**Determinants of Rice Commercialization Among Smallholder Farmers for Rice Production at Wembere Basin in Iramba District, Tanzania**

***ABSTRACT***

*The agricultural sector in Tanzania is crucial, accounting for approximately 30% of GDP and 65% of employment. In particular, rice production accounts for approximately 17% of the total grain production, and the country has nearly achieved self-sufficiency in rice. Rice production is the most important sub-sector in Tanzania since it plays a crucial role in the creation of jobs, income generation especially from rice exports, food security and poverty reduction. This paper, specifically, examined the determinants of rice commercialization among smallholder farmers for rice production in the study area guided with double hurdle model and* *Transaction Cost Theory (TCT). The study was based on cross-sectional data collected in 2023 and 2024 from 117 sample size of rice farmer households selected through a multistage sampling technique and analyzable to obtain Household Commercialization Index (HCI), coefficients and descriptive statistics. The finding results of this paper show that the level of rice commercialization level had (HCI=95.13%) in the 2023 and (HCI=94.79%) in 2024 of rice production. While, the multiple regression analysis for sex, age of household, education level, family size, market distance, price of rice purchased, bank loan use and use of improved seeds show that the coefficient for all variable is 0.001 (p<0.05 at 5% level of significance). This indicates that parameters have influence in rice production participation and high degree of commercialization. However, sex and age shows negative coefficient (-.015, -.004<0.05)and respectively, indicating that there is a variation in households in the mean difference was statistically significant at 5% with <0.05 =. indicating that households participating in agricultural commercialization would experience improved food security through increased crops diversity. This paper concluded that demographic, economic and institution factors had positive impact to commercialization determine the level of agricultural Commercialization to smallholder farmers so as to increases the notion that rice farming. The study recommends that there is a need to support agricultural commercialization to increase household food security. Tanzania, rice is the second most important food grain after maize and is a priority crop in the second Agricultural sector development Program (ASDP II), and in the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), National Rice Development Strategy Phase II (2019–2030) of the United Republic of Tanzania with annual consumption per capita of 25.4 kg (RCT, 2015).*

***Keywords:*** *Rice Commercialization, Rice Production, Farmers, Cragg’s Double Hurdle Model*

1. **INTRODUCTION**

Rice is the most significant food crop in the world and it has been considered to assist as a chief food basis for more than 50% of the world’s population for the long years (Zhang, W., Li, Z., & Wang, J. (2023). Globally, annual rice production has risen to 758.8 million tons of paddy rice. In addition to its contribution to consumption, it is a good opportunity for domestic and international markets for economic development mainly in China, India Indonesia, and USA, and other countries of the Trends in Global Rice Production in Food and Agriculture Organization of the United Nations. (FAO, 2023). These factors have drawn a lot of interest from various stakeholders, and as a result, its production has spread to many parts of the globe.

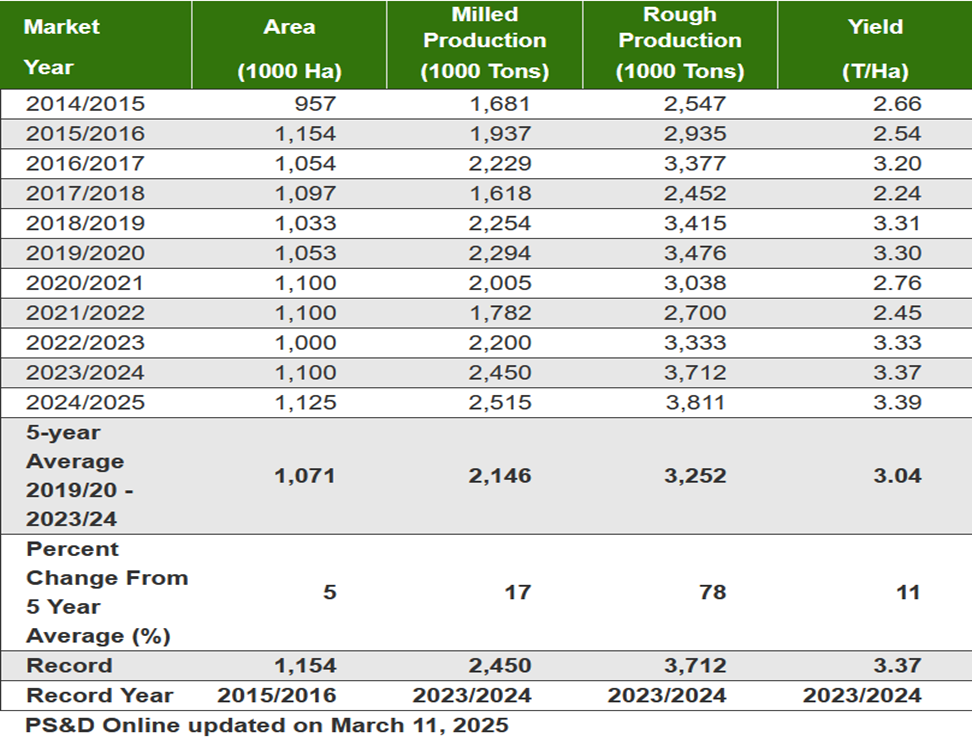
Globally, governments are facing a significant problem with food insecurity, which has emerged as one of the most crucial issues on the current international political agenda. According to the World Bank Global Report on Food Crises, 140 million people in Africa are thought to be suffering from severe food insecurity, with at least one in five of them going to bed hungry (World Bank, 2022). In Tanzania agricultural commercialization is sought by governments and development partners because it has been associated with agricultural intensification and productivity improvements (Djurfeldt et al., 2019). This is expected to raise farmers’ income from rising marketed surplus and lead to subsequent livelihood improvement. However, agricultural commercialisation is highly dynamic, affected by a wide range of biophysical, technological, socio-cultural, economic, institutional and policy related factors (Louw et al., 2008; Gupta, Vemireddy and Pingali, 2019; Pingali et al., 2019). These factors change over time and the changes may have positive or negative impacts on agricultural commercialization and livelihoods. The negative impacts are more pronounced among women and other vulnerable resource poor people.

However, the demand for rice is estimated to increase with population and economic growth, making rice production one of the most crucial policy issue.

