Adaptability study on 12 rice cultivars in Rwanda-Case study of Kayonza, Gatsibo, Gasabo and Muhanga Districts

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Abstract

Field trials done have provided the opportunity to observe the adaptability level of 12 rice varieties eventually to the increased rice production and income. This study aimed at assessing the adaptability study on 12 rice cultivars in KAYONZA, GATSIBO, GASABO and MUHANGA Districts with the specific objectives to increase the agricultural productivity of organized farmers in the marshlands targeted for development in an environmentally sustainable manner; increase the farmers' income in market-based value chains activities; test the adaptability of 12 rice varieties in 4 Districts in collaboration with Rwanda Agriculture and Animal resources Board(RAB) and to contribute to the environment-friendly rice birds scaring by providing the rice varieties having capacity of self-protection in addition to the adaptability. During the study implementation, the experimentation plot in each site was set up for the trials of 12 rice cultivars to test the rice adaptability in each of the 4 Districts with the selected sites. Each sub-bloc is for one variety with 4 small equal sub-plots to differentiate the 4 different spacing (15-20, 20-20, 25-20, and 30-20) considered during the transplantation.

To collect the data relating to the production, 5 plants selected in cross position localized by fixed wooden sticks have to be considered in each sub-plot. The results of the study showed the rice cultivars with high production from 6MT and farmers themselves will make the appreciation and then select the high ranked ones to be considered for seed multiplication and finally go to the production on large scale by farmers. To monitor the production factors, the data have been collected on the number of tillers, the number of panicles, planting space impact on production, diseases resistance, and then resulting production by each variety with different planting space (15-20, 20-20, 25-20 and 30-20).

Key words: Adaptability, productivity, cultivars, experimentation plot, planting space.

1. Introduction

Rice is the seed of two grass species of the family Oryza, one from Asia and one from Africa. Rice is one of the most widely consumed grains in the world and a substantial portion of the diet of many Asian countries, where it is grown extensively. Rice has been cultivated for centuries, even though it is very labor-intensive and requires substantial water and warm, humid weather conditions to grow. The most common method of cultivating rice is to flood fields (often called paddies) with water after sowing seed to provide hydration and deter pests and weeds. Rice can be grown practically anywhere where weather conditions are appropriate, even on a steep hill or mountain with the use of water-

controlling terraces. Worldwide, rice is the agricultural commodity with the third-highest worldwide production, with about 761.5 million tonnes (1,000 kilograms) produced in 2018. Rice is produced in about 120 countries worldwide, but China (about 214 million tonnes) and India (about 173 million tonnes) together account for more than 50 percent of both rice production globally. Nine of the top 10 and 13 of the top 20 rice-producing countries in the world are in southeast Asia

Rwanda is a hilly country and between each of the hills there are streams and marshlands. Rwanda's economy and poverty reduction efforts depend primarily on the agricultural sector and particularly food crops. Currently, agriculture sector, contributes 28% of the national GDP in the 2nd quarter of 2019 as compared to 16% in 2012. This contribution underpins the GoR's concerted efforts to maintain and increase the impressive performance of the agricultural sector, upon which poverty reduction relies. Agriculture is simultaneously the vehicle for raising rural incomes and spurring on progressive development in the secondary and tertiary sectors. Rice was introduced in Rwanda in 1960s by various missionaries from South Korea, Taiwan and the People's Republic of China (PRC). Since then, rice has become one of the major food crops grown in Rwanda. Conforming to Rwandan geographic conditions, rice is grown mostly in inland valley swamps referred to as marshlands. It has emerged as the most suitable and profitable crop for smallholder farmers in the marshlands and inland valleys in recent years. Several reasons justify this recent shift in cultivation habit (Rwanda-NRDS, 2021 – 2030).

Rice has been identified and promoted as one of the 'priority food crops' in Rwanda, because it allows better use of existing land in marshlands and reduces pressure on lands located on hillsides. Rice production is considered as one of the profitable enterprises for smallholder farmers as regards the utilization of the hydro-agricultural investments laid out. The production of rice in the country takes place mostly in marshlands in the Western, Southern and Eastern Provinces. Rwanda has tried to maximize the gains by strategically expanding marshland areas for rice production. Yet the local rice supply is not sufficient to meet local demand, which means rice import is still needed. Rwanda has 501,509 ha of irrigation potential that is divided into six (6) domains depending on water abstraction, where 123,164ha (24.6 %) is of marshland potential (Irrigation Master Plan, 2020).

