Volume 4 • Issue 3 • 2022

Research Article

Journal of Agriculture and Aquaculture

On-farm Evaluation of Agronomic Management Practices on Yield of Upland Rice in Kaffa zone

Merkine Mogiso*

Hawassa Agricultural Research Center, South Agricultural Research Institute

***Corresponding Author:** Merkine Mogiso, Hawassa Agricultural Research Center, South Agricultural Research Institute.

Received: May 16, 2022; **Published:** May 28, 2022

Abstract

Rice is commonly produced without the application of any fertilizer nutrient in the southwestern parts of Ethiopia. However, the previous research results indicated the high response of rice crops to the application of N fertilizer nutrients in different soil and environmental conditions in Ethiopia. Improved management practices are important to enhance the growth, development, and yield of upland rice. A field experiment was conducted at "Choba" on-farm during 2019 and 2020 at Gimbo district in Kaffa zone, South-west Ethiopia to evaluate agronomic management practices on rice yield and profitability. RCB design was carried out with three replications. Treatments consisted of the improved management practices with Suparica-1, improved management practice with local cultivar, Farmers' practice with Suparica-1, and farmers' practices with local cultivar. The agronomic management practices significantly (p<0.05) affected the studied parameters. Based on the results, improved management practices using improved variety produced the highest grain yield of 4516.0 kg ha-1as compared to the local cultivar with the same management practices. Both local and improved varieties showed good performance under improved agronomic management practices. The economic profitability of this study was also carried out. Based on both yield and economic profitability, growing improved variety with improved agronomic management practices was found to be appropriate practice. Therefore, the promotion and popularization of improved variety must include all the production packages that were recommended during the variety release.

Keywords: *Grain yield; Agronomic management; Economic benefit*

Introduction

Rice (Oryza sativa L.) is the most widely produced and consumed food for a large part of the world's human population, most importantly in developing countries (Seck et al., 2012). It has also become a priority commodity for food security in Africa and has grown over 75% of the African countries with a total production of 14 million tons and 16 million metric tons of consumption annually (MoARD, 2010). At present rice is gaining the same importance as some of the most common cereal crops for both domestic consumption as well as market use in Ethiopia. Currently, it is the most crucial blending crop for enjera preparation in different parts of Ethiopia. The national production area in 2019 was approximately 57 thousand hectares with 170 thousand tonnes of paddy rice with an average yield of 2.96 tonnes per hectare. The production area of rice in Ethiopia increases from 29 to 90 thousand hectares from 2010 to 2019 (FAOSTAT, 2019). It indicates the rapid distribution of rice production to different parts of Ethiopia as a staple food crop. The highest grain yield recorded in research plots was 5.4 t ha^{-1} in Ethiopia (Tadesse, 2015). However, the national productivity of the

Citation: Merkine Mogiso. (2022). On-farm Evaluation of Agronomic Management Practices on Yield of Upland Rice in Kaffa zone. *Journal of Agriculture and Aquaculture* 4(3).

crop is still far below the potential of the crop in major rice-producing countries; 4.0 t ha^{-1} in India, 5.1 t ha^{-1} in Indonesia, 5.9 t ha^{-1} in Vietnam, and 7.0 t ha^{-1} in China, and 8.8 t ha^{-1} in Egypt.

The lowlands of Gimbo in the Kaffa zone are one of the potential areas for rice production, mainly in rain-fed upland ecology. The crop plays an important role for farmers in the area, used as food for home consumption and income source. Bonga Agricultural Research Center has been conducting several variety improvement trials on rice so far. Consequently, several released varieties were evaluated and the best varieties were identified and recommended for production. However, the productivity of these varieties have been declining gradually due to the use of poor management practices. Therefore, it is necessary to study the effect of agronomic management practices on the yield performance of local and improved upland rice varieties to determine and promote the best practices in the area.

Materials and Methods

Description of the experimental site

The field experiment was conducted at Choba kebele in the Kaffa zone. Choba is located about 53 kilometers far away from the town of the district, Gimbo. The study area represents the lowland agroecology of the district. It is situated at 07° 24' N latitude and 36° 26' E longitude at an elevation of 1430 meters above sea level. Mean monthly values are in the range of 125-250 mm. The mean temperature ranges from 18.1 to 21.4°C. The soil type is characterized by Vertisols (BoNRD, 2018).

