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Factors influencing maize crop production at household levels: A case of Rukwa Region in the southern highlands of Tanzania

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Production of staple food occupies an important part in Sub-Saharan Africa's agricultural production. Maize crop in particular is the most important staple food in this area. The article mainly examines households' socio-economic characteristics affecting maize production in Rukwa in the context of the market reforms carried out in Tanzania in the mid 1980's. Rukwa region is one of Tanzania's most reliant maize producers. The article explores the importance of maize to household's crop production, its production levels and the determinants of its productivity. A number of specific issues are explored including the importance of factors such as farm size, education, and access to key inputs such as seeds, fertilizers and agricultural extension services. The study on which the article is based uses data collected from three districts of Rukwa. The findings showed that maize crop continues to play an important role in most households' livelihood. However, the crop production levels were low. Education was observed to be an important factor in raising yields, suggesting that non-agriculture policies may also be important for improving productivity and welfare of farmers. Despite the importance of maize crop to household livelihoods, several constraints were reported to hinder its productivity including access to fertilizers, improved seeds and other chemical inputs necessary for higher production, and extension services. Therefore, efforts need to be taken by both the local and central government to raise households maize productivity and hence increase the possibility of improving their well-being.

Key words: *Zea mays*, productivity and farm households.

INTRODUCTION

Agriculture is the economic backbone, engaging about 90% of Rukwa region's economically active human population. According to URT/NBS/RRCO (2004), agricultural production accounts for about 65% of the region's GDP. The major crops grown by households in the region include food crops such as maize, finger millet, beans, rice, and cassava; and cash crops such as tobacco, sunflower, groundnuts, coffee and wheat. Despite the diversity of crops cultivated in Rukwa, most of the region's cash income comes from maize, which accounts for 35% of the region's total annual food output (URT/NBS/RRCO, 2004). Rukwa's maize production and

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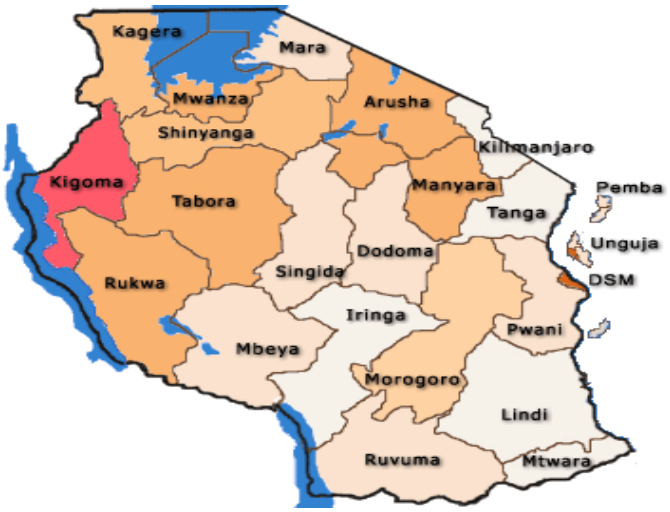

Figure 1. Map of Tanzania showing administrative regions (Source; http://www.tanzania.go.tz/census/regions.htm-4/5/2008).

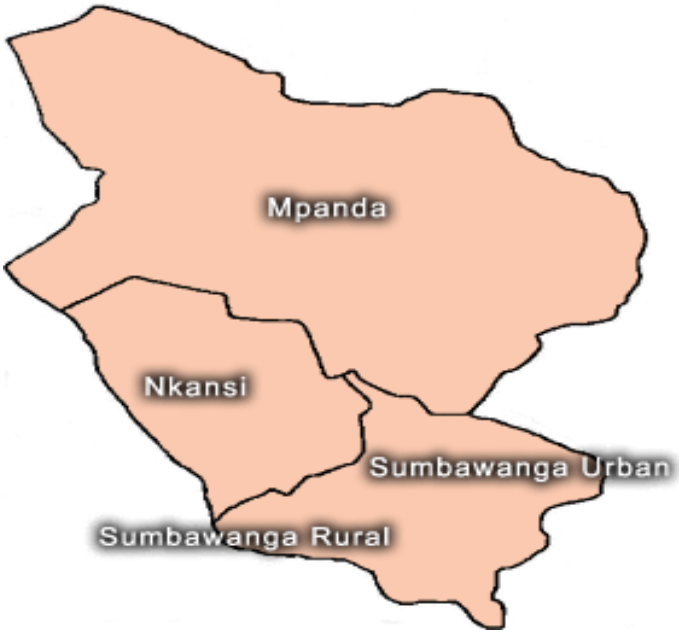

Figure 2. Rukwa region's administrative districts (Source: http://www.tanzania.go.tz/census/rukwa.htm-4/5/2008).

