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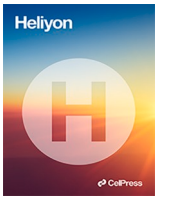

Smallholder rice farmers profitability in Agricultural Marketing Co-operative Societies in Tanzania: A case of Mvomero and Mbarali districts

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ABSTRACT

Smallholder rice farming in Tanzania is an important economic activity that has the potential to livelihood improvement of smallholder farmers, yet their profitability remains low due to several challenges they face. This study analyzed costs and benefits associated with smallholder rice farming, determined profit distribution among farmers and assessed risk bearing ability of smallholder rice farmers under changing circumstances of total variable costs, price and yields. The study was conducted in Mvomero and Mbarali districts and adopted a cross-sectional research design, the sample size was 382 smallholder rice farmers selected from three Agricultural Marketing Co-operative Societies during 2021 cropping season. Data were collected through a questionnaire-based survey and key informant interviews. Data were analyzed using Statistical Package for Social Sciences (SPSS) and excel whereby Enterprise Budgetary Technique and Sensitivity Analysis were performed. The study found an average Return on Investment of 0.42, Benefit Cost Ratio of 1.42 and Profit Margin of 24%. The level of profitability differed among co-operatives where 'Umoja wa Wakulima Dakawa' (UWAWAKUDA) had the highest return per acre (524 417 TZS) followed by Kapunga (414 111 TZS) and Madibira (316 638 TZS). Furthermore, smallholder rice farmers' Gross Margins were significantly affected by changes in Total Variable Costs, output price and yield per acre. The study concludes that rice production is a profitable business in the study area. Therefore, the local government, co-operatives and other stakeholders should improve drivers that lead to increased profitability such as the water infrastructures, organize markets and build farmers' capacities to improve yields and profitability among smallholder rice farmers.

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1. Introduction

1.1. Background information

Enhancing smallholder farmers' profitability[1] and competitiveness[2] is imperative for agricultural development in Tanzania. 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. 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 [1,2]. For several decades, rice has been one of the widely produced crops that contribute to Tanzania's food and nutrition security, socio-economic development and country's foreign exchange earnings [3–5]. Also, the livelihood of over two million people countrywide has been influenced by rice production and marketing [6]. About 2.9 million MT of rice was produced in the 2019/2020 crop season which is a more than 100% increase compared to 1.4 million MT which was recorded in the 2007/08 crop season [7]. The smallholder farming system produces about 90% of rice in farm sizes ranging from 0.9 to 3 hectares (ha), with an average farm size of 1.3 ha [3,6].

Efforts have been made by the Government of Tanzania to increase smallholder rice farmers' profitability along the rice value chain by addressing challenges facing smallholder rice farmers' competitiveness. The main focus has been on the provision of quality seeds, extension services, agricultural co-operatives formation and facilitating rice commercialization to promote smallholder farmers' competitiveness along the rice value chain [3]. The initiatives also include the development of Tanzania's Agricultural Sector Development Strategy (ASDS) II notably from 2015 to 2025, which intends to enhance the competitiveness of farmers' organizations for competitive value chains [8]. The National Rice Development Strategy (NRDS) II has been established to enhance the market competitiveness of locally produced rice by reducing costs of production to increase efficiencies and improving milling operation standards [3]. Yet, smallholder farmers still have limited competitiveness in terms of profitability, hence a serious effect on their livelihood [9].

Agricultural Marketing Co-operative Societies (AMCOS) earn credit for encouraging farmers to adopt modern production technologies which have enabled Tanzania to achieve nearly a self-sufficient status in rice production. However, the growth of populations, poor access to farm inputs, lack of access to market information and technologies, and price instability make it difficult for smallholder rice farmers to maintain sustainable profits in the coming decades [10]. The issue of smallholder farmers' profitability in rice farming has recently received considerable attention, and researchers have shown an increased interest on the matter.

