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Factors Affecting Profitability of Rice Farming under Rainfed and Supplementally Irrigated Regimes in Malinyi Tanzania

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Abstract

Using a double log model, this paper shows the percentage change in farmer Gross Profits (GPs) due to percentage change in independent variables. It therefore captures the magnitude of the impact that coefficient estimates have on GP. Farmer GPs were regressed against farm size, extension services, and agricultural credits, mode of grain storage, final output, and irrigation regime. Findings from the regression analysis show that extension services, grain storage, final output, and irrigation regimes were significant at 0.005 level of significance. With a p-value of 0.000, irrigation regime had the most influence on gross profit, whereby having access to irrigation water increased profit by 40.17%, ceteris paribus. At 0.005 level of significance, extension services, grain storage and final output had p-values of 0.001, 0.001, and 0.000 respectively and are positively influencing profit by 16.35%, 16.02%, and 29.13% respectively. We recommend communal-based Irrigation agriculture as a holistic approach in the minimization of weather-related risks. More education is needed on proper grain storage to ensure rice quality which is a huge determinant of price and profit.

Key words: Rice farming, Gross profit, Double log model, Irrigation regimes

1 Introduction

Rice (*Oryza sativa*) is a cereal grain that originates from the family *Graminae*. It grows in areas of hot and humid climates and is best suited to areas of high humidity, prolonged sunshine, as well as an assured supply of water[2]. Rice requires average temperature in the range of 21 to 37°C. This is one of the reasons it thrives in tropical and subtropical climates of southern East Asia and Africa. In the global context, Asian countries are the leading producers and consumers of rice. China, India, Indonesia, and Vietnam collectively produce around 55% of the world's total and

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consume close to 90% of what they produce (OECD/FAO, 2016). According to FAO (2021), rice production and consumption is on the rise; over 480 million tons of rice is produced annually, from approximately 715 million tons of paddy. Although per capita rice consumption is declining in Asian countries (Nasrin *et al.,* 2015), it has been steadily increasing in Africa since 1995 (Africa rice, 2020). In most parts of sub-Saharan Africa, demand has exceeded domestic production and the resulting shortage in supply was addressed by importation of 11.8 million tons in 2008, 14.8 million tons in 2018/19 and 17.5 million tons in 2021/22 (Nasrin *et al.,* 2015; Kamer, 2022).

In the Tanzanian context, rice is the second most important cereal crop after maize, (Kilimo trust, 2014, 2018; Nkuba *et al.,* 2016; Nikusekela and Kapande, 2018; Kulyakwave *et al*., 2020; Mdoe and Mlay, 2021). It is increasingly becoming a commercial crop in the country mainly due to the attainment of self-sufficiency in production (Andreoni *et al*., 2021). In addition to being a highly regarded food source, rice has also become an employment and income generator thereby directly impacting lives of over 2.2 million people (Mdoe and Mlay, 2021; URT, 2021). Majority of people involved in rice production in Tanzania smallholder rural farming households, and according to URT (2021), an excess of 1.9 million households cultivated rice during short and long rain seasons in the 2019/20 cropping year. In the said cropping year, total area covered by rice was a little over 1.7 million ha, whereby 99.26% equivalent to 1,688,241 ha of the total farmed land was occupied by smallholder farmers and the remaining 0.74% or 12,460 ha, was occupied large scale farms. Within the same time period, total harvest stood at approximately 3.4 million tons (URT, 2021).