According to the Tanzania Development Vision (TDV) 2025, the country aspires to have a diversified and semi-industrialized economy that is comparable to typical middle income countries (URT, 2021). This was expected to be achieved by, among other things, transforming the economy from subsistence to commercial agriculture with high productivity which generates high incomes and ensures food security (URT, 2021). The agricultural sector in Tanzania is crucial, accounting for approximately 30% of GDP and 65% of employment. In particular, rice production accounts for approximately 17% of the total grain production, and the country has nearly achieved self-sufficiency in rice. Rice production is the most important sub-sector in Tanzania since it plays a crucial role in the creation of jobs, income generation especially from rice exports, food security and poverty reduction (FAO, 2022; WB, 2023). It is the most rapidly growing source of food in Africa and is of significant importance to food security and food self-sufficiency. It is a strategic crop mostly produced by smallholder farmers in various agro-ecological zones. About 92% of all rice produced in Tanzania is under upland and lowland rain-fed systems while only 8% is under irrigation schemes (M.J.F. Kitilu., et al., 2019).

To overcome various challenges facing the rice industry, the Tanzanian government has been struggling to take some measures to stimulate the sector (Kadigi et al., 2020), such as the protectionist policy with an imposition of an import tariff of 75% in early 2005 followed by the formulation of policies and programs like the Ministry of Agriculture (2019) of the National Rice Development Strategy Phase II (2019–2030) of the United Republic of Tanzania. Current agricultural policy documents in Tanzania, National Agricultural Policy (NAP) in 2013, Agricultural Sector Development Strategy–2 (2015/16–2024/25) and Agricultural Sector Development Program–2 (2015/16–2024/25). On other hand, these policies emphasize on application of fertilizers, improved seed, development of irrigation infrastructures and removal of the export ban. In the same perspective, early in the 2010s, the government, through the Ministry of Agriculture Food, Security and Cooperatives (MAFSC), involved training extension staff and farmers in the System of Rice Intensification (SRI) management practices to scale up the country’s rice production. The SRI practices elaborated by Stoop et al. (2022) and the United Republic of Tanzania (2021), serve as the primary campaign tools used by the MAFSC aiming at upgrading rice yield per ha and in line with the national strategy of reduction of hunger and poverty by 2025.

**Table1: Rice yield in Tanzania**



As mention earlier, efforts were made in protecting Tanzania’s domestic rice markets including adoption of 75% tariff on imported rice as part of the EAC’s Common External Tariff (CET) which has been adopted by all member states although it is subjected to periodic exemptions in times of demonstrated scarcities to boost domestic production of rice (Msafiri, 2021). from mainly Asian countries (KilimoTrust, 2014). Kenya, the Tanzanian neighbor country in North, is the leading importer from outside the EAC, at over 300,000 tons per annum (FAO, 2022) Eighty percent of the rice imported into Kenya comes from Pakistan (80%), Vietnam (10%) and Thailand (5%) (KilimoTrust, 2023). This example of the available trade statistics (FAOSTAT, 2024) indicate that within EAC and neighboring countries, Tanzania exports rice to Kenya (35%), Rwanda (29%), Uganda (13%), South Sudan (6%), DRC (3.2%), Burundi (9%), Zambia (2.8%) and Malawi (2%).

Consistently, rice is the second leading food crop and cash crop in Tanzania after maize (Msafiri,

2021). Its annual production is estimated to be 2.2 million metric tons accounting for about three quarters of the total rice produced in East Africa making the country the top producer in the region (The United Republic of Tanzania, 2022). Importantly, the rice sub-sector is a significant source of food nutrition, employment and income for many households and a potential source of foreign exchange earnings to the country (Msafiri, 2021). The government of Tanzania is implementing several value-added initiatives including the 2019-2030 National Rice Development Strategy towards enhancing rice production and trade competitiveness.

Smallholder commercialization is a part of the greater change and can be seen as a pathway to the structural transformation of the overall economy in which farms shifts from highly subsistence-oriented production towards more specialized and advanced production system that is based on comparative advantage among smallholder farmers. Policy and strategy intervention is necessary to enhance the functioning of input and output markets, improve service provision and development of infrastructure so that the goal of structural transformation can be achieved smoothly (Barrett et al., 2022). Despite the increasing food crops commercialization, the agricultural sector in Tanzania has been experiencing various weaknesses, including low productivity and erosion of the natural resource base (URT,2021). This growing concern on declining agricultural production in Tanzania seems to suggest that the process of food crops commercialization has not enhanced agricultural production (FAO, 2023). The government of Tanzania views the increased commercialization of food crops as an important element and effective to increase income and improve the living standards in rural areas (TDV, 2025). However, scant evidences suggest that commercialization of food crops create a dilemma for smallholders whether to sustain their households with food or focus on production for the market. Using a case study of a highly commercialized smallholders farming district of Iringa in southern highlands of Tanzania, this paper assessed circumstances under which commercialization of food crops could lead to household food insecurity among smallholders. Specifically, it investigated effects of low productivity of commercialized food crops, affordability of food at the market prices for households with income from selling own food produces, shifting away from traditional crops, and specialization and its effects on food security among smallholders.

The smallholder rice farmers need to purchase sufficient agricultural inputs, thus there is a need of enough money which is not easily accessible (Girabi & Mwakaje,2013). Several studies have been conducted around the world to address the issue of determinants of commercialization for rice production among smallholder farmers (Kassie, M., & Zeweld, B, 2022; FAO, 2023; WB, 2022). However, no such study that has been conducted in Tanzania, specifically Mbarali District, where there are a good numberof smallholder rice farmers. Moreover, no study has attempted to assess the influence of access to credit facilities on performance of smallholder rice farmers. Therefore, this study intended to bridge this knowledge gap on the problem of poor access to credit facilities facing the smallholder rice farmers and to assess the influence of access to credit facilities on performance of smallholder rice farmers.

In spite of the numerous organizations that have promoted agricultural commercialization, it appears that there is still a wide gap between domestic demand and supply of rice in the country. Smallholder farmers in the country, particularly those in Wembere basin in Iramba district, Tanzania still produce rice at subsistence level despite having the comparative advantage of producing the commodity in large quantities. Not much has been done to explore the potentials and drivers of commercialization specifically, for rice production to increase productivity, to the best of the researcher’s knowledge. Therefore, the aim of this paper is to examine the determinants of commercialization for rice production. Rice commercialization is associated with on examining the determinants of commercialization for rice production in Tanzania in a case of Wembere basin in Iramba district, Tanzania. The findings from this study contribute to the existing empirical literature on who are most affected by rising agricultural commercialization, and therefore demand for a policy that ensures inclusion of food security among smallholders in Tanzania as well as similar countries in Sub Saharan Africa (SSA). Also recommended about policy discourses around agricultural commercialization tend to separate producers into different types of farm (small farms, large farms) growing different types of crops (food crops, cash crops) specifically to rice production with simple distinctions made between subsistence and commercial agricultural process.