its overall contribution to Tanzania's total maize output over the past years led the region along with three other regions, Iringa, Mbeya and Ruvuma to be nicknamed "the big four" (URT/NBS/RRCO, 2004).

In addition to the above, Rukwa is however different from the others, being much more remote (Figure 1) and its farmers have less access to commercial markets for outputs and inputs. Compared to Rukwa, the other three regions have some better road networks with some or many of the roads having tarmac (asphalt) (Figure 2). Iringa and Mbeya are also well served by the Tanzania Zambia Railway line (TAZARA) which connects Dar es Salaam Tanzania's commercial capital to Kapiri Mposhi in Zambia, providing a good way of transporting food, cash crops and other commodities from the regions. Ruvuma can also easily access TAZARA through Makambako in Iringa region which is not very far from Songea the regions capital. Furthermore, Rukwa is more reliant on maize as a source of income than other regions which have other crops such as tea, coffee, oil palm, and bananas (Mbeya), coffee and tobacco (Ruvuma) and Irish potatoes, tea, and coffee in Iringa (NBS/MAFS/MWLD/MCM/PORALG/MFEA-Z, 2006).

In the mid 1980's Tanzania undertook some policy reforms aimed at stimulating crop market incentives and opportunities. Based on the reforms it was expected that regions such as Rukwa would be able to seize the opportunity and raise their agricultural productivity based on their inherent agricultural potential. Moreover, it was assumed that under perfect market conditions households would easily access input and output markets. Though some studies (Ashimogo, 1995, 1997; Bisanda et al., 1998) have been done, concentration has been on grain storage, marketing and adoption of maize production technologies. Furthermore, based on the reviewed literature no study was found to have dealt with production constraints following the liberalization of the agricultural input and output markets. Therefore, the study aimed at exploring maize crop production constraints in Rukwa region where its production predominates. It mainly dwelt on analysis of farm households' data collected during the fieldwork and compared with previous yield estimates of Rukwa region from the official statistics.

METHODOLOGY

Study area

Rukwa is found in the south-western part of Tanzania on the shores of Lake Tanganyika. The region lies between latitudes 3° and 9° south of the equator and between longitudes 30° and 33° east of Greenwich (URT/NBS/RRCO, 2004). Rukwa is bordered to the North by Kigoma and Tabora regions, to the East by Mbeya region, to the South by Zambia and to the West by Lake Tanganyika, which lies between the region and the Democratic Republic of Congo (DRC). Rukwa is situated on the Central African Plateau and is bordered by the Western arm of the Great Rift Valley. Access to Rukwa region is a bit restricted when compared to the other three regions bordering it; as it lacks good all-weather roads.

Research design

The study employed a mixed research design during data collection. However, a cross-sectional research design (Creswell, 2003) was mostly adopted, whereby data were collected at one point in time. The choice of this approach was partly warranted by its ability to meet the objectives of the study, and also due to time limitation and financial constraint.

Table 1. Socio-economic characteristics of households.

