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# Contribution of Chemical Fertilizers on Maize Productivity in Rwanda

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**Abstract**: This study aimed to analyze the contribution of chemical fertilizers in increasing maize productivity in Rubengera sector of Karongi District. Field based observation study where different doses of chemical fertilizers was applied on three maize varieties namely WH 504,WH 505 and ZM 607 grown over 190.9444 $m^2$. Their productivity was measured in agricultural season B of 2020 (January – July 2020). The Microsoft Excel and Statistical Package for Social Sciences (SPSS) facilitated the data analysis. The results showed that in the plots without chemical fertilizers, maize plant germination rate was 97.03% whereas development parameters were 217cobs and 12.04 tons of maize harvested on the area of 61.98 $m^2$. For the plots with chemical fertilizers at dose of 100kg/ha of DAP during sowing with addition of 50kg/ha of urea during weeding, maize plant germination rate was 94.43%, development parameters were 379 cobs and the yield of maize harvested were 30.19 tons per 64.0144 $m^2$. Also, for the blocks with chemicals fertilizers at doses of 100kg/ha of DAP and 50 kg/ha of urea during sowing with addition of 50kg/ha of urea during weeding, the results maize plant germination rate was 100%, development parameters were 314cobs and yield of maize harvested were 33.79 tons per 64.95 $m^2$. Furthermore, the productivity by variety was 29.45 tons /72.4296 $m^2$ for WH505; 23.36 tons/ 62.0178 $m^2$ for ZM607 and 21.85tons /70.777 $m^{2,}$ respectively. Therefore, the application of chemical fertilizers contributes positively in increasing the yield of maize. This research can serve as additional information to policy makers to how applying chemical fertilizers contributes to increasing the crop productivity.

**Key words**: Chemical fertilizers, Karongi district, Maize productivity, Rwanda

## 1. Introduction

In Sub-Saharan Africa (SSA), maize production is a key ingredient in ensuring food security. Compared to other cereals, maize is higher yielding, lower risk, easier to process, and more versatile with the ability to grow across agro-ecological conditions (Kusse et al. 2019). Maize is consumed as a starchy base in a variety of items and provides an important source of carbohydrates, proteins, iron, minerals, and vitamin B (Connolly-Boutin and Smit 2016; German et al. 2013; Clover 2003). White maize has the highest demand in the region and is therefore priced higher and represents the vast majority of regional maize crops (Benimana et al. 2021; Kaine et al. 2015).

Agriculture is crucial for Rwanda's growth and reduction of poverty, as the backbone of the economy. The sector accounts for 39 percent of gross domestic product (GDP), 80 percent of employment, 63 percent of foreign exchange earnings, and 90 percent of the country's food needs. The Government has allocated 13% of the National budget to boost productivity and ensure food security and increasing trends have been recorded in recent years in production of food crops and cash crops, attributed to the crop intensification program launched in 2007 (Benimana et al. 2021; Uwizeyimana et al. 2018)

Fertilizers maximize crop yield and increase plant production. In case chemical fertilizers are used correctly, the chemical fertilizers can dramatically increase yield and turn otherwise poor soil into productive land (Kusse et al. 2019). The importance of fertilizer can be viewed in that they are designed specifically to support particular plants where improvement can be recognized almost immediately and plants absorb the nutrients quickly and the results are quickly visible (Gerard et al. 2018).

The Government of Rwanda initiated the Crop Intensification Program (CIP) which was started in 2007 to address food security and strengthen the country's agricultural productivity (Bosco et al. 2018; Mukabutera et al. 2016; Nahayo et al. 2017). Seven priority crops were identified including maize, wheat, rice, Irish potatoes, beans and cassava. Under the program, a focus has been made on farm consolidation, farm inputs (seeds and fertilizers), mechanization, irrigation, and extension services on the use of inputs and improved cultivation practices (Nabahungu and Visser 2011; Rutagengwa 2016).

Although Rwanda aims to become a service-led economy, the agricultural sector is expected to keep contributing significantly to the country's long term development and the country's solid growth record and macroeconomic stability provide a solid foundation for agricultural investment (Rushemuka et al. 2014; Lawther 2017). The country has committed to generating sustained agricultural growth, increasing the share of the national budget allocated to agriculture from 3 percent in 2006 to 10.01 percent in 2015 (Wasige et al. 2014; Diogo et al. 2017). These investments appear to be paying off, with annual agriculture growth averaging over 6 percent since 2007 (MINECOFIN 2013).

