and productivity are still low and unstable for most small-scale producing households (MAFC, 2011; Suri, 2011; URT, 2011; Baha, 2013; MAFAP, 2015; URT, 2015).

cConsiderable studies have been conducted on maize sub sector in country (Barreiro-Hurle, 2012: URT, 2012; Mcharo, 2013; Suleiman and Rosentrater, 2013; Lyimo et al, 2014; Suleiman et al, 2015; Urassa, 2015; Wilson & Lewis, 2015). The attention has been grounded on perception, use of improved maize varieties, production and post-harvest losses, production efficiency, storage, value chain and incentives. Although substantial research has been devoted to the sub sector, the focus has been far from the determinants of the crop yield among farming households. Therefore, the current study aimed at analysing the determinants maize yields among small-scale farmers in Mbinga District, Tanzania. The findings of the study will help to capacitate promotion, improvement and enhancement of various determinants of the yield to raise the crop yields.

2.0 Materials and Methods

This study was carried out in Mbinga district, Ruvuma region, Tanzania. The district is bordered by Njombe region to the North, Songea rural and Songea urban districts to the East, Nyasa district to the West and Mozambique to the South. It has an area of approximately 4,839.78 km² with a total of 353,683 people and a population density of 73.1 inhabitants/km² (National Census, 2012). It is characterised by highlands and low-lying areas featured with a temperate tropical climate. It is benefiting from a reliable and a sufficient uni-modal rainfall patterns with an average of 1200mm rainfall per annum. Generally, the district's weather condition is favourable for agriculture. The agriculture is predominantly small-scale farming of crops such as maize, coffee, beans, and wheat (Komba, 2021). In supporting the food security initiatives, the district is rich in maize production that contributes into the grain basket of Tanzania.

The study adopted a cross-sectional design which gave a clear print of the overall maize production within the district. This design was convenient for enhancing data collection, inexpensive and sufficient in terms of time. With a multistage sampling method 120 small-scale farmers were selected for the study. Initially, the district was chosen purposively, then four wards (Kigonsera, Kikolo, Matiri and Mpepai) were chosen randomly from a list of maize producing wards. Finally, the selection of small-scale farmers was conducted proportionally to the wards by considering the lists of maize producing households. Both quantitative and qualitative data were collected through semi-structured questionnaires that were carefully designed to meet the purpose of the study. The tool collected data on farmer's age, sex, education level, farming experience, farm size, household size, the amount of maize seeds, fertilisers, and the maize yields. A pilot study and training to enumerators were conducted prior to data collection activity for ensuring validity of the tool.

Data management was performed by the Statistical Package for Social Sciences (SPSS). The managed data set was analysed by descriptive statistics (frequency, mean and percentage) and multiple regression analysis. The techniques were used to describe small-scale farmers' characteristics and analyse the relationship between maize yields and the determinants. The Cobb-Douglas production function was adopted in analysing the linear relationship between farm inputs and output. The appropriate model for examining the determinants of maize yields was a double-

log because it is convenient in best fitting the data (Adhikari, 2013; Sarkar et al., 2010; Haq et al., 2002). The model was modified from the Cobb-Douglas production function presented in (1):

The Cobb-Douglas production function

$$Q=F(K,L)=AL^{\alpha}K^{\beta} \text{.. (1)}$$

Where,

Q	Output
K	Capital
L	Labor
A,	Positive constants
α, β	Elasticities of labor and capital respectively

This function can be estimated by regression analysis (least squares method) through transforming the equation into a double-log form as in (2).

$$\ln Q=\ln A+\alpha\ln L+\beta\ln K \text{....................................... (2)}$$

This can be extended further to accommodate more than two inputs which a small-scale farmer employed in the maize production process. The appropriate model for the study was now transformed into (3)

$$\ln Y=\beta_0+\beta_1\ln A+\beta_2\ln Fe+\beta_3\ln Fas+\beta_4\ln Ed+\beta_5\ln L+\beta_6\ln Fs+\beta_7\ln S+\beta_8\ln F+\varepsilon_i \text{ ... (3)}$$