Characteristic		Rukwa region (n = 200)	Districts		
			Sumbawanga (n = 72)	Mpanda (n = 67)	Nkansi (n = 61)
Household head's average age		44.4	43.6	45.1	44.4
Respondents' sex	Male	153 (76.5)	53 (73.6)	57 (85.1)	43 (70.5)
	Female	47 (23.5)	19 (26.4)	10 (14.9)	18 (29.5)
Household head's gender	Male	169 (84.5)	59 (81.9)	61 (91)	49 (80.3)
	Female	31 (15.5)	13 (18.1)	6 (9)	12 (19.7)
Household head's educational level	Primary school leaver	121 (60.5)	47 (65.3)	46 (68.7)	28 (45.9)
	Secondary school leaver	6 (3.0)	3 (4.2)	1 (1.5)	2 (3.3)
	Adult education	9 (4.5)	6 (8.3)	0 (0.0)	3 (4.9)
	No formal education at all	24 (13.0)	10 (13.9)	4 (6.0)	12 (19.7)
	Lower levels of Primary School (< std 7)	38 (19.0)	6 (8.3)	16 (23.9)	16 (26.2)
Household head's main occupation	Crop farming	193 (96.5)	67 (93.1)	65 (97.0)	61 (100)
	Salaried employment	6 (3.0)	4 (5.6)	2 (3.0)	0 (0.0)
	Other (e.g. fishing)	1 (0.5)	1 (1.4)	0 (0.0)	0 (0.0)
Household size	Average household size	5.88	5.29	6.22	6.21
Household's land ownership (ha)	Average land owned	3.19	2.45	4.24	2.93
	Average farmed land	2.29	2.10	2.35	2.45
Household income (Tsh)	Average Household income (2005)	521,947.00	475,069.00	704,411.00	376,867.00
	Income range (2005)	9,000 – 5,284,000.00	9,000-3,000,000.00	10,000- 5,284,000.00	12,000 – 2,670,000.00

Source: Survey Data (2006). Number in brackets indicate percentage.

Data collection and analysis

Data were collected from the three rural administrative districts of Rukwa region. Collection of data from the three districts aimed at ensuring a broader understanding of the phenomena under study in a range of localities. This is because most households in Sumbawanga and Nkansi districts depend mainly on the maize crop as a major means of livelihood, whereas households in Mpanda are also involved in tobacco farming. Data were analysed using SPSS (version 17.0) to generate different descriptive statistics.

Sampling procedures and sample size

The current study involved an interview of 200 randomly selected farm households that are involved in maize crop production from the three districts (72 from Sumbawanga, 67 from Mpanda and 61 from Nkansi). Random sampling was based on official village registers made available to the researchers by leaders of the selected villages. A total of 16 focus group discussions (FGDs) were further conducted, four each in Sumbawanga and Nkansi districts and eight in Mpanda district. In each case, only one village was selected to ensure a comparison of opinions between the different age and sex groups. A total of 107 individuals participated in the FGDs. Apart from individual questionnaires and the FGDs, in-depth interviews were also conducted with the district agricultural officers of the three districts.

Primary data collection

The study used both primary and secondary data whereby primary data were collected using pre-structured questionnaires. These were designed in a way to enable collection of information capable of answering the primary questions aimed at determining Rukwa region maize crop production levels after a period of about twenty years of agricultural trade reforms including liberalization of the maize market. The questions mainly aimed at determining the importance of maize crop in the livelihoods of surveyed households and their maize production characteristics, for example, the uses of modern technologies in production process. The questionnaire also sought information on the farm households' farming practices as well as other types of crops, amount of land dedicated to each and whether households were actively seeking extension services in relation to maize crop farming. These lines of enquiry were based on the prediction that open markets make access to technologies and innovations easier. Secondary data collected came mainly from the Ministry of Agriculture and Food Security and FAOSTAT (online). Data from the 2002/03 National Agricultural Census was also used in the current study.

RESULTS AND DISCUSSION

Socio-economic characteristics of surveyed households

The respondents' major socio-economic characteristics are shown in Table 1. Three quarters of the respondents were male; however the actual number of male headed households (MHHs) was greater than this. The lower number of female headed households (FHHs) was probably caused by the fact that some of the female respondents were only representing their spouses who could not be available for the interviews, and by the current study's approach of using random sampling

method, whereby names were drawn randomly from the village registers. The low percentage of FHHs observed in the current study is contrary to other observations of rural Tanzania, where higher percentages of them have been reported. For example, FAO (1997) reported 30% of FHHs for Ileje district in Mbeya, 32% for Mvumi division in Dodoma, 25% in Zanzibar north and 17.5% in Tanzania mainland.