**2. LITERATURE REVIEW**

**2.1. Craig’s double hurdle Model**

The Cragg’s Double Hurdle Model is widely used to examine factors affecting rice production and commercialization, particularly among smallholder farmers. This model allows for the examination of two distinct decisions: Participation decision and Intensity decision so as to whether a farmer decides to engage in rice production or commercialization. Also to indicate the level or extent of rice production/commercialization once participation occurs. The study was address by using the Craig’s double hurdle model. Craig’s double hurdle method was used in assessing the determinants of commercialization and extent of participation to rice agricultural commercialization by small holders’ farmers in the study area. Crag’s double Hurdle models, initiated by Mathenge and Olwande (2012) were considered when estimating the factors that influence farmers as economic agent’s participation in agricultural commercialization. The double-hurdle model is the type of corner solution outcomes, as they define an initial discrete probability of participation model, first it involves conditional on participation (Y>0), a second decision is made on the intensity of participation.

Tobit models were used originally on estimating these models that accounted for clustering zeros due to non-participation; however, its major limitation is that it assumes the same set of parameters and variables determined both probability on market participation and the level of participation (Wooldridge, 2002). A two-step model however relaxes these assumptions by allowing different mechanism to determine the discrete probability and level of participation. These models allow for separation between the initial decision to participate (Y>0 vs. Y=0) and decision on how much to sell given that (y>0). In this case it is assumed that some right hand side variable may affect differently the decision to participate at all and the decision on the level of participation. The first step in two-tier model involves probit estimation while the second stage can take different functional form distribution. The simplest two step model for a corner solution outcome assumes that conditional on Y>0, Y│X follows a lognormal distribution (second stage).

…………………………………………………………………… (1)

>0=1-µ(x…………………………………………………………………(2)

Double-hurdle model of Craig (1971) is commonly used two tier model, as in this model second stage is defined by a truncated normal distribution instead of log normal distribution described here. The main advantage of the truncated normal distribution over lognormal is that it nests the usual Tobit model thus allowing testing restriction implied by Tobit hypothesis against two step model (Wooldridge, 2002).

Double hurdle can be noted by:

…………………………………………………………………… (3)

>0)ln)…..(4)

This model is very useful and related to this study as it helps to estimate the factors that influence farmers as economic agents to participate in agricultural commercialization. This model gives room for initial decision to participate and decision on how much to sell. Based on this model, the decision to participate in the market and the extent of market participation for the smallholder farmer will depend on the utility from the choices. If utility realized from participation in the market is greater than that derived from non-participation. Then the smallholder will opt to participate in the marketing of his/her agricultural products and definitely the extent of participation to market for the products will be higher.

**2.2. Transaction Cost Theory**

This paper was guided by the Transaction Cost Theory (TCT), first presented by (Coase, 1937) while attempting to characterize the interaction between a corporation and the market. According to the notion, if transaction costs are not reduced to the barest minimum, smallholder farmers won’t be motivated to actively participate in the market which has an implication on profit levels (Kirsten et al., 2005) defined transaction costs to include those costs related to finding a trading partner with whom to exchange goods and services, screening and haggling with the partner and upholding the terms of the trading partner’s contract. The TCT refers to costs that occur before (ex-ante) and after (ex-post) market and the farmer physically exchanges the agricultural commodity. Ex-ante transaction costs include the costs of obtaining information and bargaining for an exchange of goods or services to occur while ex-post transaction costs, on the other hand, are incurred in coordinating production, harvesting, transportation, and processing as well as monitoring and enforcing compliance with the agreement (Mugwagwa, et al., 2005).

In this regard, a TCT can help smallholder farmers select an appropriate co-operative society for known transaction characteristics. The idea of opportunity cost is typically utilized to capture transaction costs because they are by nature hidden expenditures (Kirsten et al., 2005). The theory has been widely used in agricultural economics studies and related fields in developing countries (Mugwagwa, et al., 2020; Otekunrin, 2019). Transaction frequency is an important part of transaction cost theory and an important factor affecting transaction costs ([Williamson, 1989](https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2024.1448874/full#ref48)). In production, farmers need to employ many factors connected with multiple transaction subjects or make frequent transactions when purchasing production materials. The higher transaction frequency than that associated with connecting to a single service subject results in higher transaction costs ([Thomas and Vink, 2020](https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2024.1448874/full#ref43)). Therefore, when farmers have more frequent transactions, their transaction costs are relatively high ([Sgroi and Sciancalepore, 2022](https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2024.1448874/full" \l "ref36)), which may inhibit their participation in the commercialization. This theory is relevant to study to measure transaction costs to the smallholder farmers of rice, particularly in the context of smallholder rice commercialization. For example, it can be challenging to quantify the time and effort required to bank loan negotiate with farmers or to resolve disputes with input suppliers.

**2.3 Empirical Review**

Adugnaw, et al., 2023, conducted this study to analyze determinants of teff commercialization among smallholder farmers in Hulet Eju Enese Woreda, Ethiopia. The primary data were collected from 384 randomly selected smallholder farmers to measure the level of teff commercialization and analyze determinants of teff commercialization among smallholder farmers. To address the objectives of this study, an output commercialization index, and a beta regression model were used.The findings show that about 77.2% of smallholder farmers are classified as commercial, while semicommercial farmers account for 22.8% of all observations. Furthermore, the model results revealed that the number of oxen, teff land size, farming experience in teff production, market distance, and agroecology had statistically significant effects on teff commercialization. Therefore, sources of improved traction power, land productivity, market infrastructure, experience sharing strategies, and new varieties that can adapt to varied agro ecology should be given special priority to increase smallholder farmers’ commercialization.

A review of case studies conducted in 10 countries in Africa, Asia, and Latin America found that commercialization increased household incomes in most cases, as a result of increased labor and land productivity on farms as well as increased employment opportunities for hired labor. In most

cases, increased incomes resulting from commercialization led to increased food consumption Barrett, C. B. (2021), Hence there is a strong case for promoting food crops commercialization while seeking to ensure that the benefits and costs of the process are equitably distributed (Kilima, F. T. M., et al., 2020; Mnenwa, R., et al., 2022).