Asserted by URT (2019), Tanzania’s rice production subsector is dominated by smallholder farmers who cultivate on farms whose size range from 0.5 to 3 ha. Tanzania’s self-sufficiency status in rice production and consumption was a result of efforts put in place by the National Rice Development Strategy (NRDS) I of 2009, (Mdoe and Mlay, 2021). The second phase of the NRDS phase II followed up on the results of its predecessor and aims at increasing productivity and output within the rice subsector. Similar to NRDS phase I, this second phase also has strong components of irrigation as a means of commercializing the rice subsector. NRDS II acknowledges that most of rice produced in the country is done under rainfed conditions and that irrigation is an important prerequisite in the rice farming. It is understood that 71, 9 and 20 percent of rice farming in Tanzania takes place under lowland rainfed conditions respectively (URT, 2019). Out of 44 million ha classified as arable, 21 million ha have been set aside for rice cultivation URT, (2019); but actually, less than 0.4% is equipped with irrigation, (Manero *et al*., 2019). With irrigation conditions so dire, how accessibility or inaccessibility of supplemental irrigation water affects farmers' gross profits is imperative to investigate.

Numerous factors have been studied and documented as having influence on profitability in rice farming (Kisanga, 2015; Nkuba *et al*., 2016; Nikusekela and Kapande 2018). Literature shows that rice farming with access to supplemental irrigation is more profitable than otherwise. However, the extent of profitability remains unexplored. Despite the fact that supplemental irrigation is an important aspect in the current and future viability of the farm, most studies including but not limited to (Aberg, 2017; Nugroho, *et al*., 2018; and Lan *et al.,* 2020), focus on the effect that irrigation regimes have on yield rather than on gross profit. While high yield could imply high profits, Turley (2021) shows that it is not always the case because other factors such as market forces, customer preferences and input costs also have a bearing on profit. In fact, high yield could lower prices if supply exceeds demand (Nicholson and Snyder, 2008). The intent of this study is to show the extent to which irrigation improves farmers' gross profit.

Ambiguity also surrounds factors such as farm size, extension services and credit use as regards to having an influence on profitability in agriculture. Tashikalma *et al.,* (2014); Arifin *et al.,* (2018); and Noack and Larsen (2019), argue that profit increases with increasing farm size, while Kryszak *et al.,* (2021) argues that credit free small farms are the most profitable. Elsewhere, Ibrahim and Bauer (2013), argue that gross profits are higher for credit users than for non-credit users. This study delves into the analysis of the influence of socio-economic and institutional factors as well as the influence of irrigation regime on rice farming profitability. The double log model was employed to assess factors influencing farmers' gross profit in rice farming in Malinyi district because of its ability to measure adequacy of the coefficient estimates by showing the magnitude of their influence on the dependent variable.[3] Findings from this study provide insights on the extent of the effect of irrigation regimes on farmers' gross profit.

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[3] https://medium.com/@kyawsawhtoon/log-transformation-purpose-and-interpretation-944b4b049c9

2 Methodology

2.1 Study Area

This study was conducted in Malinyi district, Morogoro Region in Tanzania. Purposive sampling was used in selection of the study location. This area was selected because of the huge rice farming potential in Tanzania. Malinyi has only one irrigation scheme located in Itete ward[4]. The area was deemed suitable for the study because it contains farmers accessing irrigation water in the government owned Itete irrigation scheme, as well as farmers who only rely on rainfed irrigation. Villages selected for data collection were Njiwa, Midizini, Mahimbo and Minazini.

2.2 Sampling Design and Sample Size Determination

Since this was a cross-sectional study, data were collected directly from the field using a structured questionnaire. Sample size was determined by using the Yamane (1967) formula for finite population specified hereunder.

$$n = \frac{N}{1 + N(e)^2} \qquad (1).$$

Where: n = sample size, N = population size, and e is the level of precision or degree of accuracy, most commonly used at (0.05).

Multi-stage cluster sampling was employed to select respondents for the study. The first stage involved village clustering which was followed by grouping in the second stage based on irrigation regimes used in the farms. Farmers were then selected at random, and the study used a sample size of 120 farmers.

2.3 Analytical Framework

Under this section factors that influence profit of a farm enterprise were studied by using a Log-Log (double Log) model with GP as dependent variable and a number of independent variables.