A very small proportion of the household heads had attained secondary education (Table 1). Many household heads were primary school leavers, one in five had attended primary schools without completing and 10% of household heads had no formal education. However, education levels can influence households/individuals' choice of a livelihood strategy (Marzano, 2002; Galab et al., 2006). In addition, Minot et al. (2006) pointed out that an increase in an individual's years of education is expected to increase one's range of work-related skills and hence the ability to acquire new skills. According to Minot et al. (2006). a high level of education is expected to be associated with the production of higher value crops, more commercially oriented agriculture, and greater participation in non-farm activities. Crop production was the households' main occupation and this is in line with what has been reported for Rukwa region (URT/NBS/RRCO, 2004). In Nkansi district, it was the main occupation of all the household heads visited. The results conform to official estimates for the Rukwa region, according to NBS/MAFS/MWLD/MCM/PORALG/MFEA-Z (2006). About 99.8% of the region's households generally grow crops, with about 34% of them growing crops and keeping livestock. Average household size was relatively higher than 5.1 and 4.9 reported for Rukwa region and Tanzania, respectively (NBS, 2002). However, some relative differences between districts, with Sumbawanga having the smallest and Mpanda the highest household sizes, respectively were observed.

Average land owned by households was 3.19 ha and was in conformity with the official estimate of about 3.0 ha observed for Rukwa region during 2002/03 National Sample Census of Agriculture (United Republic of Tanzania - URT, 2006). However, when compared at the district levels, Mpanda districts had relatively more land than the other two districts, Sumbawanga having the least one. On ownership of cropping land by gender of household heads, there was significant ($P < 0.05$) difference between the two genders. On average, FHHs owned less land than MHHs.

This observation is in line with the actual situation in most parts of Tanzania. Land ownership is mainly a male right as a result of the highly entrenched patriarchal system.

Maize crop production in Rukwa region

Here, statuses of maize production at the study households were examined in the context of 20 years of agricultural reforms based on farmer views about the importance of maize crop and the levels of maize production recorded in 2005. The study also examined constraints facing maize producers in the region. Regression analysis was also done in order to assess how important individual constraints were and to shed light on some of the debates referred to in the introductory part.

Levels and trends of maize production

Maize crop is important to most households in Rukwa region and this was clearly illustrated during the Focus Group Discussions (FGDs). During these discussions, the crop was consistently ranked as one of the most important crops cultivated by the study households. Both the FGDs and interviewed farmers referred to its dual use as a food crop for family consumption and a source of households' income. Only where cash crops such as tobacco were well established, maize crop had less importance as cash crop. Generally, apart from differences in maize crop's importance in Mpanda relative to Sumbawanga and Nkansi districts, all the FGDs in Sumbawanga and Nkansi ranked maize as the number one crop in their areas followed by beans and then sunflower. The FGDs that ranked maize as the most important crop based their arguments on its importance both as their main staple and for its income earning commodity when surplus produce is sold. According to the FGDs and study participants, all age groups and genders were equally involved in its production.

The greater importance of maize crop to the farmers in Nkansi and Sumbawanga districts was based on the quantitative estimates of maize output and area cultivated with maize. Table 2 shows that the averages of 1237.99 kg/ha and 2020.34 kg for maize yield and output, respectively observed for households in Nkansi district in 2005 were relatively higher than the averages observed for both Sumbawanga and Mpanda districts. However, observed levels were relatively low when compared to levels observed elsewhere in the world (Table 2a). The levels were even lower than those reported for some other areas in Tanzania, for example Kilimanjaro, Mbeya, Ruvuma and Iringa regions when maize yield levels ranging between 1264.52 and 1483.40 for the 2004/05 cropping season (United Republic of Tanzania - URT, 2006). The findings further show that about half of the study households producing maize in 2005 had farm sizes larger than 2 ha and less than fifty percent of households had their farms as a single unit. The observation that yields are highest in Nkansi, where average farm size is slightly larger than elsewhere, suggests that small farms are not more productive. However, other factors might be involved on maize yield differences noted.

Table 2. Households' maize production in Rukwa for the 2005 cropping season.

Characteristics		Rukwa Region (n = 191)	Districts		
			Sumbawanga (n = 66)	Mpanda (n = 66)	Nkansi (n = 59)
Average households' total maize production (kg) in 2005		1460.10	1420.00	999.39	2020.34
Average households' maize yield (kg/ha) 2005		1057.48	990.12	963.47	1237.99
Average farm size (ha) under maize production		1.31	1.35	1.12	1.47
Is crop farm a single plot of land	Yes	91 (47.6)	22 (33.3)	33 (50)	36 (61)
	No	100 (52.4)	44 (66.7)	33 (50)	23 (39)

Source: Own Survey (2006). Numbers in brackets indicate percentage.

