GENDER INTRA-HOUSEHOLD DYNAMICS COMPARISON OF PADDY PROFITABILITY DUE TO THE ADOPTION OF IMPROVED AGRICULTURE TECHNOLOGY

Abstract

To compare gender intra-household dynamics of paddy profitability due to the adoption of improved agriculture technology.

The study used secondary information gathered from 1,184 Tanzanian households in 2020. The gross margin return was used, and a two-sample t-test with equal variance was used to compare profitability between males and females with regard to the intra-household dynamics.

The findings revealed that males are dominant in the intra-household dynamics. There was a significant difference in profit between Male (M = [-80009.6], SD = [719178.8]) and Female (M = [-120980.8], SD = [371716.2]); t(7937) = [2.9561], p = [0.0031] for decision on input use. In farm plot ownership there was a significant difference in profit between Male (M = [-79309.96], SD = [717650.8]) and Female (M = [-134222.8], SD = [179688.6]); t(7951) = [3.7523], p = [0.0031] and For the role in land preparation there was a significant difference in profit between Male (M = -75546.25], SD = [7445178]) and female (M = [122535.2], SD = [358831.1]); t(7937) = [3.4394], p = [0.0006].In addition, the study has found that smallholder farmers, in general, are making a loss in production, although females are making higher losses compared to males.

Farmers should use improved agricultural technology in package thus combining technology such as use of improved seeds, fertilizers, herbicide, labor saving machine and irrigation. Also empower female paddy producers by offering agricultural credits to smallholder farmers with favorable terms such that farmers can adopt improved agricultural technologies that will improve their rationality and, hence, the economic well-being of their households..

Keywords: Gender, Improved agriculture technology, technology adoption, profitability

1.1 Introduction

Paddy is one of the essential grain crops in many countries across the world (Zhao *et al.,* 2021). In Tanzania, it accounts for about 2.7% of Tanzania's Gross Domestic Product (GDP), where it is the second most important food and commercial crop after maize (Goweleet al., 2020). In the country, paddy is produced by nearly 18 % of Tanzanian households (Wilson & Lewis, 2015), where over 90% of the paddy produced is mainly from smallholder farming households (Busungu, 2023). Paddy production provides over 18% of Tanzania's income growth, where both males and females participate in its production chain, but 80% of the involved labour force in the rural areas is offered by females (URT,2019)

The adoption of improved agriculture technologies in paddy production is one among the increasing factors that can combat the development challenges of the country, such as continuous food insecurity, low agriculture productivity and improving farmers' well-being by providing income from sales of the crop after harvest (Otsuka and Muraoka, 2017).

The System of Rice Intensification (SRI), which has four components, including early seedling transplantation, shallow planting with one or two seedlings per hill, sparse planting, and sporadic irrigation is used as improved paddy cultivation practices but later more improved farming rice system was introduced in rural Tanzania which involved the new practices such as seed selection in salty water, direct seeding or transplanting, wide spacing, use of inorganic fertilizer, and adoption of better rice varieties (Takahashi *et al.,* 2020)

Farming households in Tanzania are characterized by gender intra-household dynamics where there is a change between males and females in terms of resource ownership, decision making and roles within a household; these dynamics cause inequality in the production resources, hence differences in the adoption of improved agriculture technology and production (Shibata *et al.,*2020)

Technological advancements increase agricultural productivity, enhancing the well-being of rural farmers, as well as increasing food security and income through the sale of agricultural products (Anang *et al.,*2020). The study by Abunga *et al.* (2012) shows that smallholder farmers argue that improved agriculture technologies are costly. Thus, they fail to use the improved agriculture technologies more. Although costly, using improved agriculture technology increases productivity and improves smallholder profitability (Tsinigo & Behrman, 2017).

Nevertheless, less is known about how improved agriculture technology improves farmers' profitability according to gender intra-household dynamics for paddy-producing households in Tanzania. Therefore, this study analyses the difference in profitability among male and female paddy farmers about the intra-household dynamics.

1.2 Literature review

1.2.1 Empirical Literature Review

1.2.1.1 Gender intra-household dynamics

Gender intra-household dynamics is the force that changes decisions, ownership of resources, and roles between males and females within the household (Badstue *et al.,* 2020). In these changes, males are considered to be dominant in decision-making and resource ownership; thus, females are more likely to involve themselves in subsistence farming, while males focus on the production of cash crops (Shibata *et al.,* 2020).