[4] BTC/MNRT Kilombero and Lower Rufiji Wetlands Ecosystem Management Project Biodiversity conservation and wetland management in Kilombero Valley Ramsar Site Integrated Management Plan - Wetland Landscape Issues

The model is as expressed hereunder:

Ln ($\pi_i) = \delta_0 + \delta_1 \ln(X_1) + \delta_2 X_2 + \delta_3 X_3 + \delta_4 X_4 + \delta_5 X_5 + \delta_6 X_6 + \varepsilon_i$............ (2)

Where: π_i = profit per unit acre for the i[th] farm, δ_0 is the intercept coefficient, $X_1 =$ farm size of the i[th] farm, X_2 = access to extension services (1 if yes, 0 if no), X_3 = credit use (1 if yes, 0 if no), X_4 = final output (1 if milled rice, 0 if paddy rice), X_5 grain storage (1 if godown storage 0 if home storage), X_6 = irrigation regime, and ε_i is the error term.

In a double log model when a variable is continuous, then beta coefficients measure percentage change in y associated with a percentage change in the continuous variable. However, with a discrete variable, there is a slight difference whereby percentage change in y associated with a discrete variable switching from 0 to 1 is given by $100 * [\, e^{\beta_2} - 1]$, hence all the independent variables followed this logic.

2.4 Data Analysis

The study used both demographic and econometric methods in the analysis of factors influencing farmers' gross profits. Farming household demographics were presented in Table format, while econometric analysis was done through social science statistical software, STATA version 14.0. Preliminary analysis included checks for linearity, heteroskedasticity, multicollinearity and normality of residuals. Diagnostic tests were carried out to ensure that classical multiple linear regression assumptions are fulfilled.

3 Results and Discussion

3.1 Socio-economic Characteristics

As seen in table 2 below, age was measured in 4 categories whereby 37.5% of the respondents had between 41-60 years of age. This shows that middle aged farmers are the most involved in rice farming in Malinyi district. Minimum and maximum ages for farmers were 18 and 77 respectively, and average age was 42.14

years. This implies that many farmers are still active and in their productive years and is consistent with Msangi, (2017) who found out that farmers in a 41-60 age group are the most efficient and overly experienced. Analysis of gender distribution showed that the number of male paddy farmers eclipsed that of females by 35% implying that males are more involved in rice faring than women. Although contrary to the notion in many African societies, this finding is coherent with Peralta, (2022), who found out that women are disempowered and are less involved in participation and have little to no influence and/or autonomy over agricultural related decisions. Furthermore, 80% of farming households were headed by males. The implication here is that male headed households were more likely to participate in paddy farming than female headed households, and that most agricultural activities were headed by men. This finding is consistent with Msangi, (2017) and Kisanga, (2015). As regards to marital status, 70% of the respondents within the farming households, reported that they were married. This implies that rice farming is considered a way of livelihood for many farmers in the district.

Education level was measured in 4 levels, whereby respondents either had not attended school, attained primary education, secondary education, or tertiary education. Many however, (70%) had attained primary education implying that majority can read and write and are capable of understanding and even grasping new skills because the more educated a farmer is, the more receptive they are to the adoption of modern ways of farming (Tashikalma *et al.,* 2014 and Kisanga, 2015). Secondary education was the next most attended level of schooling with 19% of all respondents.

Total farm size was 152.279 ha, and average farm size across both rainfed and supplementally irrigated farms was 1.269 ha. Under rainfed irrigation alone, total farm size was 95.276 ha, with minimum and maximum farm sizes being 0.2025 and 6.075 hectares respectively. Under supplementally irrigated plots, total farm size was 57.003 ha, while minimum and maximum farm sizes under supplemental irrigation were 0.2025 and 1.62 ha respectively. Total farm size under supplemental irrigation was smaller compared to farm size under rainfed irrigation due to the limitation on the size of land available for lease imposed on farmers whereby individual farmers cannot lease more than 4 acres of land (1.6 ha) within the irrigation scheme, a restriction that does not exist when leasing rainfed based plots