Table 2a. Average maize yields (kg/ha) across the world.

Season	Eastern Africa	Northern Africa	Southern Africa	Asia	Eastern Europe	South America	Mexico	World
1986 –1990	1385.54	3627.36	1939.76	2949.74	3603.92	2083.66	1772.48	3502.84
1991 - 1995	1281.42	3949.56	1854.16	3483.46	3236.18	2533.62	2270.02	3824.48
1996 - 2000	1441.78	5260.86	2380.16	3722.80	3428.38	3069.86	2379.90	4309.30
2001 - 2005	1360.28	5779.10	2769.60	3923.52	4050.66	3673.20	2757.40	4623.54

Source of data: FAOSTAT (http://faostat.fao.org/site).

Table 3 shows summary statistics on the use of modern farm inputs and technologies. With regards to the use of improved technologies, the use of them in maize production in 2005 was low. Most households relied on traditional seeds and recycled hybrid seeds. Only about ten percent of the households bought improved seeds from stockists every year. This observation is partly in line with available statistics by NBS/MAFS/MWLD/MCM/PORALG/MFEA-Z (2006) which on the 2002/03 National Sample Census of Agriculture reported that only 18% of crop growing households in Tanzania used improved seeds and only 5% of households in Rukwa region used improved seeds. The study's estimate of 9.9% for use of improved seeds by the surveyed households is of a similar magnitude to the official estimate for Rukwa region. Most of the households relied on the hand hoe in their land preparation.

The use of fertilizers was limited amongst the surveyed households (Table 3). Generally, about 42.1, 52.6 and 5.3% of the study households which reportedly use fertilizers applied farmyard manure, chemical fertilizers and both, respectively. The low use or total non-use of chemical fertilizers by the surveyed households was reportedly caused by many factors. Variation of reasons between age groups with regards to their non-use of fertilizers was observed. Many elderly and middle-aged respondents based their arguments on their experiences and traditions while the younger was blamed on unavailability and lack of money. Some younger respondents were also caught-up with the problems of traditions and customs of their communities. However, all the respondent categories were equally affected by the price of fertilizers and economic hardships as factors hindering their use of fertilizers in maize production. The information provided during the interviews gave a mixed picture; whereas some respondents seemed very genuine in their concern given the economic and infrastructural conditions of many rural areas of Tanzania which make it impossible or very expensive to access agricultural inputs, observations from the study suggest that the respondents' crop husbandry may be limited and more education is required if the situation is to improve. While some respondents said they were not using fertilizers as their lands were quite fertile, nonetheless some were ready to use them if they were given for free.

Over one-third (38.2%) of the households which produced maize crop in 2005 sought agricultural extension services from qualified staff (Table 3). However, in each district, levels of access to extension services by households were 28.8, 53 and 32.2% for Sumbawanga, Mpanda and Nkansi, respectively. Mpanda district had relatively high access to extension services due to the fact that farmers who grew had direct access to tobacco extension staff who were employed by the tobacco companies. They were also useful for maize production whenever consulted. The low access to extension services observed could in part be due to inadequacy of extension staff or the distance between the households concerned and the location of the extension

Table 3. Rukwa households' use of modern technologies in maize production in 2005 by numbers and percentage.

Characteristics		Rukwa Region (n = 191)	Districts		
			Sumbawanga (n = 66)	Mpanda (n = 66)	Nkansi (n = 59)
Tillage method used	Hand hoe	109 (57.1)	35 (53.0)	61 (92.4)	13 (22.0)
	Ox-plough	82 (42.9)	31 (47.0)	5 (7.6)	46 (78.0)
Use of fertilizers in maize production	Yes	57 (29.8)	9 (13.6)	23 (34.8)	25 (42.4)
	No	134 (70.2)	57 (86.4)	43 (65.2)	34 (57.6)
Maize seeds used	Traditional/Local seeds	134 (70.2)	50 (75.8)	46 (69.7)	38 (64.4)
	Hybrid seeds bought from input shops every year	19 (9.9)	3 (4.5)	10 (15.2)	6 (10.2)
	Hybrid seeds recycled from previous season	38 (19.9)	13 (19.7)	10 (15.2)	15 (25.4)
Household's use of extension services	Yes	73 (38.2)	19 (28.8)	35 (53.03)	19 (32.2)
	No	118(61.8)	47 (71.2)	31(46.97)	40 (67.8)