Despite current efforts being made in Rwanda to advance its food security, it is good to carry out an assessment on the extent to which these efforts are contributing to the achievement of the target outcomes. Therefore, this study was conducted to analyze the types of chemical fertilizers applied and their contribution in increasing maize productivity in Rubengera sector of Karongi district of Rwanda.



## 2. Methods and Materials

### 2.1 Description of study area

Rubengera Sector is the capital of Karongi District in western Province. Rubengera sector covers a total area of 47.34 $km^2$, 33019 Population and 697.5/$km^2$ of population density. It lies in the western mountains of Rwanda between Lake Kivu and Divide that separates the catchment of the Congo river to the west and the Nil (NISR,2012).

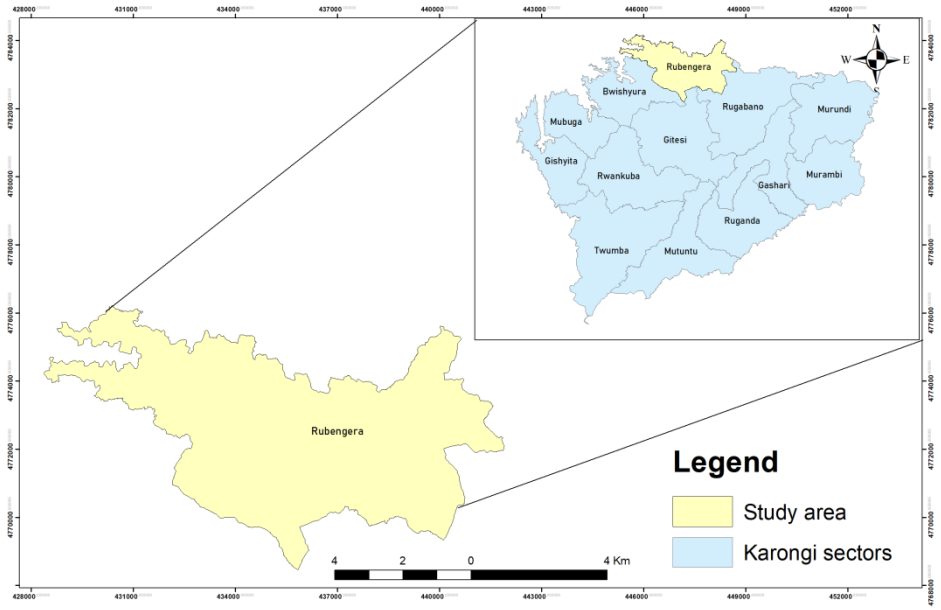


**Figure 1**: Map indicating the location of the study area

## 2.2 Data collection and analysis

The study used field based observation where the authors prepared three different blocks to test the productivity of maize varieties with the aims of gathering information on the effects of chemical fertilizers at different doses on maize productivity. The collected primary data ranged from January to July 2020, from the sowing and fertilizer application period up to the harvest time of maize. The maize varieties considered for this research were namely WH504, WH505 and ZM607 while DAP was the tested chemical fertilizer. The study also employed **secondary data:** This frequently involves the previous works from related articles including published annual reports and academic works.

The field data were collected by observing and recording daily change on growth of maize plants. Thereafter, the collected data were analyzed by using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to analyze data. Furthermore, descriptions were made based on the results of the tables. The data were coded to enable the responses to be grouped into various categories. The authors established the correlation between chemical fertilizers and maize productivity by applying the following model.

$$Y= \alpha+\beta_1X_1+ \beta_2X_2+ \beta_3X_3 +ę \quad (1)$$

Where:

Y= maize productivity

α= Constant Term β= Beta Coefficient

This measures how many standard deviations a dependent variable will change, per standard deviation increase in the independent variable.

$X_1$= 100kg of DAP and 50kg/ha

$X_2$= 100kg of DAP and 100kg/ha

$X_3$= 0 kg fertilizers

ę= Error term Null hypothesis There is no significant relationship between chemical fertilizers and maize productivity.

Z test and F test were used in the study, 0.05 level of significance was used as a reference in rejecting or accepting the hypothesis.

Finally, the results of the study were presented using tables, percentages. Tables were used to summarize responses for further analysis and facilitate comparison.