Table 2: Aggregated household demographic characteristics

Variable	Categories	No. of respondents	Percentage	Min.	Max.	Average
Age						
	18-30	29	24.2			
	31-40	31	25.8	18	77	42.14
	41-60	45	37.5			
	61-80	15	12.5			
Gender						
	Male	81	67.5			
	Female	39	32.5			
Marital status						
	Married	84	70			
	Unmarried	16	13.3			
	Divorced	11	9.2			
	Widowed	9	7.5			
H/hold head						
	Male	96	80			
	Female	24	20			

Education						
	Unattended	6	5			
	Primary level	84	70			
	Secondary level	23	19.2			
	Tertiary level	7	5.8			
	Rainfed irrigation.	60	50	0.2025	6.075	1.587
Total (ha)	95.276					
	Supplemental Irrigation	60	50	0.2025	1.62	0.95
Total (ha)	57.003					

3.2 Variable Summary Statistics

Herein is a presentation of the means for independent variables and their respective standard deviations. As shown, values for standard deviations are small, indicating that data points bundle up together closer to the mean, and data values are consistent. Farm size mean value shows that 74% of respondents operated on farms of size less than 2 hectares. Average farm size was 1.269 ha. Mean value for access to extension education suggests that 25.8% of the respondents received information pertaining to rice farming in the cropping season, 31.67% made use of agricultural credits, 37.5% of the respondents sold milled rice as final output, 42.5% of the respondents leased godown space to store their harvest. As far as irrigation regimes are concerned, 30.8% had access to supplemental irrigation water sources, implying that the remaining 69.2% had no such access.

Table 3:Summary statistics of institutional factors affecting farmers' profits

Variable name	Variable type	Mean	Std.Dev
Ln Gross Profit	Continuous	0.7232	0.3745
Ln Farm size	Continuous	0.7474	0.3609
Extension Services	dummy variable (1 yes, 0 no)	0.2583	0.4395
Credit use	dummy variable (1 yes, 0 no)	0.3167	0.4671
Final output	dummy variable (1 Rice, 0 Paddy)	0.375	0.4861
Grain storage	dummy variable (1 Godown, 0 home)	0.425	0.4964
Irrigation regime	dummy variable (1 Supplemental Irrigation, 0 rainfed irrigation)	0.35	0.502

3.3 Results from Regression Analysis

3.3.1 Influence of irrigation regime on profit variation

As shown by the regression results, four variables were statistically significant at 5% level significance. Final output and irrigation regime were however the most significant with 0.000 probability values. It is known that the higher the t value, the greater the confidence placed in a coefficient as a predictor.[5] Following this logic, t value comparison showed that irrigation regime had the highest t value of 7.78, hence was considered as having the most influence on the dependent variable *Ln Gross Profit* more than any other variable. In order to show consistency with other studies, the *null hypothesis* that irrigation regime has no influence on farmers' GP was tested by comparing the calculated t value from regression analysis with the critical t value obtained by n-k-1 degrees of freedom, at 95% confidence level. Where n= 120, k=8, thus n-k-1= 112 degrees of freedom, at 95% level of confidence. The critical t value was 1.962. Since the test statistic t-value was greater than the critical t, the null hypothesis that irrigation regime has no influence on GP was rejected. Implying that, at 95% confidence level, irrigation regime indeed has significant effect on farmers' GP.

Table 4: Double log model results

Variable	Coeff.	Std. Error	t	P-Value
Ln Farm size	0.0016	0.0550	0.03	0.976
Extension services	0.1515	0.0445	3.40	0.001
Credit use	0.0456	0.0407	1.12	0.266
Final output	0.2557	0.0454	5.62	0.000
Grain storage	0.1486	0.0438	3.39	0.001
Irrigation regime	0.3377	0.0433	7.78	0.000
R - Square	0.7514			
Adjusted R - Square	0.7382			
F – Value	56.92			

3.3.2 Factors influencing profitability in rice farming

The regression analysis results in table 6 above show that the variables explain 75.14% of the variation in the profitability of rice