The inequality in the ownership of productive resources causes female not to adopt the available improved agriculture technologies, which in turn results in low crop productivity and hence affect the income of the household (Ebere &Chibuzor, 2023)

1.2.1.2 Paddy Production

Tanzania aims to progressively transform the existing subsistence-dominated rice subsector into commercially viable production systems (Mtembeji *et al.,* 2021; *URT*, 2019) by formulating and implementing the Nation Rice Development Strategy (NRDS). The strategy regards rice as the strategic crop and a significant component of food security and income for the country. The strategy is mainly focused on eight areas, which are:

- Increased availability of and access to agricultural inputs such as seeds, fertilizers, pesticides, and appropriate farm machinery,
- Introducing improved varieties and integrated crop management options to close yield gaps, especially in irrigated rice systems,
- Reducing postharvest losses and enhancing the marketing of rice,
- Rehabilitation and development of new irrigation schemes and improving irrigation and water-harvesting technology,
- Enhancing access to and maintenance of agricultural equipment,
- Improving capacity for technology development, training, and dissemination systems,
- Enhancing access to credit and agricultural finance
- Promotion of medium- and large-scale processing industry (Demont, 2013; Trevor & Lewis, 2015)

1.2.1.3 Profitability and its Measurement

Profitability is the degree to which an activity yields profit. Some studies, for example (Mauki*et al.,*2023), used the enterprise budget to assess the paddy profitability of rice farming enterprises in Mvomero and Mbarali districts. The enterprise budgets aid in allocating the limited resources of land, labour, and capital to the best possible use. The person in charge of the resources determines the best suitable use, which could be to increase revenue, reduce soil loss, or accomplish any other objective (Craig, 2006).

Profitability permits assessing the cost and return of value-adding activities to estimate the return above variable cost, the average yield, and the average price used (Ojila &Abu, 2019; Islam *et al.,* 2017).

1.2.1.4 Improve Agricultural technology and its determinants

According to Jain et al. (2009), agricultural technologies encompass a wide range of advanced methods and tools that have an impact on the expansion of agricultural productivity. The most common areas of crop technology development and promotion, according to Loevinsohn et al. (2013), include new varieties and management regimes thus soil fertility and management, weed and pest control, irrigation, and water management. New technology typically increases output and lowers average cost of production due to improved input/output relationships, which leads to significant increases in agricultural income (Challa, 2013).

According to Saved (2017), a number of variables could affect the uptake of better varieties, including access to land and extension services, the location of the extension office, and revenue from non-farming pursuits. The asset base, institution, and characteristics of the household all affect the adoption of improved technologies (Kurgat et al., 2020)

1.2.2 Theoretical Framework

The theory of the firm, which defines the firm as a single-family producing paddy to maximize profit through production-related rational decision-making, serves as the foundation for this study. Paddy-producing households combine materials such as seeds, fertilizer, herbicides and other forces of production such as labour and machinery to create an output or product. (Beatie & Taylor, 1985). In this study, an individual smallholder household producing paddy is considered to be a firm that combines different inputs such as improved seeds, fertilizers, pesticides, machinery and irrigation systems. The household decides to use improved agriculture technologies in order to maximize yield and hence profit, which will improve their economic wellbeing, *Ceteris Paribus*.

2.0 Methodology

2.1 Sampling Design and Data Collection

Data used in this study was obtained from the National Panel Survey (NPS) 2019/20, with a sample size of 1184 households cultivating paddy. These data were collected by the National Bureau of Statistics (NBS) and the Office of the Chief Government Statistician Zanzibar (OCGS).

The dataset is suitable for the study because it contains the needed information in this study, which is mainly on agricultural production at the plot and crop yield, as well as data on the type of inputs used and sales revenue that are consistent with essential stages in the agricultural value chain, as well as information on ownership of farm plot under farming household, individual rights to plots, consumption and expenditures.

2. 2 Data analysis

Two analytical approaches were implemented; firstly, the analysis of profitability per acre of paddy production was done through Gross Margin (G.M.) analysis.

Profit = Gross return - Production costs/acre…….... (1)

Then, a two-sample t-test with equal variance was used to ascertain the null hypothesis: whether the mean of the profit obtained from paddy production between male and female are equal or not.

3.0 Results and Discussion

3.1 Characteristics of Paddy Farming Household Relative to adoption rate and gender intra-household dynamics

The results show that there is high gender inequality according to the intra-household dynamics; males seem to dominate in every part of the intra-household dynamics of paddy producers in the country. However, the dominance is severe when it comes to decisions on what to do with sales revenue obtained from farm produce. This result aligns with (Shibata *et al.,* 2020), where males were found to dominate household resource ownership and are responsible for deciding what to do with the household's income. Moreover, the results for a role in land preparation, weeding, fertilizing and harvesting contradict URT (2019), which reveals that 80% of the agricultural labour force is female, while the results show males dominate even in the role which involves providing labour force.