The study adopted the most popular method of estimating smallholder farmers' profitability which is the cost and return analysis [11]. Among the driving forces of smallholder farmers' adoption of rice farming best practices advocated in AMCOS is the amount of profit generated. Profits derived by smallholder farmers can be a measure of their competitiveness [12]. Therefore, the higher the profit margin, the greater the competitive level [13]. Several attempts have been made to examine the profitability and its drivers in different production systems in rice farming in Vietnam, Nigeria, Bangladesh and Tanzania [10,14–19]. [10,16,20–22] in their studies, employed Farm Budgetary Technique (FBT) to input and output data as an analytical tool to measure farmers' profitability using gross margins and benefit-cost ratios in Tanzania, Bangladesh and Nigeria. The results showed significant profits in rice farming [23]. also applied the FBT in estimating the profits of paddy production in Nigeria [13,24]. utilized the Cobb-Douglas stochastic frontier production function to estimate the profit efficiency of smallholder milk production in Kenya and rice production in Nepal. This paper employed the Farm Budgetary Technique devised by [25] to examine smallholder rice farmers' profitability. The key strength of using FBT in cost-benefit analysis for smallholder rice farming is that it provides a comprehensive and detailed picture of the financial performance of the enterprise. By breaking down costs and revenues into their component parts, farmers and analysts can identify the specific inputs or activities that are driving costs up or revenues down. This information can then be used to make informed decisions about how to allocate resources and improve the financial performance of the enterprise.

The Return on Investment (ROI), Gross Margin (GM), Net Present Value (NPV), Internal Rate of Return (IRR), Break-even Analysis, and Benefit-Cost Ratio (BCR) are a few examples of profitability metrics. The measurements vary from one another in terms of how profit is expressed and how easily a project's financial viability is analyzed. BCR and IRR are worthwhile in expressing project feasibility for several years (t). The NPV, as defined by Ref. [26], is the financial profitability of an investment that takes into account the risk of future profits. Investment in a project is lucrative when the NPV is greater than 0. IRR is the discount rate at which the investment's NPV of benefits equals its NPV of expenses. The benefit of the investment outweighs the cost of the investment if the BCR ratio is larger than 1. According to Ref. [27], GM is an important measure of resource efficiency in Small and Medium Enterprises (SMEs). GM, which can be stated as a normal value Tanzanian Shillings (TZS), a ratio, or a percentage of return, is the gross return less the sum of all variable expenses. When calculating ROI, fixed costs and variable costs are both taken into account.

When used as profit indicators, NPV and IRR appear more complicated than GM and ROI, especially for smallholder rice farmers like those in the Mvomero and Mbarali districts [27]. ROI ignores the time component, although this is not a concern for the current study because the profitability analysis of selected smallholder rice farmers only takes the 2020/2021 growing season into account. Return on Investment (ROI), Gross Margin (GM), Benefit Cost Ratio (BCR), and Break-even Analysis however were used in this study

[1] Profitability in smallholder rice farming refers to the ability of the farmer to generate a financial profit from their rice production activities.

[2] Competitiveness refers to the ability of smallholder farmers to offer goods that satisfy consumer demands in terms of price, quality, and quantity while making profits that allows them to thrive (Latruffe, 2010).

since they are widely utilized by different scholars, simple, yet effective parameters for assessing the financial performance of a particular business [28–30]. These metrics are used to assess the performance of small and medium businesses. The four measures were used due to the seasonal nature of smallholder rice production and the desire of the corresponding farmers to raise income and lessen poverty in the study area. Smallholder rice farmers want to know their profit in terms of the precise income (TZS) they receive after paying production costs, which include both fixed and variable costs. Also, ROI is worthwhile for smallholder farmers so that they can measure the returns in terms of how much TZS is created for every single TZS invested in production.

Surveys such as those conducted by [10,17–19,31] have reported that rice farming is a profitable business among smallholder farmers in Tanzania. However, assessment of the risk-bearing ability of smallholder rice farmers under changing circumstances of total variable costs, price and yield have not been well established. Scant evidence on the same exists in the previous studies. This research presents findings that can be used to fill this gap in the literature by showing the optimum level of production using the existing resources.

The focus was given to rice production because of the growing rice demand, especially with an increasing household income in the cities [10]. Therefore the need to analyze the profitability of smallholder rice farmers under the context of AMCOS which has been reported to be effective in providing information for the new entrant into the business become necessary. Information from this study will enrich the existing literature and guide policymakers in developing effective policies to enhance the performance of AMCOS to reduce poverty and improve members' well-being. The overall objective of this paper was to examine smallholder rice farmers' profitability. Specifically, the paper (i) analyzed costs and benefits associated with smallholder rice farming (ii) determined profit distribution among farmers and (iii) assessed risk-bearing ability of smallholder rice farmers under changing circumstances of total variable costs, price and yield in the study area.

