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Performance Evaluation of Upland Rice (*Oryza Sativa L.*) cultivars in Three Agro-Ecological Zones Of Rwanda

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Abstract

The rice crop has a wide range of environmental adaptation, ranging from upland, deep, intermediate and shallow water rice. In Rwanda, rice is almost produced in lowland ecosystem. There is no reported attempt done on upland rice before this report. That is why this study was conducted to identify rice genotypes which can get adapted in various agro-ecological sites for upland rice cultivation. The study was conducted in three sites namely Rulindo, Rugende and Rubona in Rwanda. The field trials were laid in a randomized complete block design with three replications. All three trials were conducted from January 2022 up to when?2023 wherein ten upland cultivars were used. According to the growth and yield results obtained from three different agro ecological sites, CAVM5 cultivar showed high performance on different parameters such as plant height (94.6cm), number of tillers per plant (23), and grain yield (3345.5kgha^{-1}) compared to the rest of the cultivars. The second cultivar was CAVM 7 got an average of 29.40 tillers per hill, and 96cm height and an average of 3,272.7kgha^{-1}. The worst was CAVM10 with an average of plant height (46.8cm), number of tillers per plant (19.8), and grain yield (836.4 kgha^{-1}). The results obtained from this long-term research will help researchers to breed for drought/cold tolerant & high yielding genotypes, high quality and nutrient- rich upland rice in Rwanda.

Keywords: Upland rice, adaptability, growth, performance

Introduction

Rice (*Oryza sativa* L.) is one of the most essential food crop for nearly half of the world's population (Sellamuthu et al 2011, Garris et al 2005). Rice is an important crop which supplies staple food for nearly 50% of the world population (). Globally, rice is cultivated on an area of 154 MHa with an annual production of 700 MT (FAO 2011). . Among the most cultivated cereals on the globe, rice ranks as second to wheat (Abodolereza & Racionzer, 2009). Rice occupies a unique position in many nations because of its importance in traditional diets and the main source of income of many people in the whole world.

Upland rice cultivation is a rice cultivation system that requires the usage of rainfall and less water during irrigation. In this type of cultivation, rice is directly planted in aerobic soil without creating a puddle. Then supplementary irrigation and fertilizers are used to grow high-yielding rice crops. Upland rice cultivation can be done in upland areas where land is flat and deep soils which are capable of supplying water to the crop between rainfall. It is a method based on direct seeding and/or seedlings raised from nursery. This method permits to grow other crops such as dwarf beans, cabbage, spinach, cauliflowers and any other leafy vegetables.

Upland rice cultivation does not require huge amounts of water and is not a labour-intensive process when compared to traditional methods. Water shortage is expected to be severe by 2025, making management of the limited water for varied uses difficult. Thus, Aerobic Rice Cultivation is a long-term sustainable rice production strategy that addresses water shortages and environmental concerns caused by global warm water.

Upland rice is important for sustainable crop production because it can be used to meet future food demands. In Rwanda, rice cultivation is limited to marshland areas which are also occupying less space as Rwanda is a country of thousand hills. The increase in area planted with wetland rice cultivars is being constrained by the water shortage caused by climate change. On one side, rice production is a large contributor to climate change by being a high-water consumer and the largest greenhouse gas producer. In fact, it is estimated that rice production consumes more than 65% of the available agricultural irrigation water (Li et al., 2016). and produces around 12% of global methane emissions (Waalewijn et al. 2022). On the other side, rice is the most vulnerable crop to climate adverse effects. Extreme weather events such as drought and high temperatures, alone or in combination, have shown to be very detrimental to rice production that may lead a total yield loss (Mukamuhirwa et al. 2019).