## 3. Results

### 3.1 Results on nine blocks

For Block 1, the results on the maize harvest in Table 1 indicated that the recorded harvest were 3,887 kg/ha on 7.399 $m^2$, 3,425.92 kg/ha over 6.8478 $m^{2,}$ and 4342.935 kg/ha cultivated over 7.29 $m^2$, respectively. Therefore, this expresses that 3.89; 3.43 and 4.34 tons per hectare were harvested respectively on the total area of 21.536 $m^2$.This yield showed that it was very necessary to use chemicals fertilizers for maize production. Furthermore, by applying 100-50 g of DAP and urea during sowing and adding 50g of urea during weeding period, on the total area of 21.536 $m^2$, 11,655.863 kg equivalent to 11.66 tn/ha of maize were harvested in Block 1.

**Table 2**: Results from 100-50 kg DAP/urea and adding 50kg of urea in Block 1

| Environment | Treatment Names | Plot size ($m^2$) | Maize germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 7.399 | 100 | 39 | 3,887 | 3.89 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 6.847 | 100 | 34 | 3,425.92 | 3.43 |
| Fert.100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.29 | 100 | 29 | 4,342.94 | 4.34 |
| **TOTAL** | | **21.536** | | **102** | **11,655.8** | **11.66** |

**Source**: Primary data, October, 2020

As indicated in Table 2, the result in Block 2 shown in Table 2 revealed that the maize harvest were 3,167.3 kg/ha on the land size of 7.35 $m^2$, 3,831.9 kg/ha over land of 6.9 $m^{2,}$ and 4813.9 kg/ha over 7.2 $m^2$, respectively. With reference to additional fertilizer application, by applying 100-50 g of DAP and urea during sowing and adding 50g of urea during weeding period, on the total area of 21.45$m^2$, 11,813.2 kg/ha equivalent to 11.81 tons/ha of maize harvested in Block 2 (Table 2).

**Table 2**: Results from 100-50 kg DAP/urea and adding 50kg of urea in Block 2

| Environment | Treatment Names | Plot size ($m^2$) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 7.35 | 100 | 32 | 3,167.3 | 3.17 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 6.9 | 100 | 36 | 3,831.9 | 3.83 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.2 | 100 | 32 | 4,813.9 | 4.81 |
| **TOTAL** | | **21.45** | | **100** | **11,813.2** | **11.81** |

**Source**: Primary data, October, 2020

For Block3, the results in Table 3 reveal that the maize yields were 2, 25 kg/ha over 7.35 $m^2$, 4,201 Kg/ha on 6.15 $m^2$, and 2,953 over 7.5276 $m^2$, respectively. This yield showed that it was very necessary to use chemicals fertilizers for maize production because this increased the maize productivity. Moreover, by applying 100-50 g of DAP and urea during sowing and adding 50g of urea during weeding period, on the total area of 21.45$m^2$, 10,321 equivalent to 10.32 tons/ha of maize have been harvested in Block 3 (Table 3).

**Table 3**: Results from 100-50 kg DAP/urea and adding 50kg of urea in Block 3

| Environment | Treatment Names | Plot size (m2) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest Tn/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 7.35 | 100 | 35 | 2,022 | 2.02 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 6.15 | 100 | 37 | 4,088 | 4.09 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.5276 | 100 | 40 | 4,211 | 4.21 |
| **TOTAL** | | **21.0276** | **300** | **112** | **10,321** | **10.32** |

**Source**: Primary data, October, 2020

The result in Table 4 reveal that maize yields were namely 617 kg/ha on 6 $m^2$, 1394.95 kg/ha on 7.14 $m^{2,}$ and 1531.68 kg/ha on 7.26 $m^2$, respectively. This yield showed that maize productivity was very low without the use of chemical fertilizers. This expresses that without chemical fertilizers by producing maize on the total area of 20.4$m^2$, 3,543.29 kg/ha equivalent to 3.54 tons/ha were harvested in Block 4.

**Table 4**: Results of maize without chemical fertilizers in Block 4

| Environment | Treatment Names | Plot size (m2) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 6 | 100 | 19 | 616.66 | 0.62 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 7.14 | 93.3 | 30 | 1,394.95 | 1.39 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.26 | 100 | 27 | 1,531.68 | 1.53 |
| **TOTAL** | | **20.4** | **293.3** | **76** | **3,543.29** | **3.54** |

**Source**: Primary data, October, 2020

The results in Table 5 indicated that the maize harvests were 983.55 kg/ha on 6.69 $m^2$, 412.56 kg/ha for 7.32 $m^{2,}$ and 804 kg/ha on 6.99 $m^2$, respectively. This yield showed that maize productivity was very low without the use of chemical fertilizers. In addition, without chemical fertilizers by producing maize on the total area of 21$m^2$, 2200.13kg/ha equivalent to 2.19 tons/ha were harvested in Block 5 (Table 5).