2. Materials and methods

2.1 Description of study area

The study was carried out in four District of Rwanda notably KAYONZA District in Rwinkwavu site, GATSIBO District in Kanyonyomba upper site, GASABO District in Ruzigambogo site and MUHANGA District in Ruterana site. The reason for selecting these sites, was due to RCSP project working area where farmers have irrigation infrastructures for rice cultivation, and then having the basic knowledge on rice cultivation but really have the seed availability problem to enable the rice seasonal variety rotation. The other reason was the fact that it was to see the impact of different ecological area to the same rice varieties to get the adaptive ones.

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2.1.1. Geographical location of the study area

1. Rwinkwavu site

Rwinkwavu site was one of the RCSP Project sites located in eastern Province, Kayonza District and lies between Mwiri, Gahini and Rwinkwavu sectors. It is located at agro-climatic zone of eastern savanna characterized by; rolling grassland with scattered trees and shrubs, short period of rain and long dry seasons and often large herds of grazing animals on the savanna that thrive on the presence of grass and trees. The project beneficiaries in Rwinkwavu site are made up of 3,152 households (1,605 males and 1,547 females). All beneficiaries belong to one cooperative and one Water Users Association (WUA). A total area in lower marshland developed by RCSP is on 462ha.

Figure.1. (Rwinkwavu) Satellite map of marshland development

1. Kanyonyomba Upper site

Kanyonyomba upper site was one of the Rural Community Support Project (RCSP) intervention sites across the country. The site is located in Gatsibo District, Eastern Province at about 2 hours' drive from Kigali. The Project site covers the sectors of Remera, Muhura, Rugarama and Kiziguro. The site has 574 Farmers' households (339 males and 235 females), organized into 54 Self Help Groups (SHGs) spread across 10 zones.

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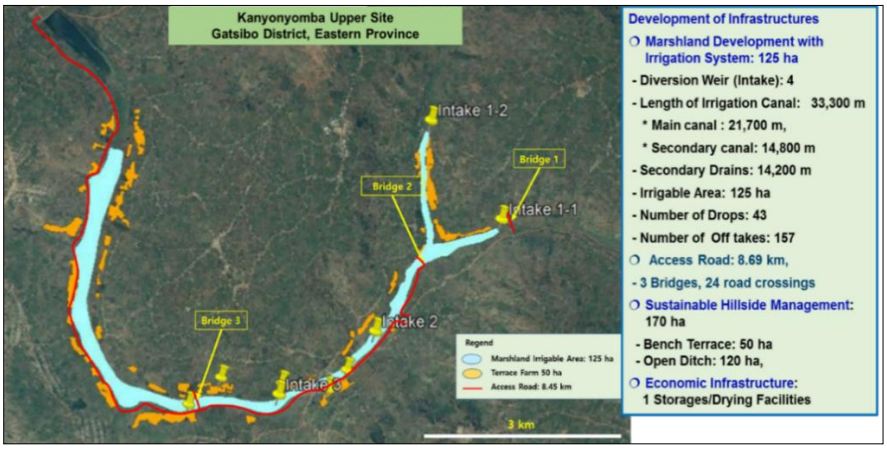

Figure.2. (Kanyonyomba) Satellite map of marshland and hillside development area

2. Ruzigambogo site

Ruzigambogo site was one of the Rural Community Support Project (RCSP) intervention sites countrywide and it is a project funded by Republic of South Korea through Korea International Cooperation Agency (KOICA) to support the Government of Rwanda to achieve its strategic goals of economic transformation whose main focus is to unlocking rural growth in order to increase agricultural production, increase beneficiary farmers' income, reduce poverty and improving living conditions. The site is located in GASABO District; at about 1 hour drive from Kigali. The Project site covers the sectors of GIKOMERO and Fumbwe of RWAMAGANA District. The site benefited 499 farmers' households (355 males and 144 females), organized into 24 Self Help Groups (SHGs) spread across 8 zones.