Where,

Y	Amount of maize yield in kilograms,
A	Age of a farmer in years,
Fe	Maize farming experience,
Fas	Family size,
Ed	Education level of the farmer (highest level reached in years),
Fs	Farm size in hectares,
L	Amount of Labour in number of workers,
S	Amount of seed in kilograms,
F	Amount of fertilizers in kilograms,
ln	Natural logarithm,
β_0	Constant term (Intercept),
β_i	Regression coefficient of ith independent variable (Where i = 1, 2, 3...n)
ε_i	Error term

After the model specification, Microsoft Excel version 2013 and STATA software package version 13 were used to analyse the main study findings. Before jumping into the data analysis activity, testing for Ordinary Least Squares (OLS) assumptions was conducted to avoid the violation of the assumptions which could make the estimates unreliable and biased. The problematic issues were remedied and the analysis was ultimately conducted.

3.0 Results and Discussion

3.1 Demographics

Gender: Table 1 indicates that the sample composed of 94 Males and 26 females which are 78.3% and 21.7% respectively. This implies majority of the farmers were predominantly married while the minority represented their husbands as household heads in their absent during the data collection activity.

Age: Results in Table 1 show the dominance of the age between 15 and 59 years in the sample by 97%. It shows maize production was mainly performed by farmers within the productive age in the study area. The results relate with Onuk et al., (2010) who identified age as an important aspect in influencing yields.

Marital status: It is shown from Table 1 that 86% of the sample was occupied by married respondents. This coincides with Amaza et al., (2006) who determined that married couples provided access to labour. This was influenced by their capacity to coordinate and organize the family plans.

Level of education: The results show that all respondents were possessing formal education which enables individuals follow instructions from experts. The results align with Ahmed et al., (2013) and Onojah et al., (2013) who determined the dominance of formal education to majority of small-scale farmers and that it was an important aspect to support farming.

Years of experience in maize farming: The findings from Table 1 show that farmers had enough experience in the farming activities. Oyewole (2012) noted that output was directly proportional to the years of farming experience. The experience facilitated farmers in improving the production techniques through reasonable decision making.

Farm size: Results from Table 1 show that 91.7% of farms were of the size less than 2.9 hectares. This show that maize farming was predominantly undertaken by small-scale farmers. This confirms that the farming is principally a smallholder in nature. The findings are also similar to Olayide (2013) who asserted that majority of farms were relatively small not more than 5.99 hectares.

Table 1. Demographics of small-scale maize farmers

Variables	Frequency (%)
Gender	
Female	*094 (78.30)*
Male	*026 (21.70)*
Respondents Age	
<15	*000 (00.00)*
15 - 29	*021 (17.50)*
30 - 44	*049 (40.80)*
45 - 59	*047 (39.20)*
60 - 74	*003 (02.50)*
>74	*000 (00.00)*
Marital Status	
Single	*006 (05.00)*
Separated	*003 (03.00)*
Married	*104 (86.00)*
Widowed	*007 (06.00)*
Level of education	
Primary level	*105 (87.50)*
Secondary level	*013 (10.80)*
Tertially level	*002 (01.70)*
Farming experience (years)	
00 - 09	*039 (32.50)*
10 - 19	*020 (06.70)*
20 – 29	*040 (33.30)*
30 - 39	*021 (07.50)*
Farm size (Hectare)	
<1.00	*006 (05.00)*
1.10 – 1.99	*081 (67.50)*
2.00 – 2.98	*023 (19.20)*
>2.99	*010 (08.30)*
Total	**100**

Source: Survey data, 2017

3.2 OLS analysis of the determinants of maize yields in the district

3.2.1 Regression analysis

In analysing the determinants of maize yields in the study area, the multiple regression analysis by using the double-log model was performed. The model analysed the relationships which exist between the inputs and the maize output (yields) in the production process. The output for the analysis is shown in Table 2.