**Table 5**: Results of maize without chemical fertilizers in Block 5

| Environment | Treatment Names | Plot size ($m^2$) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 6.69 | 96.7 | 15 | 983.55 | 0.98 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 7.32 | 100 | 21 | 412.56 | 0.41 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 6.99 | 100 | 22 | 804 | 0.8 |
| **TOTAL** | | **21** | **296.7** | **58** | **2,200.11** | **2.19** |

**Source**: Primary data, October, 2020

The results of this research in Table 6 on maize harvest in Block 6 revealed that the recorded yields were 1,660.31 kg/ha on 6.3 $m^2$, 1,610.16 kg/ha on 7.08 $m^{2,}$ and 3,044.44 kg/ha on 7.2 $m^2$, respectively. However, without chemical fertilizers by producing maize on the total area of 20.58$m^2$, 6314.93 kg/ha equivalent to 6.31 tons/ha were harvested in Block 6 (Table 4.6).

**Table 6**: Results of maize without chemical fertilizers in Block 6

| Environment | Treatment Names | Plot size (m2) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 6.3 | 90 | 23 | 1,660.31 | 1.66 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 7.08 | 100 | 30 | 1,610.16 | 1.61 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.2 | 93.3 | 30 | 3,044.44 | 3.04 |
| **TOTAL** | | **20.58** | **283.3** | **83** | **6,314.91** | **6.31** |

**Source**: Primary data, October, 2020

The results of Block 7 in Table 7 on maize harvest indicated the registered yields were 3,797.22 kg/ha on 7.2 $m^2$, 4,562.84 kg/ha on 7.32$m^{2,}$ and 4,250 kg/ha on 7.2 $m^2$, respectively. However, by applying chemical fertilizers at the dosage of 100-50 DAP/urea, by producing maize on the total area of 21.72$m^2$, 12,610.06 kg/ha equivalent to 12.61 tons/ha has been harvested in Block 7 (Table 7).

**Table 7**: Results of maize with only 100-50 kg DAP/urea in Block 7

| Environment | Treatment Names | Plot size (m2) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 7.2 | 83.3 | 37 | 3,797.22 | 3.8 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 7.32 | 91.7 | 42 | 4,562.84 | 4.56 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.2 | 93.3 | 40 | 4250 | 4.25 |
| **TOTAL** | | **21.72** | **268.3** | **119** | **12,610.06** | **12.61** |

**Source**: Primary data, May 2020

The results in Table 8 indicated that the results on maize harvest in Block 8 were namely 1,801.72 kg/ha on 6.96 $m^2$, 2,750 kg/ha on 7.2$m^{2,}$ and 3,525.85 kg/ha on 7.272 $m^2$, respectively. This yield showed that the application of DAP and Urea at this dosage of 100-50 contributed significantly on maize productivity. However, by applying chemical fertilizers at the dosage of 100-50 DAP/urea on the total area of 21.162$m^2$, 8077.57 kg/ha equivalent to 8.08 tons/ha have been harvested in Block 8.

**Table 8**: Results of maize with only 100-50 kg DAP/urea in Block 8

| Environment | Treatment Names | Plot size (m2) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 6.69 | 94.4 | 46 | 1,801.72 | 1.8 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 7.2 | 97.2 | 45 | 2,750.00 | 2.75 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.272 | 100 | 41 | 3,525.85 | 3.53 |
| **TOTAL** | | **21.162** | **291.6** | **132** | **8,077.57** | **8.08** |

**Source**: Primary data, October, 2020

For Plot 9, the results in Table 9 on maize harvest indicated that the harvested maize yields were 2,254.41 kg/ha on 7.248 $m^2$, 4,201.36 kg/ha on 7.35$m^{2,}$ and 2,952.77 kg/ha on 7.2 $m^2$, respectively. This yield showed that the application of DAP and Urea at this dosage of 100-50 contributed significantly on maize productivity. After applying chemical fertilizers at the dosage of 100-50 DAP/urea on the total area of 21.798$m^2$, 9,408.55 kg/ha equivalent to 9.4 tons/ ha

were harvested in Block 9. The last three tables (13.14 and 15) are showing the results of maize harvested for each variety (Table 9).