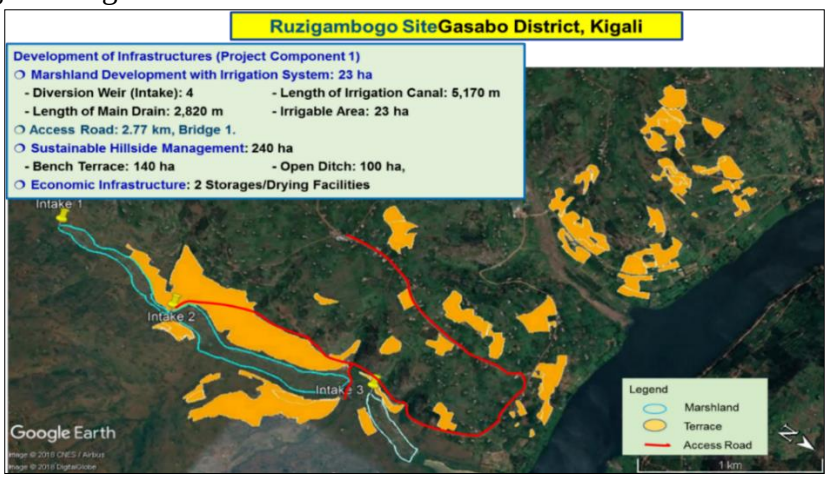

Figure.3. (Ruzigambogo): Map of marshland and hillside (terrace farm) development area

3. Ruterana site

Ruterana site is one of the RCSP intervention sites countrywide. The site is located in Muhanga District, Southern Province at about 3hours drive from Kigali City. The Project site covers the sectors of Rongi (Gasagara and Karambo cells) and Kiyumba (Rukeri and Ruhina cells).

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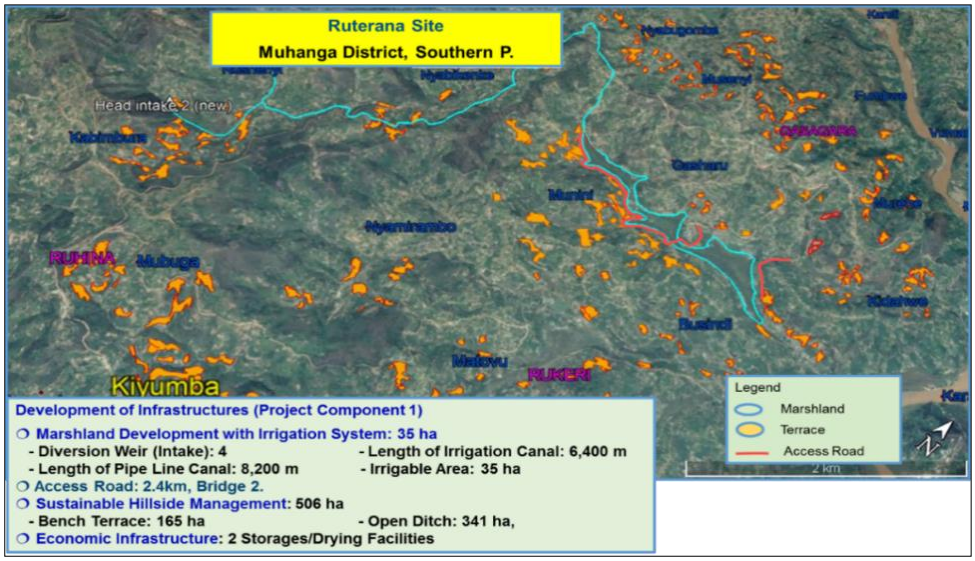

Figure.4. (Ruterana) Satellite map of marshland and hillside development area location

2.1.2. Sampling frame

The sampling frame for this study involved 4 rice experimental plots in total, where each site has one experimental plot of 10Ares.

Table.1: Sampling frame

Sites	*Province*	*Marshland Area(Ha)*	*Nb. of experimental plots*	*Plot Size/1plot(ha)*
Rwinkwavu	Eastern	462	1	0.1
K.U	Eastern	42.5	1	0.1
Ruzigambogo	Kigali-city	16	1	0.1
Ruterana	Southern	48	1	0.1
Total		568.5	4	0.4

2.1.3. Sampling unit

The sampling unit for this study constituted an experimental plot of 10 Ares per 1 plot where each variety has the bloc of $40m^2$, with 4 sub-plots for 4 different spacing during transplanting.