In Tanzania, commercialization has opened up means for increasing greater agricultural output and farmers’ income Msuya, E., et al., (2022). Unfortunately, not all rural dwellers have benefited equally from greater economic opportunities brought about through the commercialization process. An interview conducted with the smallholders’ farmers group in Iringa District, Southern Tanzania showed that commercializing food crops benefit farmers, and it may instantly move on to high value crops. Often times, increased market orientation of staple crop production offers a more pertinent option to small holders in the short terms until infrastructural facilities are developed to accompany the production, processing, transportation and marketing of high value crops. Commercializing food crops is an indispensable pathway towards economic growth and development for most developing countries relying on the agricultural sector (Barrett, C. B., et al., 2022), while food crops commercialization may not be a viable activity to ensure sustainable food security and welfare (Swinnen, J., et al.,2020).

The government of Tanzania views the increased commercialization of food crops as an important element and effective to increase income and improve the living standards in rural areas (URT, 2022). However, scant evidences suggest that commercialization of food crops create a dilemma for smallholders whether to sustain their households with food or focus on production for the market. Using a case study of a highly commercialized smallholders farming district of Iramba in centre of Tanzania, this paper examine circumstances under which commercialization of rice production and food crops could lead to household food insecurity among smallholders. Specifically, it examines effects of low productivity of commercialized food crops, affordability of food at the market prices for households with income from selling own food produces, shifting away from traditional crops, and specialization and its effects on food security among smallholders.

**3. METHODS AND MATERIALS**

**3.1 Description of the study area**

This study was conducted in Wembere basin in Iramba district, Tanzania located in the centre of Tanzania. The basin has swamp with several agro-ecological zones and agrobiodiversity that support diverse crops and livestock. Districts have smallholder farmers engaged in various crops such as sunflower, onion, round potato, maize, rice and other vegetables as well as livestock and poultry. Wembere basin or swamp is located in Singida Region which has a total surface area of 49,438 km2, out of which 95.5 km2 or 0.19 percent are covered by water bodies of Lake Eyasi, Kitangiri, Singidani, Kindai, Munang and Balengida. The remaining 49,342.5 km2 is land area. It is the 5th largest in size and occupies about 5.6 percent of mainland Tanzania's total area of 881,289 km2. Manyoni District Council (57.9%) is the largest district in the Singida Region, followed by Ikungi District Council (14.9%), Iramba District, Singida District Council, Mkalama District Council, and Singida Municipality at the tail end.

The Wembere basin is the downstream of the rivers located in north western Singida Region, Tanzania. The basin river discharge is part of the water basin of Lake Eyasi. The Wembere River originates in hilly country in central Tanzania at 6.0º south, and flows northwards through a branch of the Eastern Rift Valley. Its tributary the Nyahua River forms a seasonal floodplain 60 miles long and 1-5 km wide, covering 11,000 ha. After the Nyahua joins the Wembere from the northwest, the Wembere widens into a larger floodplain 105 km long and up to 20 km wide, and covering 140,000 ha. (4º12'-5º01' S/33º47'-34º11' E). The floodplain consists of flooded grasslands, inundated during the wet season and laced with drainage channels. Stands of the trees Vachellia seyal and Vachellia drepanolobium edge the seasonally flooded portion of the plain. This basin is selected due to the fact that production of rice has been promoted for recently years and smallholder farmers have been intensively involved in producing rice as a major cash crop. The study was carried out in three villages namely; Lugongo, Nyaha and kidaru.

**3.2. Sample Size Methods of Data Collection**

Cochran formula is used to calculate the essential sample size for the required level of precision, confidence level and the estimated proportion of the attribute present in the population. Cochran formula is most suitable for a large population. Cochran (1963) developed an equation to find the sample size for the large population proportion. The sample size formula (n) was calculated as follows:

……………………………………………………………………..…(5)

Whereas z= level of confidence (1.96 for 95% confidence level), p = expected proportion (8.3%)

ε = margin of error at 5% (0.05), n= 1.962×0.083×0.917 / (0.05)2 = 116.9 ≈**117**

Therefore, a total of 117 household participants in rice production were required; but in order to increase the statistical power of the study, 117 participants were recruited.

**Table 2. Sample Distribution N=117**

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of respondent** | **Number of respondent expected** | **Questionnaire Distribution (%)** | **Sampling techniques** |
| Lugongo Village | 39 | 39 | Random Sampling |
| Nyaha Village | 39 | 39 | Random Sampling |
| Kidaru Village | 39 | 39 | Random Sampling |
| **Total** | **117** | **100.0** |  |

**3.3. Methods of Data Collection**

This paper was used study survey where a cross section data was collected from the field and the population of the study was rice farmers. Both qualitative and quantitative data was collected by using tools of data collection which are questionnaires and personal interviews. The field survey was conducted in 2024 to collect data from primary and secondary sources in 2023 and 2024. Primary data were collected from randomly selected rice producing households using a snow ball semi-structured questionnaire, with trained enumerators conducted face-to-face interviews under the researcher’s supervision. The questionnaire used to collect primary data from respondents includes both closed-ended and open ended components to gather detailed information about the issue under study. The collected data were analyzed using descriptive and econometric methods of data analysis. For the descriptive analysis, mean and standard deviation were used. Inferential statistical tests such as t-test and coefficient test were used for the existence of any statistically verifiable differences among households participating in the rice production participation. Under econometric analysis, double hurdle model was used to estimate household rice production and the level of commercialization of rice producers. A logistic regression model was used during data analysis. Logistic regression is a process of modelling the probability of a discrete outcome given an input variable (Edgar & Manz, 2019). In all the analyses, we adjusted for facility-level clustering and a multivariate logistic regression was subjected to diagnostics aim to identify observations of outlier, leverage, and influence. Theoretical model presented in equation 1 below.

……………………………………………. (6)

**2.3. Method of data analysis of Commercialization Index**

Measurement of ricecommercialization index deals with the shift of production from consumption to more market-oriented production system (Ogutu, S. O., et al., 2020). Similarly, it refers to a significant proportion of specific commodity in output market commercialization of smallholder farming can also improve the well-being of rural farm households by stimulating investments into farm productivity, which could enhance agriculture profitability and consequently improve household incomes (Tabe-Ojong, Hauser and Mausch, 2023a). While a growing body of literature has identified agricultural commercialization as instrumental in accelerating rural economic progress through improving rural household well-being, empirical findings on the welfare implications of smallholder commercialization have been mixed and context dependent (Haji, 2022; Mmbando, Wale and Baiyegunhi, 2015; Tabe-Ojong, Hauser and Mausch, 2023a).Thus far, a growing body of literature exists on smallholder commercialization and its impacts on farmers’ welfare in developing countries (Muricho et al., 2017; Ochieng et al., 2020; Ogutu, Gödecke and Qaim, 2020; Ogutu and Qaim, 2019; Rabbi et al., 2019; Tabe-Ojong, Hauser and Mausch, 2022a).