**Table 9**: Results of maize with only 100-50 kg DAP/urea in Block 9

| Environment | Treatment Names | Plot size (m2) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH504 | 7.248 | 100 | 44 | 2,254.41 | 2.25 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | ZM607 | 7.35 | 94.4 | 40 | 4,201.36 | 4.2 |
| Fert. 100 DAP-50 Urea at planting and 50 Urea at side dress | WH505 | 7.2 | 97.2 | 44 | 2,952.77 | 2.95 |
| **TOTAL** | | **21.798** | **291.6** | **128** | **9,408.54** | **9.4** |

**Source**: Primary data, October, 2020

### 4.2 Maize variety's cumulative harvest

The results in Table 10 on the harvest of ZM 607 after using fertilizers showed the harvests of 3.43, 3.83 and 4.09 tones, respectively with a subtotal of 11.34 tones harvested on the area of 19.8978 $m^2$. The harvest without application of chemical fertilizers provided 1.39, 0.41 and 1.66 tones on the area of 20.76 $m^2$ with a subtotal of 3.46 tones harvested (Table 10). Furthermore, on the dosages of 100-50 kg DAP/urea, only 3.80, 1.80 and 2.95 with a subtotal of 8.55 tones harvested on the area of 21.36 $m^2$.

**Table 101**: C**u**m**u**lative harvest of ZM 607 variety

| Environment | Block | Plot size ($m^2$) | Maize Germination % | No. cobs harvested | Harvest kg/ha | Harvest T/ha |
|---|---|---|---|---|---|---|
| | | | **With fertilizers** | | | |
| | | | | | 3,425.92 | 3.43 |
| 100-50 kg DAP / Urea and 50 kg Urea during weeding | 1 | 6.8478 | 100 | | | |
| | | | | 34 | | |
| | 2 | 6.9 | 100 | 36 | 3,831.88 | 3.83 |
| | 3 | 6.15 | 100 | 37 | 4,087.8 | 4.09 |
| | | 19.8978 | | 107 | 11,345.6 | 11.34 |
| Sub-total 1 | | | | | 13,94.95 | 1.39 |
| | | | **Without fertilizers** | | | |
| | 4 | | 93.3 | 30 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 7.14 | | | | |
| | 5 | 7.32 | 100 | 21 | 412.568 | 0.41 |
| | 6 | 6.3 | 90 | 23 | 1,660.32 | 1.66 |
| Sub-total 2 | | 20.76 | | 74 | 3,467.84 | 3.46 |
| 100 DAP and 50 Urea only | | | | | 3,797.22 | 3.8 |
| | 7 | 7.2 | | 37 | | |
| | | | 83.3 | | | |
| | 8 | 6.96 | 94.4 | 46 | 1,801.72 | 1.8 |
| | 9 | 7.2 | 97.2 | 44 | 2,952.78 | 2.95 |
| Sub-total 3 | | 21.36 | | 127 | 8,551.72 | 8.55 |
| **TOTAL** | | **62.0178** | | **308** | **23,365.2** | **23.36** |

**Source**: Primary data, October, 2020

With regard to the maize variety WH 504, the results in Table 4.11 indicated the harvest of maize with application of chemical fertilizers on the dose of 100-50 kg DAP/urea during planting period and adding other 50 kg of urea during weeding. The findings in Table 4.11 showed the yields of 3.89, 3.17 and 2.02 tones, respectively as equivalent to 9.08 tones yielded on the area of 22.099 $m^2$ (Table 11). By only utilizing 100-50 kg DAP/ urea, the harvests of 4.56, 2.75 and 2.25 tones were harvested which sum up 9.56 tones on the area of 21.768 $m^2$ yielded (Table 11).