While upland rice cultivation occupies 11% globally and 20% in East African countries, it only occupies 0.1% in Rwanda. Rice production in Rwanda is limited to marshland areas which are also occupying less space as Rwanda is a country of thousand hills. The adoption of upland rice cultivation in Rwanda will expand the area under rice cultivation and thus, will increase the quantity of locally produced rice and then cuts on rice importations. Moreover, the upland rice cultivation will contributes to reduction of methane gas emission caused by continuous

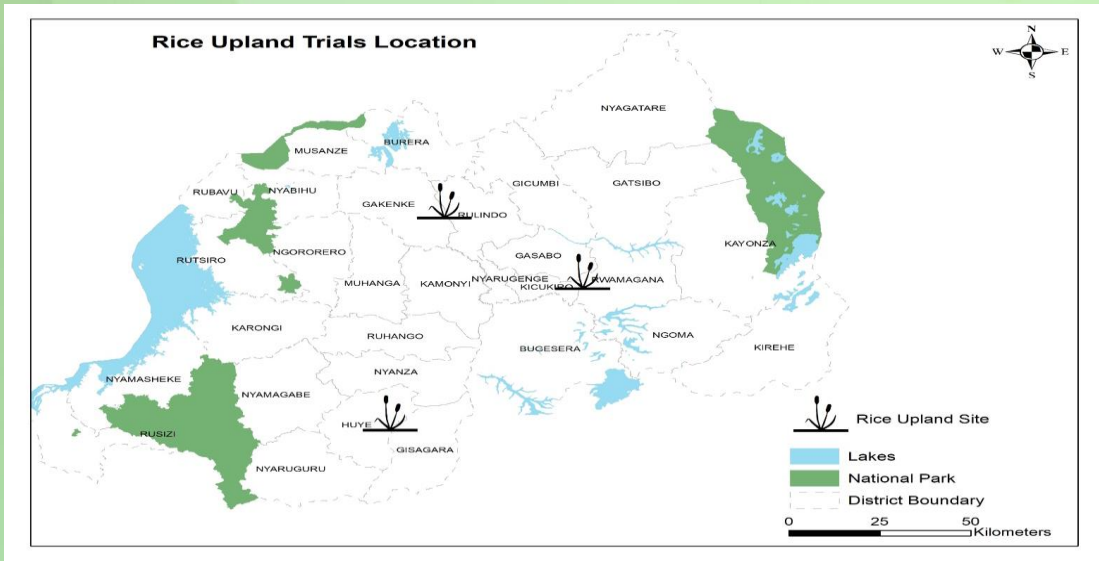
standing water in flooded rice. However, there is no information on rice cultivars that are best adapted to Rwanda agro-ecological conditions. Hence, the present research was undertaken to evaluate the adaptability and performance of ten upland rice cultivars with the specific objectives of evaluation and selection of the best high yielding and early maturing upland rice cultivars.

Materials and Methods

Experimental site description

The three Agro ecological zones that hosted the trials were selected based on they representativity of the agro-ecological zones where rice is grown. The experiments were conducted at:

- Rugende site in the lower altitude regions of 1374m in the Eastern region of Rwanda in Rwamagana District
- Rubona site located at 1687m in the middle altitude in the Southern Rwanda in Huye District
- Rulindo site is situated in the higher latitude regions at 1778m, Nothern region of Rwanda. in Rulindo District.



Map: Upland rice trials locations in Rwanda

Plant materials and experimental design

This study comprised ten (10) cultivars i.e., CAVM1, CAVM2, CAVM3, CAVM4, CAVM5, CAVM6, CAVM7, CAVM8, CAVM9 and CAVM10. Those materials were planted in the field using randomized complete block design (RCBD) with three replications at each site for a period of 4 years starting from 2019 rainy season since it was grown under rainfed system with a protective irrigation. Each experimental plot had an area of 6 m^2 with 3m length and 2 m width separated by a distance of 1 m between blocks and 0.5m between plots within a block. A spacing of 25 cm between rows was maintained. A seeding rate of 70 kg/ha was used for all treatments. All plots were fertilized uniformly at the rate of 100 kg/ha Urea and 100 kg/ha DAP. All DAP and one third of Urea was applied at planting. The remaining two third urea were divided in to two and applied at mid tillering and panicle initiation (near flowering) stages of the crop. All other cultural practices were applied uniformly to all plots as per package of practices of this rice crop.

Data collection

Simple random method was used to select the samples on which data had to be collected. Ten rice plants were sampled from 30 central rice plants. Data were collected on plant height and number of tillers on monthly basis. Rice Grain yield (kg ha^{-1}) were recorded after harvesting time.