Table 1: Characteristics of paddy farming household relative to adoption rate and gender intra-household dynamics

	Gender intra-household dynamics		
Adoption levels	**Male (%)**	**Female (%)**	**Total**
	Decision on input use		
None Adopters	68	32	100
Low Adopters	51	49	100
Medium Adopters	49	51	100
High Adopters	61	39	100
	Plot ownership		
None Adopters	69	31	100
Low Adopters	69	31	100
Medium Adopters	66	34	100
High Adopters	76	24	100
	Right to use the plot.		
None Adopters	71	29	100
Low Adopters	70	30	100
Medium Adopters	69	31	100
High Adopters	41	59	100
	Role in Land Preparation		
None Adopters	65	35	100
Low Adopters	43	57	100
Medium Adopters	51	49	100
High Adopters	54	46	100
	Role in weeding and fertilizing		
None Adopters	66	34	100
Low Adopters	44	56	100

Medium Adopters	46	54	100
High Adopters	61	39	100
	Role on harvesting		
None Adopters	63	37	100
Low Adopters	44	56	100
Medium Adopters	42	58	100
High Adopters	61	39	100
	Decision on what to do with the sales		
None Adopters	95	5	100
Low Adopters	95	5	100
Medium Adopters	92	8	100
High Adopters	100	0	100

Although males dominated most parts of intra-household dynamics when females had the right to use the plot, they adopted the improved technology; thus, they fell under the higher adopters. The right to use the plot gave the ability to use the improved agricultural technology (Openko, 2020). Also, when the males were the ones who decided on what to do with money obtained from the sales of farm produce, they highly adopted improved agriculture technology, which can ensure the optimum level of crop harvest. This observation is also in line with that of (Shibata *et al.,*2020), who found that men are high adopters of improved agricultural technology when they are assured that the technology will lead to high crop harvest.

3.2. Profitability of Household Producing Paddy

The results show that, on average, paddy farming households are losing 96,530 TZS per acre.

235 113. 1 – 331 643.1= -96 530 TZS per acre

Paddy farming households obtain a total revenue of 235 113.1 and a production cost of 331 643.1 TZS, by deducting the production cost from the revenue a loss of 96 530 TZS equivalent to 41% of uncovered variable cost incurred by paddy producers. On the one hand, the loss incurred may be due to a lack of poor technical advice to paddy farmers, which may cause over or under-application of the technology practices such as the use of more fertilizer than the recommended amount that may yield high farm produce.

On the other hand, the provision of subsidized input to farmers who need more knowledge of how the inputs are applied leads to the inefficacy of those inputs, hence low yield in production. Moreover, the loss incurred by paddy producers may be due to the negligence of farmers where some of them do not lead to an estimation of variable cost that will definitely outweigh the revenue obtained from the sale of paddy (Omotilewa *et al.,* 2019; Rahman & Zhang, 2018)

$$\frac{-96,530}{235,113.1} \times 100 = 41 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

3. 3 Comparison of profitability due to gender intra-household dynamics

In comparing profitability according to the gender intra-household dynamics, the decision on input use, farm plot ownership, and role in land preparation were found to be significant.

There was a significant difference in profit between Male (M = [-80009.6], SD = [719178.8]) and Female (M = [-120980.8], SD = [371716.2]); t(7937) = [2.9561], p = [0.0031] for decision on input use. In farm plot ownership there was a significant difference in profit between Male (M = [-79309.96], SD = [717650.8]) and Female (M = [-134222.8], SD = [179688.6]); t(7951) = [3.7523], p = [0.0031] and For the role in land preparation there was a significant difference in profit between Male (M = -75546.25], SD = [7445178]) and female (M = [122535.2], SD = [358831.1]); t(7937) = [3.4394], p = [0.0006]

The results show that generally, farmers are operating at a loss; however, females incur more losses compared to males. Table 2 reveals that when males had made decisions on the input use, the loss incurred was minimal compared to when females made decisions on the input use. Delecourt and Fitzpatrick (2021) revealed that female businesses are less profitable than those operated by males. However, this result contrasts with that of Bernhardt *et al.* (2017), who found that if females were to operate household businesses, there would be a more significant increase in profitability than for males.