[5] https://www.allbusiness.com/barrons_dictionary/dictionary-t-value-4942040-1.html

farming in Itete ward of Malinyi district. This means that, the regressors explain the dependent variable (Gross profit), by 75.14% and the remaining 24.86% of the variation is owed to factors outside the model. Moreover, regression results showed that access to extension services was statistically significant at 5% level of significance, implying that, ceteris paribus, gross profit increases by 16.35% with access to extension services than without it. Additionally, other factors held constant, as the choice of output that a farmer sells at the going market price, changes from 0 to 1 in favor of milled rice, gross profit increases by29.13%. Furthermore, condition upon which grain is stored after harvest largely influences farmers' gross profits. This implies that, other factors held constant, as the dummy variable changes from 0 to 1 in favor of renting godown space, profit increases by 16.02%. This is because significant losses are avoided when rice is stored under ideal conditions. Previous studies inform that storing rice in less humid areas, and where temperature variation is minimal, often helps in quality preservation, but do not show by what extent proper storage improves farmers gross profit (Nkuba *et al.,* 2016) for instance argued that poor storage reduces yield by 8 to 26%, while Wilson and Lewis (2015) reported 35% losses due to poor, inadequate storage. Poor storage is among reasons for broken grains during milling, which consequently implies low prices, hence negatively impacting gross income and profit (Wilson & Lewis, 2015). The influence of irrigation regime, which was the main focus of this study, included two criteria for the measurement of its influence on gross profit. Rice farmers either relied wholly on rainfed irrigation or supplemented rainfall with irrigation water. Regression results revealed that the variable irrigation regime was statistically significant at 5%, and that other factors are held constant, having access to supplemental irrigation, as the dummy variable changes from 0 to 1, increased farmers' gross profit by 40.17% than inaccessibility thereof.

Farm size and credit use were expected to be positive and significant, however, while coefficient signs were positive, the two variables were insignificant. Considering the fact that 74.7% of respondents had farm size below 2 ha, (average farm size was 1.269 ha), it becomes clear why farm size had no significant effect on profit. By the same token, average farm size under rainfed irrigation, was 1.587 ha, and 0.95 ha under supplemental irrigation. Land is an input in production; thus income, profit, and productivity depend on a right combination of inputs. Below par use of inputs largely dents any efforts put up by a firm or individual to maximize agricultural profits (Debertin, 2012). Based on this logic, farm size was an insignificant influencer of profit in this study. The insignificance of farm size is best explained by Noack and Larsen, (2019), who argue that larger farms are the most profitable than smaller ones. Similarly, FAO, (2015), found out that, average farm sizes in rice farming in China and India though smaller, are associated with significantly high output. They explain that differences in economic development between countries, determines the significance of farm size on farmers income and profit and because Tanzania's level of economic development is low compared to that of China or India, small farms are insignificant influencers of gross profit. As regards to credit use, more than half of the respondents, (68.3%), mentioned that they didn't use credits during the cropping season, mainly due to stringent lending conditions. This finding conformed with Wilson, (2021), who found that smallholder farmers often lack finance and credits. The insignificance in credit use can be backed by the mean for credit use shown in table 3 which shows that only about 31.67% of farmers used credits who are fewer than the non-users, hence could not have a significant effect on profit. Moreover, majority of the non-credit users operated under rainfed irrigation, which is associated with low enterprise profitability as compared to supplemental irrigation. (Ibrahim and Bauer 2013), affirm that non-credit users often earn low profits as compared to credit users.