\* 100………… (7)

Statistical Package for Social Science (SPSS version. 23) was utilized to perform descriptive and inferential statistics. Percentage, frequency, minimum, maximum, mean, and standard deviation were employed as descriptive statistics. Furthermore, the multiple linear regression tests were used to determine the relationship between categorical variables and rice commercialization, while the independent sample t-test was used to determine the mean difference between continuous variables and rice commercialization.

**2.4. Theoretical Model**

This study based on Barrett (2021) behavior of Agricultural market participation model and overcoming global food security challenges through science and solidarity which is mainly focused on the Utility maximization. The key assumption for the model is that, the decision of farm household is based on the principle of utility maximization where by one can be a net seller or net buyer.

The household utility function as described by Kirimi et al., (2013) can be shown as follows:

……………………………………………………………….……... (8)

Whereby U is the utility function (assumed to be twice differentiable, increasing and strictly quasi-concave). Xi and Xm are vectors of home produced and market produced goods respectively that are consumed by household i, L, is the leisure and Dh presents a set of demographic characteristics that influence the preference of household members and the level of utility derived from consumption of goods and leisure. Utility of the household is maximized from consumption of goods subject to farm production, income and time constraints as described here under:

………………………….. …………………………………………... (9)

……………………………………………. (10)

…………………………………………………………………………….... (11)

Where by Q(.) is a production function, Qi is quantities of goods produced by household on the farm, L is the total farm labor inputs, A and K are household fixed quantities of land and stock of capital, Pi is the price of good i, Pm is the price of marketed purchased goods; marketed of surplus good i, ω is the wage rate; Lf is the household labor supply used by the farm, N is the non-farm income, T is the total time available for household that is located between farm work and leisure.

The income and time constraints can be combined into one equation as:

…………………………………….. (12)

Rearranging the equations will give:

…………………………………….… (13)

The left hand side of the equation represents household expenditure on home producedand marketed purchased goods and leisure time while the right hand side is the income equation, representing the value of total agricultural production, the household entitlement on time ,labour value used on farm which includes hired labor and non-farm income .

The household production decision is made first, and general full income is allocated between agricultural production and leisure. The first order condition can be solved for input demand (L\*) and output supply (Q\*) in terms of prices, wage rate, land and capital

*…………………………………………………………………….…* (14)

……………………………………………………………… (15)

Given the optimum input (L\*) and output level (Q\*), the full income obtained when profit is maximized is given by substituting L\* and Q\* into equation

………………………………………………………….….. (16)

………………………………………………..…… (17)

Where Y\* is the full income that is achieved under the assumption of maximized profit, μ \* on the consumption side, first order equation can be solved for consumption demand as;

…………………………………………..……….…………….… (18)

………………………………………………………………….. (19)

The above equation shows the demand for home produced goods , and market produced goods, one of which is food. The equations combined through the profit effects, given that production decision contribute to income through farm profit as the factors influencing production affects income and hence market participation decision. Based on this and incorporating households’ demographic characteristics (D), determinants of agricultural commercialization can be represented as:

……………………………………………... (20)

**3.5. Model Specification**

The basic quantitative parameter of interest targeted is the household commercialization index this was computed to estimate the level of commercialization among smallholder farmers. A correlation Analysis was performed to measure the degree of association among the factors for rice farmer’s commercialization and the level of commercialization.

The household commercialization index measures the ratio between gross value of crop sales by a household in a given year to gross value of all crops produced by the same household (*i*) in the same year (*j*) and is normally expressed as a percentage.

*…………………………………….* (21)

In this study, the household commercialization index (*HCI*) is explained in terms of the volume of produce sold to the market by the household to the value produced. Due to the nature of the dependent variable, OLS model was employed to analyze the effects of different factors over the independent variable. The justification is that the sample respondents were producing rice both for sale and consumption, as a result, the researchers preferred to use OLS model as the dependent variable was found to be continuous i.e. JAD 2 (1) 2011 factors determining the degree of commercialization when all the households were participating regardless of the amount they are supplying to the market.

**3.6. Econometric model**

To examine the determinants of rice commercialization among smallholder farmers for rice production at Wembere basin in Iramba district, Tanzania of rice multiple linear regression model was used. The model was found to be appropriate because all the sample respondents produce and supplied positive amount of rice to the market. The multiple linear regression model employed was specified as shown below eqn (22). This paper applied a variety of econometric models to examine determinants of commercialization and rice production as a function of individual characteristics. The multiple linear regression model was specified as follows;

* + 1. *Y* is the rice production of a smallholder farmer measured as total output of a Likert scale item (1 = not sure, 2 = not at all, 3 = to a small extent, 4 = to a moderate extent, 5 = to a great extent).
    2. *X1* is the sex of the respondent (1 = male, 2 = female).
    3. *X2* is the age of respondent in years.
    4. *X3* is the land owned by a respondent in acres.
    5. *X4* is the access to extension to services (1 = if have access, 0 if otherwise).
    6. *X5* is the household size of the respondent.
    7. *X6* is the level of education of the respondent
    8. *X7 is* Quantity of rice produced
    9. *X8 is* Oxen owned
    10. *X9 is* Market distance
    11. *X10 is*Price of rice purchased
    12. *X11 is* Bank Loan use (1=Yes, 2=No)
    13. *X12 is* Use of inorganic fertilizers
    14. *X13 is* farm income
    15. *X13 is* Use of improved Seeds
    16.  is a constant.
    17.  is a stochastic error term

………………………………………………………………………………………. (22)

**Table 3. Explanatory Variables Commercialization for Rice Production**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Descriptions** | **Types** | **Expected sign** |
| SEX | Sex (male = 1 and female = o) | Dummy | + |
| AGE | Age of household in years | Continuous | + |
| EDULEV | Education level (in years) | Continuous | + |
| FAMSIZE | Family size | Continuous | - |
| FARMICOME | Farm income | Continuous | + |
| FARMSZ | Farm Size (in hectares) | Continuous | + |
| LANDOWN | Number of hectre of land owned | Continuous | + |
| RICEPRD | Quantity of rice produced | Continuous | + |
| MAKTDTC | Market distance (in Km) | Continuous | - |
| PRIPURC | Price of rice purchased from the rice farmers | Continuous | + |
| EXTN | Extension Services/contacts (yes = 1 and No = 0) | Dummy | + |
| BALOA | Bank Loan use (yes = 1 and No = 0) | Dummy | + |
| FERTLZR | Use of inorganic fertilizers (yes = 1 and No = 0) | Dummy | + |
| IMPSEED | Use of improved Seeds (yes = 1 and No = 0) | Dummy | + |