Table 2: Two-sample t-test for decision on input use

Group	Obs	Mean	Std. Err	Std.Dev	(95%Conf. Interval)	
Male	4768	-80009.6	10415.23	719178.8	-100428.3	-59590.94
Female	3171	-120980.8	6601.056	371716.2	-133923.5	-108038
Combined	79939	-96374.33	6791.535	605133	-133923.5	-108038
Diff		40971.18	13859.77		13802.39	68139.96

t = 2.9561
Degrees of freedom = 7937
P = 0.0031

Further, the results in Table 3 show that when males owned the farm plot, the loss incurred was low at an average of 79 309.96 TZS per acre compared to when females owned the plot made a loss of 134 222.TZS per acre. The use of more inputs, such as a large amount of fertilizer on a plot, increases the cost but lower the output per acre, likely due to insufficient knowledge on the use of inputs where female seems to be more ignorant of the proper use of the inputs (Openko&Oleskiyzhuk, 2020; Steven & Wu, 2022).

Table 3: Two-sample t-test for farm plot ownership

Group	Obs	Mean	Std. Err	Std.Dev	(95%Conf. Interval)	
Male	5480	-79309.96	9694.443	717650.8	-98314.92	-60305
Female	2473	-134222.8	3613.338	179688.6	-141308.3	-127137.3
Combined	7953	-96385.21	6779.555	604597.9	-109674.9	-83095.5
Diff		54912.85	14634.33		26225.72	83599.98

t = 3.7523
degrees of freedom = 7951
P= 0.0002

According to the results in Table 4, when the role of land preparation was left to men, the loss incurred was 75 546.25 TZS, which is low compared to that of women, which is 122 535 TZS. This is because land preparation requires a larger workforce, and men are found to have this ability compared to women and can use animal draft power to simplify the exercise more than women can. This was also supported by Thangavel *et al.* (2022), who found that males were utilizing agricultural machinery, which can simplify the job and provide effective way of land preparation for crop production purposes.

Table 4: Two-sample t-test for the role in land preparation

Group	Obs	Mean	Std. Err	Std.Dev	(95%Conf. Interval)	
Male	4,420	-75546.25	11198.61	744517.8	-97501.13	-53591.37
Female	3,519	-122535.2	6048.956	358831.1	-134395	-110675.4
Combined	7,939	-96374.33	6791.535	605133	-109687.5	-83061.13
Diff		46988.95	13662.08		20207.67	73770.23

t = 3.4394
Degrees of freedom = 7937
P = 0.0006

Other gender intra-household dynamics variables including the role of weeding and fertilizer use, the right to use the farm plot and the role of who is responsible for harvesting the crop were all insignificant.

Likewise, the difference between males and females who decide on what to do with money obtained from the sales of crops was insignificant from the t-test. This means that, there were no differences in farm profitability that the household could get if either men or women became dominant with respect to gender intra-household dynamics.

4.0 Implications for policy and practice in light of the study's findings, the study recommends the following;

First, female paddy producers are to be empowered by sensitizing them on improved agriculture practices. As per the policy on the National Strategy for Gender Development which aims to create conducive environment for equal opportunities in employment for both women and men. The study expose female paddy producer to be more vulnerable to opportunities thus empowering female paddy producer should be facilitated to enable a health community while reducing poverty.

Second, farming households should be aware of the benefits of using improved agriculture technology in a package, as most of their plots fall into the category of "none adoption," meaning they do not use improved agriculture technology in the production of paddy. The agriculture extension experts should create awareness to households producing paddy on the significance and benefits of adopting improved agriculture technologies in package.

Thirdly, the paddy farming households should be sensitized on the proper way of using the improved seeds, fertilizers and pesticides to ensure the good management of farm resources. This will reach the agricultural technology which aims at facilitating maximum production as stated by the National science and technology policy for Tanzania

Lastly, favorable lending terms for agricultural inputs should be made available to small farming households,that will facilitate the purchase and adoption of improved agricultural technology, which is vital for increasing output and profit maximization.

5.0 Conclusion

This study has shown that males are dominant in making the decision on input use, right to use the plot, role in land preparation, role in weeding and fertilizer use, role on harvesting and decision on what to do with the sales farm and on the plot ownership. However, when females had the right to use the plot, they highly adopted improved agriculture technology compared to males, on the other side when males had the opportunity to decide on what to do with the sales, they also highly adopt.

Therefore, the cooperation of both men and women in making farm decisions is encouraged since this will help to make informed decisions such as on the right time to do weeding and fertilization in the farm and timely harvesting of the crop. Besides that, a household where both men and women cooperate in planning how the farm income will be committed to various activities of the household will be much better at allocating its limited financial resources to various farming activities like purchasing improved agricultural technologies such as good seed varieties and fertilizer as well as supporting non-farming activities.

The results reveal that, in general, smallholder farmers are making a loss, although the females are making higher losses compared to the males in the decision on input use, farm plot ownership, and role in land preparation. The loss obtained is always tricky for farmers to notice

since they do not have a tradition of keeping all farm records, especially the cost incurred in all aspects, from the preparation of the land until when the crops are sold out.

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