Source: Own Survey (2006). Numbers in brackets indicate percentage.

staff office and/or residence. According to NBS/MAFS/MWLD/MCM/PORALG/MFEA-Z (2006), Rukwa and Lindi rank last in terms of access to crop extension services, with only 17% of households having access to extension services. The highest access reported was about 64% in Dar es Salaam and Iringa regions. In some areas, the extension staff served more than one village. This was quite challenging to manage due to the geographic orientation of some areas in Rukwa region, with the western rift valley passing through the region. Other factors are the underdevelopment of infrastructure and lack of cheap means of transport like motorcycles. Despite some officers having bicycles, the terrain made them inefficient mode of transport.

Despite the fact that access to extension services was a problem to some of the households, others were less keen to access the services. The use or non-use of agricultural extension services among the surveyed households varied between the age groups. Many elderly and middle-aged respondents believed that they had appropriate expertise and experience to produce maize, mainly based on their years of farming or the experience of others in their villages. On the other hand, many young respondents mentioned ignorance to be a major factor in not seeking extension advice. This observation is supported by Dos et al. (2003) who argued that young farmers are more open to new technologies compared to old ones who had accumulated enough experience. The belief acted as an obstacle to adoption of new technologies compared to the younger who had less experience. Apart from these two fairly clear distinctions, the findings show that other factors, including lack of money for adoption of technologies advised and unavailability of extension staff, affected all age categories in similar ways. However, some of the elderly and middle-aged respondents, due to their traditions and/or experiences, lacked motivation for seeking extension services for their maize production due to the crop being perceived as a food crop, and/or other reasons that are beyond the scope of this study.

Factors influencing maize production at household levels in Rukwa region

Table 4 details 2005 surveyed households' maize yields, output, farm characteristics, household characteristics and location on maize yields and output. Two models were estimated using ordinary least squares. The first model aimed at investigating the importance of farm, household and location characteristics on yields and the chosen measure of productivity in this area. The second model used total output as its dependent variable. A common set of independent variables was used. In executing the analysis, the natural logarithm of yields and outputs was chosen to be used in the above models. This was mainly prompted by the fact that the relationship between the above dependent variables is not linear. In addition, there is a likelihood that natural limits could be in operation for both maize yields and outputs.

First, a set of farm characteristics and farming method variables were specified. They include:

i) Total farm size (in ha), which was intended to shed light on the small farm efficiency hypothesis, a dummy variable indicating if the farm land is in a single plot, which may reveal whether economies of scale are available from having consolidated plots.
ii) Three further variables, the proportions of land dedicated to maize production and to cash crops, and whether the household sells maize, capture the extent to which farms rely on maize or have access to other forms of incomes. It might be expected that households with a large part of land dedicated to cash crops put less effort into maize production, and so have lower maize yields.
iii) The number of crops and livelihood strategies adopted

Table 4. Simple linear regression of the natural logarithms of the surveyed households' 2005 maize yields (kg/ha) and output (kg) in 2005.

Farm characteristics and farming methods	Natural logarithm of households' maize yield (kg/ha) in 2005	Natural logarithm of households' maize output (kg) in 2005
Households farm size (ha)	0.006 (0.040)	0.355*** (0.042)
Is crop farm a single plot of land (1=yes; 0=no)	-0.121 (0.125)	-0.095 (0.131)
% of a household's farm land allocated to maize production	-0.006 (0.004)	0.010** (0.004)
% of a household's farm land allocated to cash crops	-0.001 (0.004)	0.000 (0.004)
Household's sale of maize (1=yes; 0 = no)	0.376** (0.164)	0.399** (0.171)
Number of crops grown by household in 2005	-0.041 (0.078)	0.007 (0.081)
Number of livelihood strategies adopted by household	-0.148** (0.060)	-0.137** (0.062)
Household's use of fertilizer in maize production (1=yes; 0=no)	0.202 (0.133)	0.256* (0.139)
Household's use of improved maize seeds (1=yes; 0: no)	0.010 (0.130)	-0.081 (0.136)
Household use of extension services (1=yes; 0 = no)	-0.156 (0.130)	-0.208 (0.136)
Household's tillage method (1=oxen; 0= hand hoe)	0.423** (0.156)	0.499** (0.163)
Household head's age	-0.010** (0.005)	-0.008 (0.005)
Sex of household head (1=male; 0=female)	0.095 (0.176)	0.129 (0.184)
Actual school years of household head	0.046* (0.026)	0.062** (0.027)
Household size	0.003 (0.023	0.024 (0.024)
Sumbawanga district (1= Sumbawanga; 0= otherwise)	-0.116 (0.178)	-0.186 (0.186)
Nkansi district (1: Nkansi; 0= Otherwise)	-0.141 (0.186)	-0.168 (0.194)
	Constant: 7.435*** (0.562)	Constant: 5.223*** (0.587)
	N = 191;	N = 191;
	R^2 = 0.243 and	R^2 = 0.557 and
	F Stat 2.814***	F Stat 11.016***