Table 2. Determinants of maize yields; regression analysis estimates

Variable	Coefficient	Robust Standard Error	*t*	*P*>|t|
Ln_A	-.0877170	.2359027	-0.37	0.711
Ln_Ed	-.1435423	.1202760	-1.19	0.235
Ln_Fas	.0560127	.1312948	0.43	0.670
Ln_Fe	-.0330458	.0870573	-0.38	0.705
Ln_Fs	.8933541	.1522154	5.87	0.000*
Ln_S	.2039806	.0822531	2.48	0.015**
Ln_F	.1481990	.0535858	2.77	0.007*
Ln_L	.2361729	.1107317	2.13	0.035**
Constant	1.586657	.6839152	2.32	0.022**
Total observations (120), F(8, 111)= 15.63, Probability>F = 0.0000, R-squared = 0.5673				

Source: Survey data, 2017

Note: * is significant at 1%, ** is significant at 5%

3.2.2 Regression model results

The computed R-square of the model is 0.5673 indicating that 56.73% of the variations in maize yields was correctly explained by the farm inputs in the production process. The F-test value 0.0000 is highly significant showing that the farm inputs were vitally explaining the variations of the maize yields. This denotes the best fit of data used in the study.

3.2.3 The input-output relationships of maize farming in the district

Farm size: The coefficient for farm size is positive (0.8934) and significant at 1% level indicating a 01% increase in the farm size would improve the yields by 0.89%, at ceteris paribus. The findings are in line with Liu et al., (2021); Rada & Fuglie, (2019); Wu et al., (2018); Kimhi (2003); Dorward (1999) who identified a positive contribution of the farm size on maize yields. Importantly, the study notes that a proper utilization of the extra farms (plots) could result into improved maize yields among farmers.

Amount of seeds: The coefficient of regression for the amount of seeds is positive (0.2040) and significant at 5% indicating 01% increase in the amount of seeds would increase maize yields by 0.20%, at ceteris paribus. The findings are similar with Fang and Belton (2020) who asserted that an increase in the amount of seeds affect maize yields positively. The results imply that improvement in extension services is required especially in the provision of trainings on seeds spacing. This signifies that proper spacing could result into improved maize yields within the district.

Amount of fertilisers: The coefficient for the amount of fertilisers is positive (0.1482) and significant at 1% showing that 01% increase in the amount of fertiliser could result into 0.15% increase in the maize yields, provided that other inputs remain fixed. The results concur with Liu et al., (2021) and Urassa, (2015) who identified that the use of fertilisers boosts the yields. This implies that access to affordable technology (fertiliser) was important determinant for sustainable small-scale maize production. The optimal use of fertiliser was required to reach the ideal production capacity of small-scale farms. The results recognise the significance of price control mechanisms for fertilisers as an important input in the maize production process.

Amount of labour: The coefficient for the amount of labour is positive (0.2361) and significant at 5% level. This indicates that 01% increase in amount of labour could increase maize yields by 0.24%, at ceteris paribus. The findings are in consonance with Fang and Belton (2020) and Olujenyo (2008) who noted a direct proportional increase in the amount of labour to an increase in the yields. The positive relationship between labour and the yields was important determinant in ensuring sustainable maize production in the study area. Thus, the reasonable additional units of labour could result in the increase in the yields.

4.0 Conclusion and recommendations

This paper analysed determinants of maize yields among small-scale farmers in Mbinga district, Ruvuma region, Tanzania. The study employed a cross-sectional design and a multistage sampling method to gather data from 120 small-scale farmers. Data were collected at Kigonsera, Kikolo, Matiri and Mpepai wards. Semi-structured questionnaires were administered to the maize farming households whereas interview guides were administered to the District Agricultural Officer and Ward Executive Officers for gathering data on the distribution of farmers within the district and wards respectively. The results from the double-log model indicate that farm size, amount of seed, fertiliser and labour were the significant determinants of maize yields among the farmers in the district. The study concludes that farmers should ensure the increase and proper utilization of farm inputs (farm size, seeds, labour and fertilizers) in the production process so as to boost the yields for their livelihood sustenance.