Results and Discussion

During 4 years of data collection in this research three varieties namely CAVM 1, CAVM 5 and CAVM 7 have shown high level of adaptability & performance in terms of growth parameters across the three agro-ecological zones of the country (Rulindo, Rugende and Huye) whereas the cultivar CAVM10 was the shortest and with fewer number of tillers $hill^{-1}$ The cultivar CAVM 7 was the tallest (96cm) and developed 29.40 tillers per hill, followed by the cultivar CAVM 5 with94.6cm of plant heigh , and 23 tillers per hill; and the cultivar CAVM 1 85.30cm of plant height and 25.30 tillers per hill.

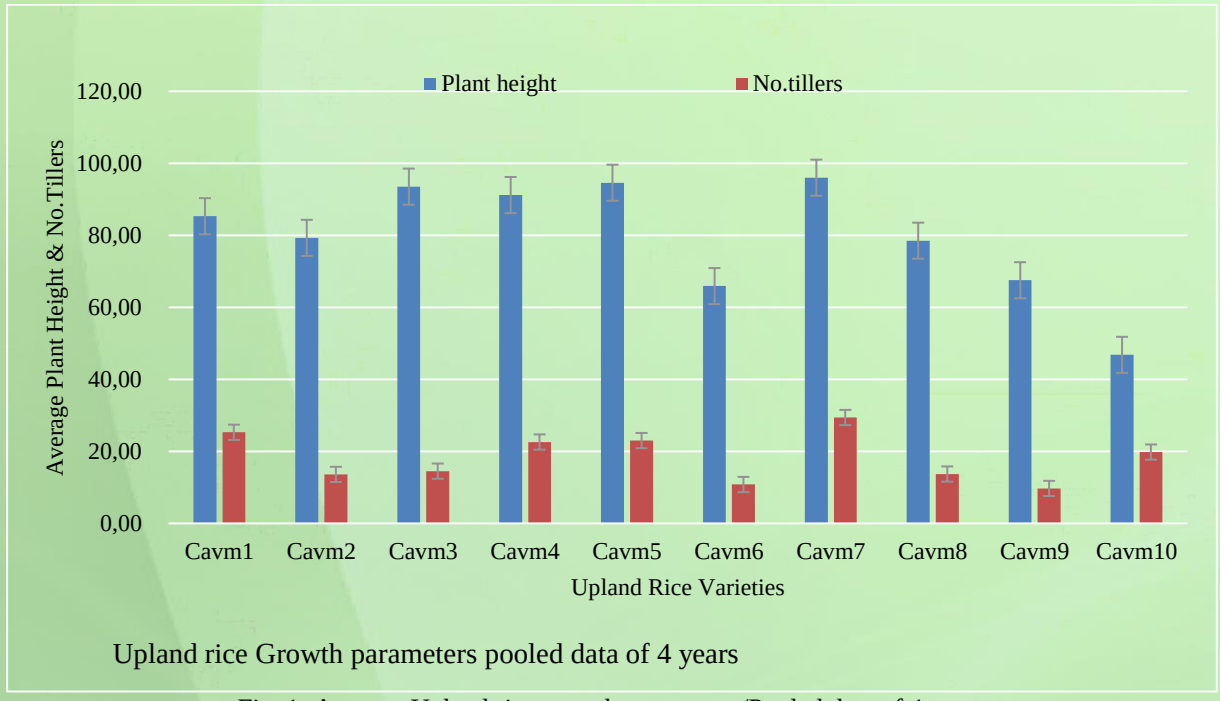


Fig. 1: Average Upland rice growth parameters/Pooled data of 4 years

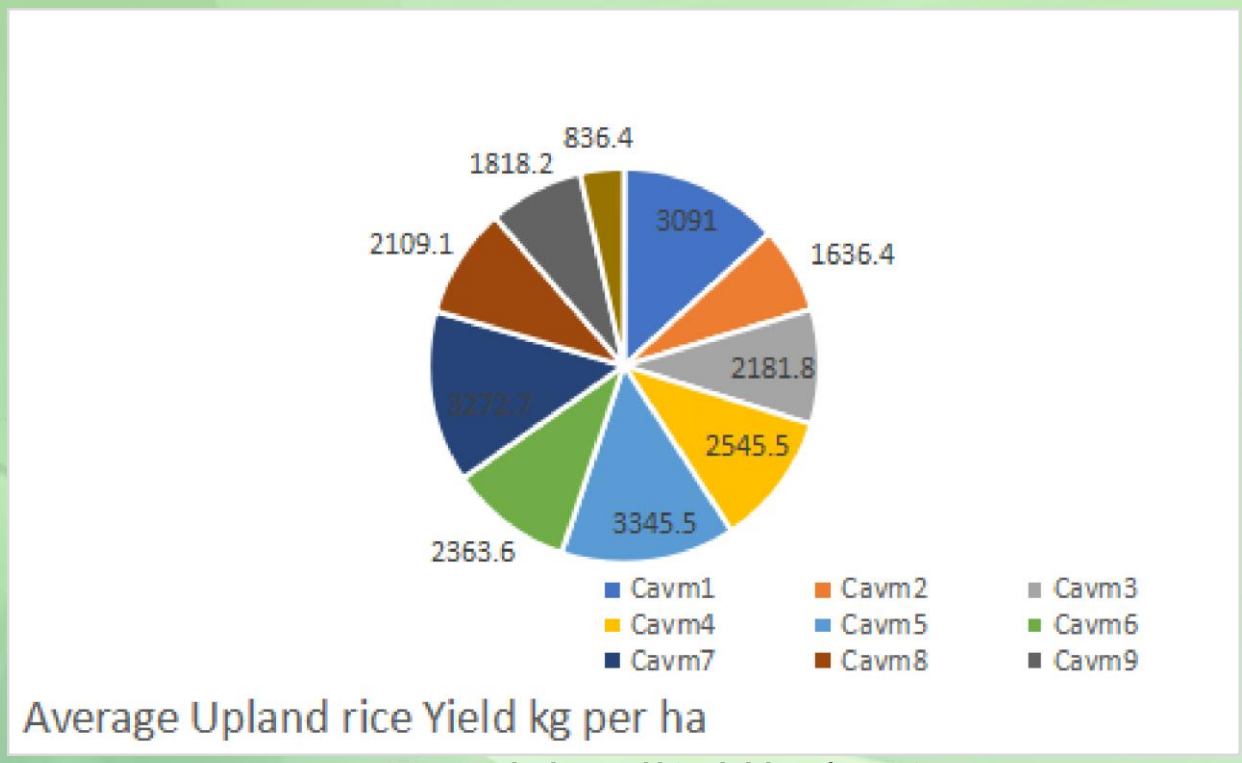


Fig. 2: Average Upland rice yield (pooled data of 4 years)

During 4 years of data collection in this research three varieties namely CAVM 1, CAVM 5 and CAVM 7 have shown high level of performance in terms of Yield across three agro-ecological zones of the country (Rulindo, Rugende and Huye sites compared to the rest 7 upland rice varieties as shown in figure 2:
The cultivar CAVM 5 got an average of 3,345.5 kg per hectare.
The cultivar CAVM 7 got an average of 3,272.7 kg per hectare.
The cultivar CAVM 1 got an average of 3,091 kg per hectare.

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Conclusion

During four years of this study, three best performing upland rice genotypes were identified across three agrozones of Rwanda. Since this is the new rice cultivation system in Rwanda, farmers can start adopting this new rice cultivation systems while the researchers will be working on breeding the adapted ones for drought/cold tolerant & high yielding, high quality and nutrition purpose on upland rice in Rwanda.

Reference

Abodolereza A, Racionzer P. 2009. Food Outlook:Global Market Analysis, pp: 23-27

FAO (2011) The State of Food Insecurity in the World.

Garris AJ, Tai TH, Coburn J, Kresovich S, McCouch S. 2005. Genetic structure and diversity in *Oryza sativa* L. Genetics 169(3): 1631-1638.

Sellamuthu R, Liu GF, Ranganathan CB, Serraj R.2011. Genetic analysis and validation of quantitative trait loci associated with reproductive-growth traits and grain yield under drought stress in a doubled haploid line population of rice (*Oryza sativa* L.). Field Crops Research 124: 46-58.