**4. RESULT AND DICUSSION**

**4.1. Descriptive analysis**

Table 4, the result of descriptive analysis of continuous variables discussed in this paper is to examine the determinants of rice commercialization among smallholder farmers for rice production on average. With regard to a standard deviation of 1.116 for oxen provides pull plough power which is a major input in the rice production process, shown that 6.19 an average of cows is used for cultivating rice farms. On average, smallholder farmers owned 6.19 oxen, which was more than the pairs of oxen owned by smallholder farmers. At the 5% level of significance, the average land size and oxen ownership among smallholder farmers were statistically significant (P<0.05). Furthermore, the age of smallholder farmers of rice production and the education level has taken about an average of 1.15 and 2.43, respectively. At the 5% level of significance, the t-test result showed that the average age and education level is statistically significant(P<0.05). This implies that smallholder farmers’ age is the responsibilities of family as most of them have to take care so as to meet day to day family living expenses, should increase incomes through agriculture commercialization. the distance between the homesteads of smallholder farmers and the nearest market center has taken about an average of 1.15km from home of farmers. At the 5% level of significance, the t-test result showed that the average distance from the nearest market statistically significant (P<0.05). This implies that more commercialized farmers used less time to reach market for selling rice because the less of distance travel to selling place due to the t-test result indicated that the market distance (km) to smallholder farmers was statistically significant at 5% level of significance. Therefore, the t-test results show that the mean was statistically significant at 5% level, indicating that there was variation in households in terms of the average distance to the nearest market between market participants.

**Table 4. Descriptive Statistics Analysis of Continuous Variables**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** | **P-value** |
| Age | 26.00 | 74.00 | 1.15 | .376 | 0.0095 |
| Education level (in years) | 0.00 | 9.00 | 2.43 | .836 | 0.0006 |
| Household size | 2.00 | 12.00 | 1.00 | .049 | 0.0087 |
| Annual income | 2.00 | 60.00 | 5.91 | 1.124 | 0.0228 |
| Total farm size (hectares) | 0.25 | 6.00 | 3.25 | 1.363 | 0.0014 |
| Rice quantity produced (in tons) | 0.40 | 8.30 | 6.10 | 1.094 | 0.0001 |
| Rice sold (in tons) | 0.00 | 7.50 | 5.90 | 1.277 | 0.0001 |
| Oxen owned | 0.00 | 4.00 | 6.19 | 1.116 | 0.0109 |
| Market distance (km) | 3.00 | 18.00 | 1.15 | .376 | 0.0006 |

**Survey data (2024), indicates significant *p*≤0.05**

**4.2. Determination of Household Commercialization Index (HCI) for Rice Production**

Analysis of Determination of Household Commercialization Index (HCI) for Rice Production is a key metric used to assess the extent to which a farming household participates in the market. In the context of rice production, HCI measures the proportion of rice output that is marketed versus what is retained for household consumption. A higher HCI indicates a greater degree of commercialization, which is essential for agricultural development and rural economic growth.

……………………………………………………………….……. (23)

Where:

HCI= Commercialization Index

*GVS ij* = Gross Value of Rice sales of *i*th household for *j*thcrop

*GVPij* = Gross Value of Rice Production of *i*th household for *j*th crop.

HCI = 0% implies full subsistence farming (no market participation).

HCI = 100% indicates full commercialization (all output is sold).

0% < HCI < 100% represents partial commercialization

Value of rice sold = Total quantity of rice sold × Market price

Total value of rice produced = Total quantity of rice produced ×Market price

HCI ranges between 0% (subsistence farming) and 100% (full commercialization).

According to Table 5, the results show the level of Household Commercialization Index (HCI) for Rice Production to the rice producer farmers in 2023 and 2024 are 0.95133 and 0.94793, respectively. The average commercialization indices of commercial farmers in two years were almost similar of the average of the whole observation of the commercialization variables. Wembere basin or swamp in Iramba district -Singida show that the level of rice commercialization had significant of households in the high commercialization category (HCI=95.13%) were in the 2023, followed by 2024 (HCI=94.79%). According to FAO (2023), Household crop commercialization was further categorized into low (<33%), medium (33-66%) and high (66-100%). The results are presented in Table 5 show that level of Household Commercialization Index (HCI) were in the high level. This implies that there is high level of rice commercialization in the Wembere basin area. Also implies that a high degree of commercialization brought about high revenue to farmers, which makes it easy for farmers to purchase the required inputs for increased food production. In addition, generated revenue will provide a means to increased access to a variety of food stuffs in the market. This results are similar studies to Oladimeji, Y.U., & Abdulsalam, Z. (2022) and Barrett, C.B. (2021), to increase rice production to meet local demand and reduce imports, which constitute a significant portion of the national consumption. The government, along with various NGOs, has implemented programs to support rice farmers by providing improved seed varieties, promoting the use of fertilizers, and improving irrigation infrastructure with a gradual increase in agricultural commercialization, however, the engagement of smallholder farmers in the agricultural input and output markets, including labour markets, has increased considerably.

**Table 5. Summary for Commercialization Index**

|  |  |
| --- | --- |
| **Commercialization Variable cost** | **Average Costs of the Variable Per Unit** |
| Average Farm Preparation Cost | 55,000 |
| Average Improved Seed Cost | 70,000 |
| Average Fertilizer Cost | 70,000 |
| Average Market Distance (Km) Cost | 40,230 |
| Average Harvesting Cost | 50,000 |
| Average Extension Services/Contacts Costs | 25,500 |
| Average Bank Loan Follow Up Costs | 20,000 |
| **Fixed Cost** |  |
| Average Farm Hiring Cost | 45,000 |
| Average Oxen Owned Cost | 250,000 |
| **Total Cost (TC)** | **625,730** |
|  | |
| **Average Value of Crop Produced (Gross Value of Production)** | |
| **2023** | 13,688,945,000 |
| **2024** | 12,899,800,000 |
|  | |
| **Average Value of Crop Sold (Gross Value of sales)** | |
| **2023** | 13,022,753,000 |
| **2024** | 12,228,111,000 |
|  | |
| **Household Commercialization Index (HCI)for Rice Production (%)** | |
| **2023** | **HCI** = 0.95133= 95.13% |
| **2024** | **HCI** = 0.94793= 94.79% |

**4.3. Econometric Results of Rice Production**

The linear regression model results indicated in [Table](#_bookmark21) 6 below show that the determinants of rice commercialization among smallholder farmers for rice production was determined by the interaction of different demographic, economic, and institutional factors. Before conducting regression, the correlation of dependent variables and independent variables was checked and those variables satisfying the correlation conditions were included for regression analysis. The presence of multicollinearity among explanatory was conducted, on which the several variables together may be highly interdependent. The collinearity statistics check of diagnostics are produced by tolerance and VIF values. Table 6 indicates the collinearity statistics. The collinearity diagnostics are also checked to confirm the multicollinearity and displayed in Table 5, the results of this analysis clearly indicates that there is no multicollinearity between light condition and time of determinants of rice commercialization among smallholder farmers for rice production at Wembere basin in Iramba district.