The study recommends that the government should ensure access to quality and affordable inputs to farmers by employing effective price control mechanisms on fertilisers and improved seeds which are imperative in improving the yields. Farmers should be capacitated on accessing affordable loans through financial inclusion programs and expand market access that can be reliable through the formation of farmers' associations. Farmers should be exposed to better farming techniques such as the rational application of inputs through effective provision extension services. Finally, the study recommends that more research should be conducted on the livelihood analysis and value chain in the production process.

Consent

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

References

Adhikari, R. K. (2013). Economics of Organic Rice Production. Journal of Agriculture and Environment, 12, 97–103. https://doi.org/10.3126/aej.v12i0.7569

Ahmed, A.S., Suleiman, A. and Aminu, A. (2013). Social and Economic Analysis of Small Scale Maize Production in Kura Local Government Kano State, Nigeria. International Journal of Science, Research and Technology in Extension and Education Systems.

Amaza, P. S., Umah, J. H., and Adojobi, A. O., (2006). Determinants and Management of Food security in Nigeria: Some Empirical Policy Guide Contributed poster prepared for presentation at the international Association of Agricultural Economics Conference Gold Coast, Australia.

Baha, M., Temu, A., and Philip, D., (2013). Sources of technical efficiency among smallholder maize farmers in Babati district, Tanzania. African Journal of Economic Review, Vol. 1(02).

Barreiro-Hurle, J., (2012). Analysis of incentives and disincentives for maize in the United Republic of Tanzania. Technical notes series, MAFAP, FAO, Rome.

BEFS (Bioenergy and Food Security Projects), (2013). Tanzania. BEFS Country Brief. Online available at www.fao.org/bioenergy/foodsecurity/befs. Accessed on February 16, 2022.

Dicks, L. V., Rose, D. C., Ang, F., Aston, S., Birch, A. N. E., Boatman, N., Bowles, E. L., Chadwick, D., Dinsdale, A., Durham, S., Elliott, J., Firbank, L., Humphreys, S., Jarvis, P., Jones, D., Kindred, D., Knight, S. M., Lee, M. R. F., Leifert, C., … Sutherland, W. J. (2019). What agricultural practices are most likely to deliver "sustainable intensification" in the UK? Food and Energy Security, 8, e00148. https://doi.org/10.1002/fes3.148.

Dorward, A. (1999). Farm size and productivity in Malawian smallholder agriculture. The Journal of Development Studies, 35(5), 141-161.

DTMA, (2014). Maize in Tanzania: Breakthroughs yet to come. A Quarterly Bulletin of the Drought Tolerant Maize for Africa Project. Vol. 3(03).

Dutta S, Chakraborty S, Goswami R, Banerjee H, Majumdar K, Li B, et al. (2020) Maize yield in smallholder agriculture system—An approach integrating socio-economic and crop management factors. PLoS ONE 15(2): e0229100. https://doi.org/10.1371/journal.pone.0229100.

Erenstein, O. (2010). The evolving maize sector in Asia: challenges and opportunities. J. New Seeds 11, 1–15. doi: 10.1080/15228860903517770.

Fang, P. and Belton, B. (2020). Maize production, farm size, and tied credit in Southern Shan State, Myanmar. IFPRI Discussion Paper 1961. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.133972.

FAO (Food and Agriculture Organization of the United Nations). (2020). FAOSTAT: FAO statistical databases. FAO (Food and Agriculture Organization of the United Nations).

FAO, 2016. Smallholder productivity under climatic variability: Adoption and impact of widely promoted agricultural practices in Tanzania, by Aslihan Arslan, Federico Belotti and Leslie Lipper. ESA Working Paper No. 16-03. Rome, FAO.

FAO, 2021. FAOStat. Food and Agriculture Organization of the United Nations, Rome.

FAO, IFAD, UNICEF, WFP and WHO (2018). The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., ... and Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. Science, 327(5967), 812-818.

Government of Tanzania (GoT), (2018). National population projections. Tanzania Bureau of Statistics.

Grote U, Fasse A, Nguyen TT and Erenstein O (2021) Food Security and the Dynamics of Wheat and Maize Value Chains in Africa and Asia. Front. Sustain. Food Syst. 4:617009. https://doi: 10.3389/fsufs.2020.617009

Haq, R., Brenton, J. D., Takahashi, M., Finan, D., Rottapel, R., and Zanke, B. (2002). Constitutive p38HOG mitogen-activated protein kinase activation induces permanent cell cycle arrest and senescence. Cancer research, 62(17), 5076-5082.