Materials Used for the Experiment

NPS (48% P_2O_5, 19% N, and, 5% S), and Urea (46% N) were used as inorganic P_2O_5 and N sources.

Planting Material

The improved rice variety Suparica-1 and local cultivar were used as a test crop.

Treatments and Experimental Design

The experiment was conducted during the main cropping seasons of 2019 and 2020. Treatments consisted of improved management practices with Suparica-1, improved management practice with local cultivar, Farmers practice with Suparica-1 and farmer's practices with local cultivar. Improved management practices used were growing of suparica-1 with row spacing of 2.5cm, seed rate of 80 kg ha^{-1}, three times tillage, three times weeding, application of fertilizers at the rate of 100 kg NPS and 100 UREA per hectare and farmer's practices were growing local cultivar sowing with broadcasting, using unfixed seed rate, till twice, weed once with herbicide application and without fertilizer application. The rate and time fertilizer application for improved management practices were done as per the recommendations. The experiment was laid out in a randomized complete block design replicated three times considering farmers as replication. A large plot size of 5 m x 10 m area was used.

Data Collection and Measurements

Growth parameters

Plant height: was determined by measuring the length of ten randomly selected sample plants from the ground level to the tip of the panicle in each plot at physiological maturity.

Panicle length: done by measuring the length of the panicle from the node where the first panicle branch emerges to the tip of the panicle and determined from an average of ten randomly selected plants per plot.

Yield and yield components

The number of tillers (both productive and unproductive) per m^2: The numbers of tillers were determined by counting the tillers from an area of 0.5 m x 0.5 m row plants by using a quadrant in each plot and then converting to a square meter area.

The number of panicles per m^2: The number of panicles was determined by counting the panicles from an area of 0.5 m x 0.5 m row plants of each plot and then converted to a square meter area.

The number of total spikelets per panicle: The number of spikelets was determined by counting all spikelets (filled and unfilled) from ten randomly selected panicles of ten sample plants in each plot and averaged.

The number of filled spikelets per panicle: The number of spikelets was determined by counting only filled spikelets from ten randomly selected panicles of ten sample plants in each plot and averaged.

Thousand-grain weight: was determined by weighing randomly drowned 1000 grains of the well-developed, whole, or undamaged grains and then adjusted to 14% MC.

Grain yield: grain yield was determined by harvesting the rice crop from the plot area, threshed, cleaning, and weighing using an electronic balance, and then adjusted to 14% moisture content.

Statistical Analysis

The collected data were subjected to analysis of variance (ANOVA) using proc Anova procedures of SAS version 9.3 (SAS Institute, 2002-2010). The treatment means of significant treatment effects were compared using the Least Significant Difference (LSD) test at a 5% probability level (p<0.05).

Partial Budget Analysis

It was performed using the average grain yield to detect economically gainful management practices. The yields of all treatments were adjusted downward by 10% to reflect possible lower yields expected by the farmers due to differences in management factors. The price of seed was ETB 12 and 15 per kg for local and improved variety, respectively. The local wage rate was ETB 70 per person per day was considered under variable costs. The farm gate price of grain was ETB 10 and 12 per kg for local and improved variety, respectively. A gross farm gate benefit was obtained by multiplying adjusted yield (kg ha^{-1}) with farm gate price (ETB kg^{-1}); while the marginal rate of return for each treatment was calculated as change of benefit divided by change of cost and multiplied by 100 CIMMYT. 1988. However, economic advantages were determined by arranging treatments in order of increasing costs and then considering MRR between each treatment. Finally, the treatment with the highest MRR was recommended for production.