Table 6 show the econometric model, fourteen variables were found to multiple regression analysis to rice commercialization among smallholder farmers for rice production, however eight variables have a significant influence of the rice commercialization among smallholder farmers of rice production. These are sex, age of household, education level, family size, market distance, price of rice purchased, bank loan use and use of improved seeds.

Sex and age of household relationship to rice commercialization among smallholder farmers on rice production of rice participation. The coefficient result shows that the mean difference was statistically significant at 5% level, indicating that there is a variation in households in the mean difference was statistically significant at 5% with <0.05 = (<0.05) indicating that there is variation in the household head in terms of average year of household heads influencing negatively between age and sex to rice commercialization and rice production of rice production. This finding results is supported by Oladimeji., et al., (2022), determinants of rice commercialization among smallholder farmers in sub-Saharan Africa, 68.4% of the respondents that commercialized were male while the rest were female. However, for non-commercialized respondents, 67.5% were male while the rest were female. This implies there were more male rice farmers than female rice farmers in the sample. This finding could be associated with the possibility that rice farming is a labour and resource intensive enterprise (requires much productive resources that men are usually more endowed with than women especially in African setting). The usual practice in farming enterprise is that women tend to support their husbands in the processing aspect of rice production activities.

Education level is a continuous variable measured a contribution of rice commercialization among smallholder farmers on production in which had positively influence the probability of rice production participation and degree of commercialization of rice at 5% level of significance, the results shows that the coefficient for education level is 0.001 (<0.05). This indicates that household who were more educated had better in rice production participation and high degree of commercialization. The positive relationship could be due to the fact that educated people can more easily contribute to the generation of new technologies and more readily utilize those technologies (World Bank 2023). Furthermore, educated people manage their fields properly and then this activity results have pushes to get good production and productivity of the land. This result is in line with the findings of Ochieng, J., et al., (2023) which is analyzed by Cragg’s Double Hurdle Model and confirmed that level of education has positive and statistically significant effect on market participation of farmers in rice marketing.

Farm size relation with sales volume was positive and influenced the marketable supply of rice positively at a 5% level of significance. This shows that if the farm size of a household increases by a unit or simply by a hectare, the supply of rice to the production increases by 0.031tons holding other things constant. This can be explained by the fact that farm households that have larger land sizes produce rice in larger amounts and have the probability to revenue/profitability more. In addition, through diversification, they produce other crops like maize, sorghum, and others that can support household consumption needs, and since rice has a better market price than other crops, more rice is supplied to the market. The land is an important factor in production and the larger the size of productive land the producer owns, hence the higher the production levels are likely to be due enabling a household to produce a market surplus and be gifted to sell a substantial amount of produce Gebremedhin, B., et al., (2023). This result is in line with the findings of Arega et al. (2008) which stated that a larger household is likely to consume more output, leaving smaller and decreasing proportions for sale; Gebreslassie et al. (2023), family size had negative and significant association with the market participation of the smallholder wheat farmers; Guta et al. (2020) family size negatively affected vegetable market participation; Nigus and Tsegaye (2022), found that family size negatively and significantly affected Avocado market participation. These findings are in contrast to the findings of Osmani and Hossain (2015), who found that family size has a positive effect on smallholder market participation, and Banchamlak and Akalu (2022) found that family size is positively associated with farmers’ likelihood of participating in vegetable market supply in the Yayo and Hurumu districts of Ethiopia.

Oxen owned was hypothesized to have a positive influence on the dependent variable and in the regression model it has shown a positive sign on the coefficient and the variable influenced the rice production is positively at a 5% level of significance of the coefficient 0.005. This shows that if the number of oxen owned by a farmer increases by a unit, the production of rice to the will increases by 0.005 tons holding other things constant. Since land preparation in the Wembere basin Irambadistrict is merely done by using oxen, having more of it enables producers to prepare land on time and effectively to produce rice in larger plots and increase the production. The finding is similar with previous study by FAO, (2023) as the livestock assets and rural livelihoods with the role of oxen in smallholder agricultural production.

According to Table 6 is all about access to market distance, the regression result showed that those households who have access to market for selling rice have more probability to be rice market participant, however the coefficient is negative and statistically significant of -0.001 at 5% significance level (Table 6). Average partial effect result indicates that a unit increase in access to facilities for households who have access to market information, the probability to be market participant decrease by about 0.1%. Access to price information and communication services are key in prompting the market participation decision and encourage the degree of commercialization. This confirms Ochieng, J., et al., (2023), who found that those households who have high access to communication facilities have increased information flow which enables farmers to link to buyers at a lower cost.

Improved seed, most of the farmers were using well-known local rice varieties and little improved varieties. However, farmers need high yielding improved varieties critically. According Table 5 to the farmers’ response, the existing newly supplied rice varieties. Improved seed affected sales volume in a positive relation and influenced the production of rice at a 5% level of significance. This shows that if the quantity produced increases by a unit, the supply of rice to the market increases by 0.022 tons holding other things constant. Rice in the Wembere was produced in a better market oriented way than other crops. It can be explained by a farmer who produces more would probably supply more to the market. In line with this finding, Kusse, H.,et. Al (2022), also showed higher yield increases the farmer’s likelihood to participate in the market because the surplus above their household consumption needs makes more supply to the market. The quantity of rice produced is positively related to the intensity of market participation as the quantity produced is critical for semi-commercial farmers who first have to produce for home consumption and only sell surplus The need for other promising new varieties is continued as it holds a high- value question for researchers to provide varieties to increase productivity sustainably in the dis- trict. FAO (2023), revealed the contribution of access to improved rice varieties via that adoption helps to participate in rice markets and that in turn had a higher significant impact on welfare indicators; such as consumption expenditure, rice income, average yield, and access to credit.