Homann-Kee Tui, S., Bluemel, M., Valbuena, D., Chirima, A., Masikati, P., van Rooyen, A. F., and Kassie, G. T. (2013). Assessing the potential of dual-purpose maize in southern Africa: A multi-level approach. Field Crops Research 153: 37-5.

Khan, M., and Ahmad, M. (2002). Role of farm size in input use and productivity of potato in Shigar valley of Baltistan area [Pakistan]: An econometric analysis. Sarhad Journal of Agriculture (Pakistan).

Kimhi, A. (2003). Plot size and maize productivity in Zambia: the inverse relationship re-examined (No. 888-2016-65083).

Komba, Y., (2021). A Socio-economic History of Coffee Production in Mbinga District, Tanzania, c.1920 – 2015. [Online] Scholar.sun.ac.za. Available at: <https://scholar.sun.ac.za/bitstream/handle/10019.1/110006/komba_history_2021.pdf?sequence=1&isAllowed=y> [Accessed 25 February 2022].

Krupnik, T. J., Ahmed, Z. U., Timsina, J., Yasmin, S., Hossain, F., Al Mamun, A., ... & McDonald, A. J. (2015). Untangling crop management and environmental influences on wheat yield variability in Bangladesh: an application of non-parametric approaches. Agricultural Systems, 139, 166-179.

Liu, B., Xue, Y., Han, G., Zhang, L., Huang, Y., Hou, C., and Cao, Y. (2021). An alternative and clean utilization of refractory high-phosphorus oolitic hematite: P for crop fertilizer and Fe for ferrite ceramic. Journal of Cleaner Production, 299, 126889. https://doi.org/10.1016/j.jclepro.2021.126889.

Lyimo, S., Mduruma, Z., and Groote, H. D. (2014). The use of improved maize varieties in Tanzania. African Journal of Agricultural Research,9 (7):643-657.

MAFAP (2015). Database - Public Expenditures by Categories. Retrieved 10/04/2017 from http://www.fao.org/inaction/mafap/database/en/.

MAFC, (2011). Agricultural statistics, accessed at http://www.kilimo.go.tz

Mcharo, A. C., (2013). Perception of farmers on the effectiveness of agricultural extension agents in knowledge transfer to maize growers in the Kalindi district. Unpublished dissertation presented at Sokoine University.

Mehmood, Q., Riaz, M., Sail, M. H. and Moeen, M. (2018). Identifying key factors for maximizing wheat yield: A case study from Punjab, Pakistan. Pak. J. Agric. Res., 31(4): 361-367. https://doi.org/10.17582/journal.pjar/2018/31.4.361.367.

National sample census of agriculture 2007/2008, (2012). Smallholder Agriculture: Regional report - Ruvuma region, URT, Ministry of Agriculture, Food Security and Cooperatives, Ministry of

Livestock Development and Fisheries, Ministry of Water and Irrigation, Ministry of Agriculture, Livestock and Environment, Zanzibar.

Ntabakirabose, G., Mbabazize, M., and Shukla, J. (2015). An analytical study of the factors influencing Maize production in Rwanda: A case study of Gatsibo District. The International Journal of Business and Management, 3(10): 146 - 181.

OECD/FAO (2019). OECD-FAO Agricultural Outlook. Paris: OECD Agriculture Statistics.

Olayide, S.O., (2000). Characteristics, Problems and Significance of Small Framers in Nigeria. VE Bello CARD Publisher, pp: 43.

Olujenyo, F. O. (2008). The determinants of agricultural production and profitability in Akoko Land, Ondo-State, Nigeria. Journal of social Sciences, 4(1), 37-41.

Onojah D. A., Aduba, J. J., and Oladunni, O. A. (2013). Relationship between Farmers Socio-Economic Characteristics and Maize Production in Nigeria. The chasm Global Journal of Current Research.