Results and Discussion

A combined analysis of variance showed a significant (p<0.05) difference among treatments for grain yield and other parameters studied (Table 3). The highest grain yield (4516.0 kg ha-1) was recorded for improved variety under improved agronomic management practices. However, the lowest grain yield was recorded both for improved variety (2534.8 kg ha-1) and local cultivar (2954.0 kg ha-1) when grown under farmers' management practices. On the other hand, both the local cultivar and improved variety performed well under improved agronomic management practices. The local cultivar grown under improved management practices gave a 24.5% yield advantage over farmer's practices. However, improved variety showed poor performance under farmer's practices, which had a 14.2% of yield reduction as compared to the local cultivar under the same management practice. Improved varieties have a high response to improved management practices, particularly for fertilizer application. In addition, rice is sensitive to weed competition, especially at early growth stages. Weed can cause yield reduction in rice up to 30-35%. The yield advantage of 43.9% and 24.5% was recorded with improved variety and local cultivar, respectively when grown under improved agronomic management practices over farmer's practice. This indicates the possibility to increase the productivity of upland rice sustainably using improved agronomic management practices recommended for a specific crop variety and location. Therefore, it is difficult to promote the yield response of a given improved variety without fulfilling its requirements which were suggested by experts during variety development. Adopting a consistent crop variety and agronomic management system on a farm will develop a more resilient crop production system and provide more sustainable crop yields (Walia, 2021).

Treat	Parameters							
	PHT	PL	TN	PN	TSP	FSP	TGW	GYD
IP	121.5	20.3	367.3	314.0	116.2	101.5	35.0	5353.3
FP	93.5	18.3	365.3	268.0	78.0	64.5	30.3	3311.8
IVFP	96.1	18.0	330.0	234.0	86.1	77.1	31.3	2864.1
LCIP	106.1	19.7	470.7	334.7	92.5	80.9	33.3	4673.9
Mean	104.3	19.1	383.3	287.0	93.2	81.0	32.5	4050.8
LSD (5%)	17.0	2.1	133.4	102.5	18.3	19.6	2.3	774.07
CV (%)	8.2	5.4	17.4	17.8	9.8	12.1	3.6	9.6

Treat= treatment, IP = Improved practice, FP = Farmers practice, IVFP = Improved variety with farmers practice, LCIP = Local cultivar with improved practice, PHT = Plant height, PL=Panicle length, TN=Tiller number m^2, PN=panicle number m^2, TSP total spikelet's per panicle, FSP=filled spikelet's per panicle, TGW=thousand grain weight and GYD=grain yield kg ha^{-1}

Table 1: *Grain yield and yield components of upland rice as affected by agronomic management practices at Gimbo in 2019.*

Treat	Parameters							
	PHT	PL	TN	PN	TSP	FSP	TGW	GYD
IP	119.5	18.8	359.3	319.3	113.2	98.1	34.0	3678.7
FP	96.9	18.1	286.7	225.3	82.9	65.9	30.0	2596.3
IVFP	88.3	17.7	279.3	198.0	95.6	69.3	30.3	2205.5
LCIP	108.1	19.9	392.0	324.7	103.8	83.9	30.3	3149.4
Mean	103.2	18.6	329.3	266.8	98.9	79.3	31.2	2907.5
LSD (5%)	11.7	1.9	95.7	37.9	19.4	15.4	2.3	861.8
CV (%)	5.7	5.0	14.5	7.1	9.8	9.7	3.7	14.8

Treat= treatment, IP = Improved practice, FP = Farmers practice, IVFP = Improved variety with farmer's practice, LCIP = Local cultivar with improved practice, PHT = Plant height, PL=Panicle length, TN=Tiller number m^2, PN=panicle number m^2, TSP total spikelet's per panicle, FSP=filled spikelet's per panicle, TGW=thousand grain weight and GYD=grain yield kg ha^{-1}

Table 2: *Grain yield and yield components of upland rice as affected by agronomic management practices at Gimbo in 2010.*

Treat	Parameters							
	PHT	PL	TN	PN	TSP	FSP	TGW	GYD
IP	120.5	19.6	363.3	316.7	114.7	99.8	34.5	4516.0
FP	95.17	18.2	326.0	246.7	80.4	65.2	30.2	2954.0
IVFP	92.2	17.9	304.7	216.0	90.8	73.2	30.8	2534.8
LCIP	107.1	19.8	431.3	329.7	98.1	82.4	31.8	3911.7
Mean	103.7	18.9	356.3	277.3	96.0	80.2	31.8	3479.1
LSD (5%)	11.4	1.8	75.1	50.5	14.4	11.1	2.6	1194.7
CV (%)	7.1	5.2	16.3	14.0	9.8	11.0	3.6	11.8