**Table 11**: C**um**ulative harvest of WH 504 variety

| **Environment** | **Block** | **Plot size (m2)** | **Maize Germination %** | **No. cobs harvested** | **Harvest kg/ha** | **Harvest T/ha** |
|---|---|---|---|---|---|---|
| | | | With fertilizers | | | |
| | | | | | 3,887.01 | 3.89 |
| 100-50 kg DAP / Urea and 50 kg Urea during weeding | 1 | 7.399 | 100 | | | |
| | | | | 39 | | |
| | 2 | 7.35 | 100 | 32 | 3,167.35 | 3.17 |
| | 3 | 7.35 | 100 | 35 | 2,021.77 | 2.02 |
| | | 22.099 | | 106 | 9,076.13 | 9,08 |
| Sub-total 1 | | | | | 6,16.667 | 0.62 |
| | | | Without fertilizers | | | |
| | 4 | 6 | 100 | 19 | | |
| | 5 | 6.69 | 96.7 | 15 | 9,83.558 | 0.98 |
| | 6 | 7.08 | 100 | 30 | 1,610.17 | 1.61 |
| | | 19.77 | | 64 | 3,210.39 | 3.21 |
| Sub-total 2 | | | | | 45,62.84 | 4.56 |
| 100 DAP and 50 Urea only | 7 | 7.32 | | 42 | | |
| | | | 91.7 | | | |
| | 8 | 7.2 | 97.2 | 45 | 2750 | 2.75 |
| | 9 | 7.248 | 100 | 44 | 2,254.42 | 2.25 |

| | | | | |
|---|---|---|---|---|
| Sub-total | 21.768 | 131 | 9,567.26 | 9.56 |
| **TOTAL** | **70.777** | **301** | **21,853.8** | **21.85** |

Finally, for the WH 505 maize variety, the chemical fertilizers of 100-50 kg DAP/urea during plantation and adding 50kg of urea was added as detailed in Table 4.12. This application led to the harvests of 4.34; 4.81 and 4.21 tons, respectively equivalent to 13.36 tones yielded over 22.0176 $m^2$ (Table 12). The application of DAP/urea on the dose of 100-50 kg only contributed to 4.25, 2.25 and 4.20 tons, respectively and the total harvest was 10.70 tones on the area of 21.822 $m^2$ (Table 12). The results obtained without the use of chemical fertilizers were 1.53, 0.80 and 3.04 tons.

**Table 12**: C**u**m**u**lative harvest of WH 505 variety

| **Environment** | **Block** | **Plot size ($m^2$)** | **Maize Germination %** | **No. cobs harvested** | **Harvest kg/ha** | **Harvest T/ha** |
|---|---|---|---|---|---|---|
| | | | **With fertilizers** | | | |
| | | | | | 4342.935 | 4.34 |
| 100-50 kg DAP / Urea and 50 kg Urea during weeding | | 7.29 | 100 | 29 | | |
| | 2 | 7.2 | 100 | 32 | 4813.888 | 4.81 |
| | 3 | 7.5276 | 100 | 40 | 4211.169 | 4.21 |
| | | | | 101 | 13367.992 | 13.36 |
| | | 22.0176 | | | | |
| | | | | | 1531.68 | 1.53 |
| | | | **Without fertilizers** | | | |
| | 4 | 7.26 | 100 | 27 | | |
| | 5 | 6.99 | 100 | 22 | 804.0057 | 0.8 |
| | 6 | 7.2 | 93.3 | 30 | 3044.444 | 3.04 |
| | | 21.45 | | 79 | 5380.1297 | 5.38 |
| Sub-total 2 | | | | | 4250 | 4.25 |
| | 7 | 7.2 | | 40 | | |
| Fert 100 DAP and 50Urea only | | | 91.7 | | | |
| | 8 | 7.272 | 100 | 44 | 2254.415 | 2.25 |
| | 9 | 7.35 | 94.4 | 40 | 4201.36 | 4.2 |
| Sub-total 3 | | 21.822 | | 124 | 10705.775 | 10.7 |
| **TOTAL** | | **72.4296** | | **304** | **29453.897** | **29.45** |

**Source**: Primary data, October, 2020

## 5. Conclusion

The current study was conducted to analyze the contribution of applying chemical fertilizers on maize productivity in Karongi district, western Rwanda. Field observation was undertaken to test the result son maize productivity on plots with and that without chemical fertilizers. The results

showed that chemical fertilizers could increase maize productivity comparatively to produce without them. It is noted that after within plots in which chemical fertilizers were applied, 33.79 tons per 64.95.35 $m^2$ and 30.19 tons per 64.0144$m^2$ were respectively harvested. In plots without application of chemical fertilizers, 12.04 tons per 61.98 $m^2$ were harvested. Thus, a difference of 21.75tons and 18.15 tons from plot with chemical fertilizers to plots without chemical fertilizers, respectively. It is concluded that the application of chemical fertilizers contributed to increasing maize productivity but is still limited in scope. Although the expansion of this technique may require high cost that can necessitate government effort in increasing farmers 'capacity, if adopted more significant contribution on increasing maize productivity can be expected.

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