Standard errors in brackets and ***Significant at 1% (0.001) level, **Significant at 5% (0.05) level and *Significant at 10% (0.1) level.

by the household were also included as this may also indicate whether farmers put less effort into maize production.

iv) A set of variables that capture input use were also included: use of fertilizers, type of maize seeds, use of extension staff, and use of oxen for tilling land, aiming to capture the benefits of improved farming practices that are associated with higher yields elsewhere.

A second set of variables captures key household characteristics of age, gender and education levels of the household head and household size. There is evidence elsewhere that education and experience may lead to higher yields, although it is not clear if these are important in the cultivation of a staple crop grown by the vast majority of the population. Gender may be important if for example, FHH are constrained to production for home consumption, or have difficulty in acquiring hired labour. Household size aimed to capture the notion that large sized rural households would be able to easily supply the labour required for their crop production due to abundance of own labour. A final set of variables are the dummies for the districts, which capture other characteristics that are not captured by the above, for example variations in soil quality between the districts, or proximity to markets. Results of the simple linear regressions are presented in Table 4.

The first point to note is that the fit of the yield model was quite low especially compared to the output model. This observation suggests that there were other factors determining variations in yields that were not included in this model. One important omission is soil quality but unfortunately, that variable was not possible to collect in this survey. Nevertheless, the F statistics showed that the models are useful for shedding light on maize yields and output levels.

Regarding farm characteristics and farming methods, there were lots of consistency and many appeared to be significantly associated with outputs, but a few were not. For example, farm size, the proportion of farmland allocated to maize production and use of fertilizers. These factors were statistically significant. On the other hand, the age of a household's head was significantly associated with yield but not output. There was no evidence on the inverse farm size-productivity relationship: smaller farms had marginally and statistically insignificant higher yields. The lower yields, due to an increase in amount of land allocated may be due to factors such as households failing to do their weeding in time. According to Bisanda et al. (1998), late weeding can also lead to seriously low maize yields. However, the study generally shows that households with more land and those allocating a higher proportion of their land to maize production despite the lower yields observed they

got significantly higher maize outputs in 2005 compared to those with less land and those allocating a smaller proportion of the land to maize production. The number of crops grown and number of livelihood strategies in place had the expected outcome and were associated with lower maize yields and maize outputs, although the results showed that only the latter influence were statistically significant. One very strong result is that households that sold maize had much higher yields and output than those that did not sell – suggesting that commercialisation of staples may be associated with higher productivity. This observation is further supported by Davis et al. (2007) who argued that market access is very important if households are to get greater returns from their crop and livestock production activities. In a similar way, households that devote more land to cash crops also have lower maize yields, supporting the hypothesis that effort on food crops may be lower.

Surprisingly, despite the literature available (Kaliba et al., 2000; Gemeda et al., 2001; Sasakawa African Association, 2007; World Bank, 2007a) showing that access to extension services may boost maize and other crops yields, there was no significant influence of access to extension services on either higher maize yields or output in 2005 (Table 4). However, according to the information indicated in Table 3, only about one-third of the surveyed households had access to extension services. This may explain the insignificant levels observed. In addition, access to agricultural extension services without access to fertilizers and other inputs may have no effect on crop yields. Some of the households also reported to not doing so because of failure to follow the advices.