Bank loan use influenced the rice commercialization among smallholder farmers on production of rice positively and significantly by 0.021 at a 5% level of significance. This shows that if households participated in credit, the production and supply of rice to the market increased by 2.1% tons holding other things constant. This might be due to the reason that rice producer households with labor and financial shortages need to use hired labor for land preparation, weeding, and harvesting, as a result, they utilize credit for paying labor and fertilizer costs for rice production in larger amounts. In line with this, other researchers also showed that access to credit enables producers to increase the amount of inputs and other inputs (fertilizer, seed, oxen) which in turn boosts output produced and surplus for the market and food security (FAO,2023). Total farm income is influenced the rice commercialization among smallholder farmers on production of rice of rice positively at a 5% level of significance due to coefficient of 0.027. This shows that if households’ annual income (in thousands), increases by a unit, the supply of rice to the market increases by 0.027tons holding other things constant. It might be due to a farmer with a better annual income having a better opportunity to produce rice in larger size by employing all necessary production inputs and supplying more rice to the market than those with lower income.

[**Table 6.**](#_bookmark20) **OLS Regression Results for Rice Production**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | **Coefficient** | **Std. Error** | **t-ratio** | **Collinearity statistics** | |
| **Tolerance** | **VIF** |
| Sex | -0.015 | 0.102 | -0.15 | .845 | 1.030 |
| Age of household | -0.004 | 0.004 | -0.91 | 0.896 | 1.116 |
| Education level | 0.001 | 0.013 | 0.72 | 0.882 | 1.134 |
| Family size | 0.031 | 0.021 | 1.45 | 0.915 | 1.093 |
| Farm income | 0.027 | 0.042 | 2.27\*\* | 0.959 | 1.043 |
| Farm Size | 0.063 | 0.004 | 15.33\*\*\* | 0.911 | 1.097 |
| Number of hectre of land owned | 0.063 | 0.065 | 0.95 | 0.916 | 1.091 |
| Quantity of rice produced | 0.067 | 0.094 | 0.70 | .997 | 1.003 |
| Oxen owned | 0.005 | 0.054 | 0.64 | .911 | 1.064 |
| Market distance | -0.001 | 0.0088 | -0.21 | .993 | 1.102 |
| Price of rice purchased | -0.053 | 0.081 | -0.66 | .994 | 1.006 |
| Extension Services/contacts | 0.168 | 0.079 | 2.13\*\* | .997 | 1.004 |
| Bank Loan use | 0.021 | 0.004 | 4.73\*\*\* | .971 | 1.030 |
| Use of inorganic fertilizers | 0.150 | 0.057 | 2.66\*\*\* | .965 | 1.023 |
| Use of improved Seeds | 0.022 | 0.079 | 0.52 | .945 | 1.023 |
| Constant | -0.764 | 0.21 | -3.62 | .992 | 1.022 |

Number of observations = 117 R-squared = 0.954. Root MSE = 3.385 Adj R-squared = 0.9484.

F (13, 106) = 167.67 Prob.> F = 0.0000.

**5. CONCLUSION AND RECOMMENDATIONS**

This paper is set out to examine the determinants of rice commercialization among smallholder farmers for rice production at Wembere basin in Iramba district. The study shows that farmers in the Wembere basin were oriented towards a semi-commercial farming system in the rice crop output market, pinpointing an opportunity still exists to improve farm households’ scale of commercialization. Moreover, like many literatures that found a positive association between commercialization and rice production, the study results also suggest positive effects of commercialization on household production with HCI comparisons considered criterion decision (moderate vs. low, high vs moderate, and high vs. low commercialization categories).

In the study area, most of the smallholder farmers were producing rice in a better market oriented way than other crops grown in the area and it created better employment opportunities for most farm households. The results show that level of Household Commercialization Index (HCI) were in the high level at Wembere basin or swamp in Iramba district -Singida which the level of rice commercialization had significant high at (HCI=95.13%) were in the 2023, followed by 2024 (HCI=94.79%). Also implies that a high degree of commercialization brought about high revenue to farmers, which makes it easy for farmers to purchase the required inputs for increased food production. In addition, generated revenue will provide a means to increased access to a variety of food stuffs in the market. Furthermore, determinants of rice commercialization among smallholder farmers for rice production were sex, age of household, education level, family size, market distance, price of rice purchased, bank loan use and use of improved seeds.

Hence, the study concludes that any policies and strategies targeted at improving the commercial status of smallholder farmers can contribute to an improvement in their welfare status. Therefore, the study calls for the promotion of commercialization in the rice farming systems in Wembere basin specifically and Tanzania, in general. This can help the farmers increase their income, and food security (both on consumer goods/services and other assets), and enjoy a better life. Moreover, in a commercial farming system, as farmers rely more on purchased inputs, agricultural commercialization has a spillover effect on the input market, thus, creating more capital and employment in other sectors and stimulating economic growth in rural areas. In the Wembere basin, commercialization can be enhanced by improving public service delivery for the rural community, investing in modern agriculture, establishing a well-functioning market system, and employing market oriented production strategies.

This paper recommends that the levels at which strategies to raise agricultural crop production and improve food security for commercialization should be addressed. The stakeholders include International Agencies, Regional Co-operations, the Central Government, district councils, NGOs, other development partners, and households curity and malnutrition. International institutions should continue to help poor countries like Tanzania to build the internal capacities and strengthen local and international institutions; maintain food security, and get rid of hunger and malnutrition. Currently, cash crops are the biggest determinant of food security in Singida and Iramba districts; the Government, District Councils and other development partners are urged to create capacity and build sustainable institutions including for people to generate income through small and medium enterprises (SMEs) for bulk production of cash crops including sunflower, onions, simsim and finger millet, commercial fishing at Kitangiri and Magungumuka lakes as along Wembere basin. Major problems related to rice production in the area were a lack of improved rice production technologies, the requirement of heavy crop management especially weeding, fertilizer supply and high prices, problems related to security problems sometimes causing conflict, weak extension service provision, weak research extension-farmer linkage, weak monitoring of traders and market by concerned government organization. The rice crop is a significant contributor and the same will be in the future as the crop has considerable potential to improve the livelihood of farm households and communities. Thus, attention should be given to Wembere basin in Iramba district for rice production and marketing related constraints.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

I hereby affirm that this paper was composed by myself, that the work herein is my own except where explicitly stated otherwise in the text. During the preparation of this paper, I have used Chat GPT 3.5 to assist me in the writing process to improve language, flow, and readability.

**CONSENT**

As per international standard or university standard, respondents’ written consent has been collected and preserved by the author(s).

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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