2.1.4. Data collection instruments

The data were collected on 5 representatives with 5 fixed wooden sticks in each sub-plot and the data to be collected were based on:

i. Number of tillers
ii. Number of panicles

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iii. Disease incidence (blast &rice yellow mottle virus: RYMV)
iv. Production period per cultivar
v. Yield per sub-plot
vi. Productivity per cultivar
vii. Appreciation by rice cultivar

3. Results and discussion

3.1. Introduction

This section provides results and discussions of the findings according to the objectives of the study. These objectives included:

- To analyze the adaptability of 12 rice cultivars in the study areas;
- To assess the rice productivity factors in the study area;
- To study the extent at which rice cultivars improved the productivity.

3.2. Adaptability of rice cultivars

The 12 rice cultivars cultivated in all 4 sites have behaved some differently but other looked similar in terms of period of production, resistance on diseases and same production yield after harvesting. Considering each site, the resulting yield vary of cultivar to the other and the adaptive ones in season A 2022 have given good production beyond 5.5MT/ha and the diseases appearing did not be observed.

3.2.1. The production steps during the experimentation

The rice cultivation stages including the preparation of field, seed selection and nursery-bed preparation, field maintenance, harvesting, threshing and winnowing have been done successfully in all sites during season A 2022. The rice cultivars cultivated are the basic seeds bought from Rwanda Agriculture Board (RAB). Some pictures below summarize the main activities done during the production period in different research sites.

The table below summarizes the production results for the adaptive cultivars on each site and then compare the sites for the purpose to give idea to the effect of different environmental areas which behave differently.

3.2.2. The rice cultivars diseases observed during the conducted experimental research

Rwinkwavu site:
The 3 cultivars named Basmati, Gwiza and Johnson showed the diseases symptoms especial the rice yellow mottle virus (RYMV) on Basmati with the incidence of 62% and Johnson with the incidence of 92%. The rice blast appeared on Gwiza cultivar with incidence of 0.5%.

Kanyonyomba Upper site:
The 5 cultivars showed the diseases symptoms where 3 of them named Basmati, Johnson and Muturage had at the same time Blast and RYMV; Neri-25 showed the RYMV (0.5%) and Gwiza the blast at 0.5%.

Ruzigambogo site:
The 5 cultivars out of 12 showed the diseases symptoms where 1 of them presented RYMV symptoms (Cyuzuzo, 5%) and 4 remaining have presented the blast(10% Umutebo; 15% Neri-25; 50% Basmati and 95% Gwiza).

Ruterana site:
The 3 cultivars out of 12 showed all the blast diseases symptoms (Cyuzuzo, 10%), (Umutebo, 20%) and (V-30, 20%).

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Generally, the long grain rice cultivars are sensitive to the diseases than the short grain varieties, and during this research at least 4 long grain cultivars did not show any disease symptom in all the sites of study.

3.3. Discussion of the results

- The Umutebo rice cultivar is more productive in Rwinkwavu site with 8.3MT/ha and other sites is less production;
- Cyuzuzo rice cultivar is more productive in Rwinkwavu site with 8.2 MT/ha and other sites is less production but failed in Ruterana site;
- Neri-25 cultivar is more productive in Ruzigambogo site with 7.5 MT/ha and other sites is less production but failed in Ruterana site;
- Muturage cultivar is more productive Kanyonyomba Upper site with 10.5 MT/ha and other sites is less production but failed in Ruterana site;
- Basmati has failed in all sites;
- Gwiza cultivar responded well only in Kanyonyomba Upper and failed in 3 remaining sites;
- Rumbuka cultivar gave good production yield in three sites except Ruterana where it has failed;
- Ganza cultivar has only performed in Rwinkwavu and Kanyonyomba Upper site and failed in Ruzigambogo and Ruterana sites;
- Johnson cultivar gave less production in all three sites with 4.2M/ha(Rwinkwavu site), 3.7MT/ha(Kanyonyomba Upper site), 4.2MT/ha(Ruzigambogo site) and 3.8MT/ha(Ruterana site).