Onuk, E.G., Ogara, I. M., Yahaya, H. and Nannim, N. (2010). Economic Analysis of Maize Production in Mangu Local Government Area of Plateau state, Nigeria.

Oyewole, S. O., (2012). Analysis of Income Diversification Strategies and Food Security Status of Farmers in Oyo State of Nigeria. Unpublished M.Sc Thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria.

Rada, N. E., & Fuglie, K. O. (2019). New perspectives on farm size and productivity. Food Policy, 84, 147-152.

Sarkar, M., Hasan, M., Feardous, M., Shuhel, M., and Moniruzzaman, M. (1970). Comparative economic analysis of borrwer and non-borrower Boro rice farmers in some selected sites of Mymensingh District. Bangladesh Journal of Agricultural Research, 35(1), 65–76. https://doi.org/10.3329/bjar.v35i1.5867.

Shiferaw, B., Prasanna, B., Hellin, J., and Banziger, M. (2011). Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. Food Secur. 3, 307–327. doi: 10.1007/s12571-011-0140-5.

Suleiman, R. A., Rosentrater, K. A., and Bern, C. J. (2013). Effects of deterioration parameters on storage of Maize. 2013 Kansas City, Missouri, July 21 - July 24, 2013.

Suleiman, R., and Rosentrater, K. A. (2015). Current Maize Production, Postharvest Losses and the Risk of Mycotoxins Contamination in Tanzania. 2015 ASABE International Meeting.

Suri, T. (2011). Selection and comparative advantage in Technology adoption: Econometrica.

The United Republic of Tanzania, (2011). Production quantity of Primary Crops.

The United Republic of Tanzania, (2012). Agricultural Public Expenditure Review (PER) for Inputs Support Programme, for Financial Year 2012/13.

The United Republic of Tanzania, (2015): Annual Agricultural Sample Survey Report 2014/15.

Urassa, J. K. (2015). Factors influencing maize crop production at household levels: A case of Rukwa Region in the southern highlands of Tanzania.

USAID, (2010). Staple foods value chain analysis. Country report Tanzania. USAID- complete program document.

van Ittersum, M. K., van Bussel, L. G. J., Wolf, J., Grassini, P., van Wart, J., Guilpart, N., Claessens, L., de Groot, H., Wiebe, K., Mason-D'Croz, D., Yang, H., Boogaard, H., van Oort, P. A. J., van Loon, M. P., Saito, K., Adimo, O., Adjei-Nsiah, S., Agali, A., Bala, A., . . . Cassman, K. G. (2016). Can sub-Saharan Africa feed itself? *Proceedings of the National Academy of Sciences*, *113*(52), 14964–14969. https://doi.org/10.1073/pnas.1610359113.

Wilson, R. T., and Lewis, J. (2015). The maize value chain in Tanzania. A Report from the Southern Highlands Food Systems Programme.

Wu, Y., Xi, X., Tang, X., Luo, D., Gu, B., Lam, S. K., and Chen, D. (2018). Policy distortions, farm size, and the overuse of agricultural chemicals in China. Proceedings of the National Academy of Sciences, 115(27), 7010-7015.

Xu, Z., Chau, S. N., Chen, X., Zhang, J., Li, Y., Dietz, T., Wang, J., Winkler, J. A., Fan, F., Huang, B., Li, S., Wu, S., Herzberger, A., Tang, Y., Hong, D., Li, Y., & Liu, J. (2020). Assessing progress towards sustainable development over space and time. Nature, 577, 74– 78. https://doi.org/10.1038/s41586-019-1846-3.

Zhang, W., Qian, C., Carlson, K. M., Ge, X., Wang, X., & Chen, X. (2021). Increasing farm size to improve energy use efficiency and sustainability in maize production. Food and Energy Security, 10(1). https://doi.org/10.1002/fes3.271.

Zorya S, Morgan N, Rios LD (2011). Missing food: The Case of Postharvest Grain Losses in Sub-Saharan Africa. The International Bank for Reconstruction and Development / The World Bank. Report No. 60371-AFR. The World Bank, Washington, DC.