1.2. Theoretical framework

1.2.1. Porter's Diamond Model of Competitiveness

This study was guided by Porter's Diamond Model of Competitiveness [32]. In his study on competitive advantage [32], identified six (6) factors as determinants of the competitiveness of firms. He argued that a firm is likely to succeed in a particular industry because of certain conditions. These conditions are factor conditions; demand conditions; related and supporting industries; strategy, structure and rivalry; government-supportive policy and the role of chance which includes factors that can harm or benefit the competitive position of farmers and are out of farmers' control, such as unreliable rainfall, drought and diseases. Meeting such conditions has an implication on the competitiveness of smallholder rice farmers in terms of profit levels. The strength of this model is that it can help to identify the competitive advantages of the industry and provide guidance for policy development and investment decisions among smallholder rice farmers regarding their returns. The model has been successfully used by several researchers to analyze determinants of competitiveness of various agricultural industries [33–36], and was therefore regarded appropriate for the study on smallholder rice farmers who are members of AMCOS in Tanzania.

1.2.2. Transaction Cost Theory

The study was guided by the Transaction Cost Theory (TCT), first presented by [37] 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 [38]. 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 [39]. Focusing on transactions makes sense as transaction costs are the underlying reason smallholder farmers engage in AMCOS. In this regard, a TCT-based type of AMCOS 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 [38]. The theory has been widely used in agricultural economics studies and related fields in developing countries [39–42]. The limitation of using this theory is that it can be difficult to measure transaction costs, particularly in the context of smallholder rice farming. For example, it can be challenging to quantify the time and effort required to negotiate with buyers or to resolve disputes with input suppliers.

1.3. Characteristics of the studied AMCOS

This section summarizes the characteristics of the three co-operative societies that were the focus of this study. Kapunga AMCOS was initiated in October 2007 via local collective action with assistance from USAID. Kapunga has a relatively small member base (800 members). Although there is potential in offering similar services in the future, there was no financial support for members in the form of subsidized input costs or credit at the time the data was gathered. Agricultural training and study tours were organized by co-operative leadership for members of neighbouring co-operatives. Instead of using the co-operative, middlemen were used to sell most of the rice that was produced and few managed to sell at Chimala Centre which is 32 km from the scheme. All members under the irrigation scheme grew high-yielding improved variety TXD 306 (Saro 5). No land rent was paid to the co-operative society.

By comparison, UWAWAKUDA is older and formally organized with a member base of 949. By virtue of these differences, the

UWAWAKUDA offers some services that the Kapunga co-operative does not. The UWAWAKUDA cooperative was formed in 2007 via collective action and a government initiative with support from Agricultural Development Denmark Asia (ADDA) and Rural Economic and Agriculture Development Agency (READA). This AMCOS do not have a Saving and Credit Cooperative Society attached to it as it was a case of Kapunga and Madibira. It is the only AMCOS that was very close to a research institute (CHOLIMA Research Institute) compared to the other two co-operatives which had to travel to CHOLIMA, Uyole and TARI Ifakara) for similar services. The co-operative organizes training and demonstrations on farm preparations and use of inputs and has employed an extension officer. As for Kapunga, middlemen were used to sell most of the rice that was produced and few managed to sell at Dakawa town Centre which is 20 km from the scheme. Land rent is paid to the cooperative.

Madibira was the oldest, more formally organized with a member base of 3000. By virtue of its time of existence, it offers some services that the Kapunga and UWAWAKUDA co-operative does not. The Madibira co-operative was formed in 1997 via a government initiative with support from AFRICAN DEVELOPMENT FUND (ADF) and Rural Economic and Agriculture Development Agency (READA). This AMCOS has a Saving and Credit Co-operative Society attached to it as it was a case of Kapunga. This co-operative secured research services from CHOLIMA Research Institute, Uyole and TARI Ifakara. The co-operative organizes training and demonstrations on farm preparations and the use of inputs and shares a government extension officer found at the district level. As for Kapunga and UWAWAKUDA, middlemen were used to sell most of the rice that was produced and few managed to sell at Mafinga Centre which is 70 km from the scheme. Land rent was paid to the cooperative as one of its sources of income. In addition, the three co-operatives do not provide credit and agricultural inputs, such as fertilizer at subsidized cost to their members instead they organize the service providers for easy access by farmers.