Table.2.Production results in 4 sites

Cultivars	Planting-space	Rwinkwavu	K.U	Ruzigambogo	Ruterana
Umutebo	15-20	8.3		6.2	5.9
	20-20		6.7		
	25-20				
	30-20				
Kibondo	15-20			6.7	
	20-20	8.5			x
	25-20		6.4		
	30-20				
Cyuzuzo	15-20			6.7	
	20-20	8.2	7.4		x
	25-20				
	30-20				
Neri-25	15-20				
	20-20		6.6		x
	25-20	6.7			
	30-20			7.5	
Muturage	15-20	9.2			6
	20-20		10.5		
	25-20				
	30-20			7.5	
Gwiza	15-20	x	6.4	x	x

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	20-20				
	25-20				
	30-20				
Yun er tiane	15-20			9.2	
	20-20	9.6			5.8
	25-20		9.7		
	30-20				
Rumbuka	15-20				x
	20-20	9.6	20	7.5	
	25-20				
	30-20				
V-30	15-20	7.5		8.3	5.6
	20-20		10.5		
	25-20				
	30-20				

Ganza	15-20	6.2		x	X
	20-20		10.5		
	25-20				
	30-20				

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The following figure show the rice cultivars production yields in 4 sites of study and the variation from one site to the others:

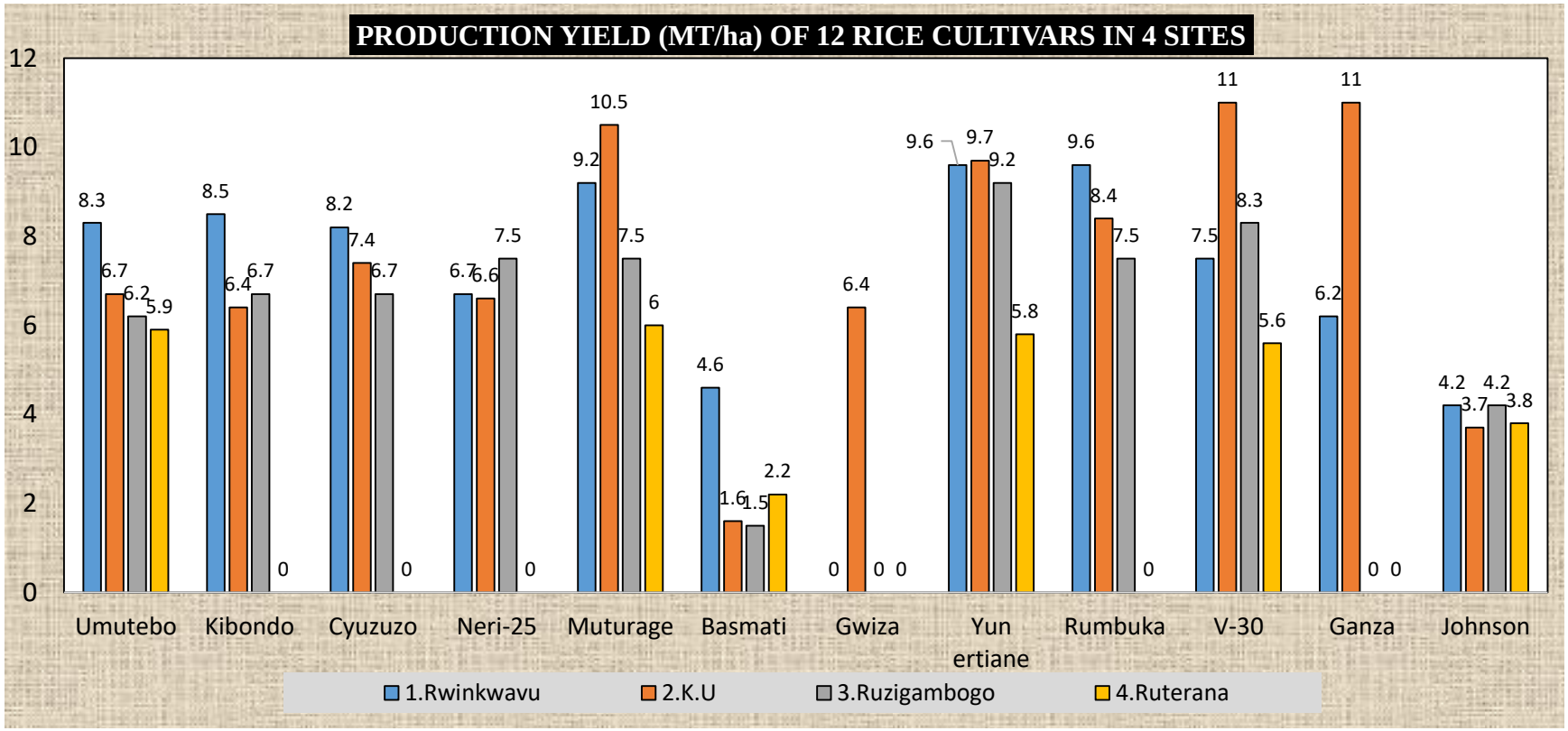

Fig.5. Production yield of 12 rice cultivars in 4 sites

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4. Conclusions

The rice cultivars have been tried in four different areas to assess their role to the improvement of productivity during season A 2022 and it was observed specific results to each site, showing the environmental effect to the multi-location areas on productivity.

4. 1. The adaptability of 12 rice cultivars in four sites

- The production results of 12 rice cultivars, only 4 cultivars were productive in all sites of different Districts such as Umutebo, Muturage, Yun er tiane and V-30. Considering the planting space, it depends on the type of land of different sites and the yields may consequently be different due to the different type of land. Practically, one cultivar may be high productive to one site and less productive in the other as it is presented in the following table.
- One cultivar named Ganza has only performed in Rwinkwavu site/Kayonza District and failed in the other sites of Kanyonyomba upper, Ruzigambogo and Ruterana:
- One cultivar named Gwiza has only performed in Kanyonyomba Upper site/Gatsibo District, and failed in the other sites of Rwinkwavu, Ruzigambogo and Ruterana.
- Four cultivars such as Kibondo, Cyuzuzo, Neri-25 and Rumbuka have been successful in all sites except Ruterana site:
- Rumbuka and Muturage cultivars have shown the speciality to be self-protective due to the erect leaves:

4.2. Rice productivity in the study areas

The four sites have been developed by Rwanda Government through RCSP project and the irrigation infrastructures are in place. The selected sites have the marshlands where farmers grow rice, but the productive cultivars to facilitate the seasonal rotation are not there and it is the role of this research to provide them after trial.

The productivity for the adaptive rice cultivars selected in 4 sites are:

- **Rwinkwavu site: 9 adaptive cultivars were selected and they are**

  Umutebo (8.3MT/ha); Kibondo (8.5MT/ha); Cyuzuzo (8.2MT/ha); Neri-25(6.7MT/ha); Muturage (9.2MT/ha); Yun er tiane (9.6MT/ha); Rumbuka (9.6MT/ha); V-30(7.5MT/ha) and Ganza (6.2MT/ha).

- **Kanyonyomba Upper site: 10 adaptive cultivars were selected and they are**

  Umutebo (6.7MT/ha); Kibondo (6.4MT/ha); Cyuzuzo (6.7MT/ha); Neri-25(6.6MT/ha); Muturage (10.5MT/ha); Yun er tiane (9.7MT/ha); Rumbuka (8.4MT/ha); V-30(11MT/ha); Gwiza (6.4MT/ha) and Ganza (6.1MT/ha).

- **Ruzigambogo site: 8 adaptive cultivars were selected and they are**

  Umutebo (6.2MT/ha); Kibondo (6.7MT/ha); Cyuzuzo (8.2MT/ha); Neri-25(7.5MT/ha); Muturage (7.5MT/ha); Yun er tiane (9.2MT/ha); Rumbuka (7.5MT/ha) and V-30(8.3MT/ha).

- **Ruterana site: 4 adaptive cultivars were selected and they are**

  Umutebo (5.9MT/ha); Muturage (6MT/ha); Yun er tiane (5.8MT/ha) and V-30(5.6MT/ha).

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- The trials have been done in season A 2022, and it should be better to the respective cooperatives to repeat same trials in season B 2022 to be sure and confirm the results from SA 2022;
- The planting spaces influence the yielding and the most farmers don't put attention on this which leads to reduction of the productivity and with this trials cooperatives have to consider the planting space which is more productive;
- The selected cultivars considered as adaptive should be well treated as they will be re-used in the next trials and even seed multiplication to enable farmers starting the production with them.

Conflicts of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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