4 Conclusion and Recommendations

This paper focused on the factors influencing gross profit of rice farmers across irrigation regimes in Itete Ward of Malinyi District. This was done by using a double log model which adequately showed the elasticity and/or percentage change of the dependent variable due to percentage change in the independent variable, thereby showing the extent to which socio-economic and institutional factors as well as supplemental irrigation improves farmers' gross profits. Communally constructed and owned water reservoirs that can collect and retain water from the wet season could help mitigate weather-related risks while also increasing chances for credit accessibility and usage. Findings showed there were fewer females in rice farming as compared to males, thus calling for gender balance through women involvement in important decision-making spheres and/or aspects of rice farming. We also recommend organization of field schools to help in practical training, hence equip farmers with skills and knowledge necessary for them to realize higher productivity and much larger profits.

References

Aberg, A. (2017). Rice Yields under Water-saving Irrigation Management. *A meta-analysis*. Stockholm University.

AfricaRice, (2020). *Continental investment plan for accelerating rice self-sufficiency in Africa (CIPRiSSA).* https://www.africarice.org /post/africarice-publication-on-continental-investment-plan-for-accelerating-rice-self-sufficiency

Andreoni, A., Mushi, D. and Therkildsen, O. (2021). *Tanzania's 'rice bowl': Production success, scarcity persistence and rent seeking in the East African Community* 45.

Blischke, W.R., Karim, M.R. and Murthy, D.N.P. (2011). *Warranty Data Collection and Analysis*. https://doi.org/10.1007/978-0-85729-647-4.

Chambers, R., Kokic, P. and Cruddas, M. (2000). Winsorization for Identifying and Treating Outliers in Business Surveys. *Proceedings of the Second International Conference on Establishment Surveys*, *1*, 1–12.

Debertin (2012). *Agricultural Production Economics* (second edn). Pearson Education.

Dinh Thi Lan, P., Nguyen Thi, H.N. and Nguyen, T.H. (2020). Impact of irrigation techniques on rice yield and dynamics of zinc in plants and soil. https://doi.org/10.17221/660/2019-PSE.

FAO (2015). The economic lives of smallholder farmers. *An analysis based on household data from nine countries.*

FAO (2021). Special Report – 2021 FAO Crop and Food Supply Assessment Mission (CFSAM) to the Democratic Republic of Timor-Leste. In *Special Report – 2021 FAO Crop and Food Supply Assessment Mission (CFSAM) to the Democratic Republic of Timor-Leste* (Issue April). https://doi.org/10.4060/cb5245en.

Feng, C., Wang, H., Lu, N., Chen, T., He, H., Lu, Y. and Tu, X. M. (2014). Log-transformation and its Implications for Data Analysis. *Shanghai Archives of Psychiatry*, *26*(2), 105–109. https://doi.org/10.3969/ j.issn.1002-0829.2014.02.

Global Drought Observatory: *https://edo.jrc.ec.europa.eu/gdo*.

Greene, W. H. (2012). *Econometric analysis* (Seventh ed). Pearson Education Limited.

Gujarati, D.N. and Porter, D.C. (2008). *Basic econometrics* (Fifth edit). McGraw-Hill/Irwin.

Hayes, A.F. and Cai, L. (2007). Using heteroskedasticity - consistent Standard Error Estimators in OLS Regression: An Introduction to Software Implementation. *Behavior Research Methods*, *39*(4), 709–722. https://link.springer.com/content/pdf/10.3758/BF03192961.pdf.

Kisanga (2015). *Performance of Rice Value Chain in Kahama District, Tanzania* [Sokoine University of Agriculture, Morogoro]. http://eprints.ums.ac.id/37501/6/BAB II.pdf.

Kryszak, L., Guth, M. and Czyżewski, B. (2021). Determinants of farm profitability in the EU regions. Does farm size matter? https://doi.org/10.7221/415/2020-AGRICECON

Kulyakwave, D.P., Xu, S., Yu, W., Sary, S. and Muyobozi, S. (2020). Profitability Analysis of Rice Production, Constraints and Consumption Shares by Small-scale Producers in Tanzania. *Asian Journal of Agricultural Extension, Economics & Sociology*, *January*, 1–12. https://doi.org/10.9734/ajaees/2019/v37i430280

Leavens and Anderson (2011). *Gender and Agriculture in Tanzania Gender issues in land policy and administration* (Issue 134). https://evans.uw.edu/sites/default/files/public/UW_EPAR_Request_134_Gender and Ag_04102011.pdf.