Regarding household characteristics, there were no statistically significant effects of age, gender or household size on yields or output. Education level however, had statistically significant impact on maize yields. This may reflect greater awareness of good farming practices, e.g. how and when to apply fertilizers or pesticides, or store seeds from one harvest to the next. Certainly, there seem to be some support for the idea that educating farmers who grow food crops would have positive impacts.

The district dummies had no significant influence in maize yields and outputs. This suggests that unobserved differences between the districts (such as soil quality) are not significant, although of course the latter may be already picked up in the variables that capture use of fertiliser etc (because there may be a relationship – positive or negative - between soil quality and whether a farmer uses fertilisers).

Generally, observations from the regression analysis were consistent with the information provided by the surveyed farmers. For example, households had raised in the interviews the issue of lack of access to modern inputs (fertilizers and improved seeds) due to either unavailability or price restrictions being constraints to their maize production. This finding is supported generally by the regression analysis results on maize output – lots of the corresponding variables have statistically significant coefficients, suggesting that farmers who had access to these inputs had higher outputs. However, the yield regression analysis is less conclusive: using modern inputs and methods do raise yields but not to a statistically significant extent. It is possible that the lack of access to extension services, and the re-use of seeds rather than purchasing new seeds each season, reduces the effect that inputs have on yields.

The regression analysis further suggests that households that sell maize, rather than keep the whole harvest for home consumption, have higher yields than those that do not. This does not necessarily imply causation but is suggestive of the importance of boosting productivity in order for farmers to generate surplus output. Yields also tend to be higher among farmers that are less diversified while the more livelihood strategies are adopted, the lower the maize yield. Again this does not necessarily imply causality but is suggestive that while diversification may be an appropriate response to risk and vulnerability, it will not necessarily enable farmers to escape from poverty traps. Education is also a very important factor associated with higher yields. Some of these results confirm expectations, while others are more surprising. For example, the lack of a significant positive influence of access to extension services on increased yields and output, or access to extension services is normally expected to help raise productivity levels. This was the case with the SG 2000 project implemented in the northern part of Tanzania, where access to reliable extension services and the promotion of input use, for example chemical fertilizers, led to a rise in smallholders' maize yields to between 4.5 and 5.1 tonnes/ha, compared to the national average yield of around 1.3 tonnes/ha (Sasakawa African Association, 2007).

Conclusions

Generally, the study has revealed that productivity of maize and the other crops produced in Rukwa region were relatively lower than levels reported in other parts of the world in general, but broadly in line with official estimates for the region. This may have been due to a multitude of factors. For example, both survey observations and observations from the focus group discussions (FGDs) have shown maize to be one of the most important crops for farmers. Nevertheless, there was a consensus that farmers faced significant barriers in improving yields and output levels. Farmers reported, for example, that accessing important inputs such as new seeds, fertilizers and extension services was difficult, either because these inputs were expensive, not available

locally or not available altogether or because they felt their soil was fertile enough already and they distrusted modern inputs (that is, sought no advice on fertilizer). However, the lack of statistical significance in the yields regression results of impacts of fertilizer, extension services advice and seeds suggests that a combination of factors is at work: simply using the inputs does not raise yields, as they need to be used in the right quantities, at the right time and in combination with other factors. In addition, the data on fertilizer, for example, was not detailed enough to reveal whether farmers did use fertilizers in the right quantities, or the right types of fertilizer. The lack of statistical significance might be because so few used fertilizer that the regression cannot identify an effect.

The study also concludes that households' heads' education level was relevant to the commercialization of maize production and that education level was positively related to higher maize yields. For example, results from the regression suggest that households that sold maize rather than keep the whole harvest for home consumption had higher yields than those that did not. This, in itself is an interesting result, suggesting that raising productivity is key to establishing well-functioning markets in key food staples. Furthermore, the finding that education is positively related to both yields and commercialisation, suggest that improvements in education may also be a fruitful way of improving performance of the agricultural sector. Although this does not necessarily imply causation, it does suggest the importance of education in boosting productivity in order for farmers to generate surplus output. Higher levels of education were also observed to be positively related to higher maize output. This finding suggests that with more education farmers can easily overcome constraints of poor agricultural extension services and access to market information; they can therefore, easily get information from printed media and other sources such as agricultural pamphlets, brochures and posters which are locally available or could be obtained during agricultural shows.

Conflict of Interest

The authors have not declared any conflict of interest.

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