Treat= treatment, IP = Improved practice, FP = Farmers practice, IVFP = Improved variety with farmer's practice, LCIP = Local cultivar with improved practice, PHT = Plant height, PL=Panicle length, TN=Tiller number m^2, PN=panicle number m^2, TSP total spikelet's per panicle, FSP=filled spikelet's per panicle, TGW=thousand grain weight and GYD=grain yield kg ha^{-1}

Table 3: *The combined (2019 and 2020) values of grain yield and yield components of upland rice as affected by agronomic management practices at Gimbo.*

A partial budget analysis was also carried out to check the profitability of management practices to compare treatments because of economic profitability rather than only looking at the maximum biological yield (CIMMYT, 1998). Based on this, the highest net benefit was obtained from improved variety under improved management practice while the lowest net benefit was obtained from the local cultivar under farmer's management practice (Table 4). Accordingly, the highest economic benefit was recorded for improved variety under improved agronomic management practice.

Conclusion

Implementation of the recommended agronomic management practices improves the productivity of crops with quality. Crop management practice is the set of agricultural practices applied to improve the growth, development, and yield of crops. Improved rice variety under improved agronomic management practices had given higher grain yield as compared to same varieties under farmer's practice. In addition to this, the local cultivar also showed better yield performance as compared to farmer's practices under improved agronomic management practices. On the other hand, the improved variety had given the lowest yield even from the local cultivar under farmer's practice. This indicates that improved variety alone cannot give the expected yield if the other production packages are not properly applied. The yield advantage of 43.9% and 24.5% was recorded with improved variety and local cultivar, respectively when grown under improved agronomic management practices over farmer's practice. As a whole, the combined result indicated that growing improved variety together with recommended agronomic management practices can increase the yield up to 4516 Kg ha-1. Thus, creating awareness and increasing access to the use of improved varieties and full technology packages considering the fertility status of the soil is crucial to enhancing productivity and also closing yield gaps. The use of fertilizer with proper crop management is particularly important for realizing the genetic potential of improved varieties.

Acknowledgments

I am thankful to South Agricultural Research Institute (SARI) and Bonga Agricultural Research Center for their financial support.

Treat	HGY	AGY	GB (ETB/ha)	TVC (ETB/ha)	NB (ETB/ha)	MRR
FP	2954.00	2658.60	26586	4500.00	22086.00	-
IVFP	2534.80	2281.32	27375.84	4800.00	22575.84	1.63
LCIP	3911.70	3520.53	35205.30	6200.00	29005.30	4.94
IP	4516.00	4064.40	48772.80	6500.00	42272.80	44.23

FP = Farmers practice including local cultivar, IVFP = Improved variety under farmers management practice; LCIP = Local cultivar under improved management practice; IP = Improved variety under improved management practice; HGY. = Harvest grain yield; AGY. = Adjusted grain yield; GB = Gross benefit; TVC = Total variable cost; and NB = Net benefit

Table 4: *Partial budget analysis for the agronomic management practices on upland rice yield.*

References

1. BOANRD (Bureau of Agriculture and Natural Resource Development). Meteorological data of the district.
2. CIMMYT. (1988). From Agronomic Data to Farmer Recommendations: An Economics Training Manual, Completely revised edition. Mexico, D.F, CIMMYT, 2018: 79p.
3. FAOSTAT. FAO Statistics Division, available at: http://www.fao.org/faostat/en/#data/QC. 2019: (Accessed on April 20, 2021).
4. MoARD. National rice research and development strategy of Ethiopia, Ministry of Agriculture and Rural Development, Addis Ababa, Federal Democratic Republic of Ethiopia. 48p.
5. SAS Institute. The SAS system for windows, V.9.3. SAS Institute. 2002-2010: Carry, NC, USA.
6. Seck, P.A., Diagne, A., Mohanty, S. and Wopereis, M.C., (2012). Crops that feed the world 7: rice. Food Security. 2012: 4(1): 7-24.
7. Taddesse L. (2015).Estimation of Genetic Variability and Trait Association in Nitrogen Use Efficiency of Upland Rice Varieties in North-Western Ethiopia. International Journal of Research and Review. 2(9): 527-535.
8. Walia, M. Basics of Crop Management, University of Nevada, Reno, FS-21-07. (2021): Accessed on August 02, 2021, at https://extension.unr.edu/publication.aspx?PubID=4103