Manero, A., Wheeler, S.A., Zuo, A. and Mdemu, M. (2019). Exploring the Head Versus Tail-End Dichotomy on Yield and Farm Incomes in Smallholder Irrigation Schemes in Tanzania. *Water Resources Research*, *55*(5), 4322–4342. https://doi.org/10.1029/2018WR023483.

Mdoe, N.S.Y. and Mlay, G.I. (2021). *Agricultural commercialization chains: Tanzania Rice Case Study and the Political Economy of Value* (Issue March).

Msangi, H. (2017). Examining the inverse relationship between farm size and efficiency in Tanzanian agriculture. https://ageconsearch.umn.edu.

Nasrin, S., Lodin, J. B., Jirström, M., Holmquist, B., Djurfeldt, A.A. and Djurfeldt, G. (2015). Drivers of rice production: Evidence from five Sub-Saharan African countries. *Agriculture and Food Security*, *4*(1), 1–19. https://doi.org/10.1186/s40066-015-0032-6.

Nicholas, J.C. (2007). *Variable Transformations: An introduction* (p. 15).

Nikusekela, N.E. and Kapande, G.K.J. (2018). *Market Chain Analysis and Development for Rice Produced in Kigoma Region, Tanzania, Final Report*.

Nkuba, J., Ndunguru, A., Madulu, R., Lwezaura, D., Kajiru, G., Babu, A., Chalamila, B. and Ley, G. (2016). Rice value chain analysis in Tanzania: identification of constraints, opportunities and upgrading strategies. *African Crop Science Journal*, *24*(1), 73. https://doi.org/10.4314/acsj.v24i1.8s.

Noack, F. and Larsen, A. (2019). The contrasting effects of farm size on farm incomes and food production. https://doi.org/10.1088/1748-9326/ab2dbf.

Nugroho, B.D., Toriyama, K., Kobayashi, K., Arif, C., Yokoyama, S. and Mizoguchi, M. (2018). Effect of intermittent irrigation following the system of rice intensification (SRI) on rice yield in farmers' paddy fields in Indonesia. https://doi.org/10.1007/s10333-018-0663-x.

OECD/FAO (2016). Agricultural Outlook 2016-2025. In *OECD Publishing*. https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2016_agr_outlook-2016-en%0Ahttps://stats. oecd.org/Index.aspx?DataSetCode=HIGH_AGLINK_2016.

Peralta, A. (2022). *The Role of Men and Women in Agriculture and Agricultural decisions in Vanuatu.* https://doi.org/10.1002/app5.344.

Tashikalma, A., Sani, R. and Giroh, D. (2014). Comparative profitability analysis of selected rainfed and irrigated food crops in Adamawa state, Nigeria. *Global Journal of Pure and Applied Sciences*, *20*(2), 77. https://doi.org/10.4314/gjpas.v20i2.1.

Turley, L.O. (2021). *Characteristics of higher profit farms. Economic and Policy update, volume 21, issue 8.* https://www.agecon.ca.uky.edu

URT (2019). *National Rice Development Strategy Phase II.* (Issue NRDS II, p. 60).

URT (2021). *National Sample Census of Agriculture 2019/20*.

Walter, N. and Snyder, C. (2007). *Microeconomic theory: Basic principles and extensions* (10th Edition). Thomson South-Western.

Williams, R. (2020). Lecture Notes on Heteroskedasticity. *Lecture Notes on Heteroskedasticity*, 1–16.

Wilson T.R. and Lewis, I. (2015). *The Rice Value Chain in Tanzania. A report from the Southern Highlands Food Systems*

Programme. *January*, 1–111. https://doi.org/10.13140/RG.2.2.19592.65289.

Wooldridge, J. M (2012). Introductory Econometrics. A modern approach. 5th edition.