2. Methodology

The study from which this paper emanates was conducted in Mbarali and Mvomero districts in Mbeya and Morogoro regions respectively. The districts were purposely selected for the study as they fall within suitable agro-ecological zones for rice production and are among the top rice-producing districts with a considerable number of rice value chain actors [8].

The study adopted a cross-sectional research design whereby data were collected at a single point in time. The study involved three hundred and eighty-two (382) respondents estimated using the [43] formula. From the two districts, three AMCOS were purposively selected, criteria for selection were good performance and involvement in the rice farming business. Kapunga smallholders and Madibira AMCOS were selected from Mbarali District while UWAWAKUDA AMCOS was selected from Mvomero District. The selection of respondents was done based on the sampling frame of 4749 members obtained from the AMCOS offices and the criteria was farmers with sizes of rice farms ranging from 0.9 to 3 ha in the irrigation scheme. The sampled individuals were selected from the list of farmers by using a simple random sampling technique. A structured questionnaire was used to collect quantitative information from individual smallholder rice farmers.

The analysis of costs and benefits associated with smallholder rice farming and estimating profitability realized by smallholder farmers was undertaken using an Enterprise Budgetary Technique (EBT) devised by Ref. [25]. The EBT was specified as follows:

Farm budget	Equation
TR	$\sum$ Income from paddy, rice, rice bran and broken rice
TIC	$\sum$ Intermediate costs
TLC	$\sum$ Labour costs
TVC	TIC + TLC
TVC	$\sum$ All variable costs
GM	TR-TVC
TFC	$\sum$ All fixed costs
TC	TVC + TFC
NP	TR − TC
PM (%)	(TR-TC/TR) 100
ROI	NP/TC
OER	TVC/TR
BCR	NFI/TC
Break-even price	TC/Yield
Break-even yield	TC/Sale price

Where: TR = Total Revenue, TIC = Total Intermediate Costs, TLC = Total Labor Costs, TVR = Total Variable Costs, GM = Gross Margin, TFC = Total Fixed Costs, TC = Total Costs, NP=Net Profit, PM= Profit Margin, ROI= Return on Investment, BCR= Benefit Cost Ratio, NFI=Net Farm Income. Competitiveness was determined using profit levels, which allowed for analyzing farmers' profitability based on PM.

To determine profit distribution among farmers, profitability percentiles were calculated using the weighted average method and Tukey Hinges for quartiles calculation [44,45]. The profitability structure and distribution were determined by categorizing profits or loss earning scale as less than 5%, 5%–25%, 25%–75%, 75%–95% and 95%–100%. The medium profitability was from the 1st quintile to the 3rd quintile which is the inter-quintile range. Extreme outliers in the distribution were used to categorize extreme losses from 0% to 5% and extreme profits from 95% to 100%. Low profit/loss 5%–25% and high 75%–95%.

In this study, Sensitivity Analysis was undertaken to assess the risk-bearing ability of smallholder rice farmers under varying

circumstances of price and yield and variable costs [46]. This method was used to assess the effect of output price, yield and variable costs on the gross margin as a measure of the profitability of the enterprise by varying 10% above and below (that is ±10%) the received price, attained yield and total variable costs of rice farming.

Break-even analysis is a useful tool for determining the minimum price or yield required for a business to cover its costs and achieve a profit of zero. Regardless of whether it optimizes profit, an organization frequently finds it useful to understand what price (or output level) must be reached for total revenue to be exactly equal to the total costs [30]. This can be done with a break-even analysis and in this case, break-even analysis was done to determine the minimum output and price necessary to prevent a loss for the smallholder rice farming business

$$\text{Break} - \text{even price} = \frac{Total\ Costs}{Yield}$$

The agricultural operation generates an economic profit if unit farm-gate prices are higher than the break-even price.

$$\text{Break} - \text{even yield} = \frac{Total\ Costs}{Sale\ price}$$

The smallholder rice farming business makes a profit if per-acre yields are higher than the break-even yield.

Table 1
Average Farm Budget Structure among Smallholder Rice Farmers (in TZS per acre).

	AMCOS			
Budget Items	Kapunga	Madibira	UWAWAKUDA	Overall
Income from paddy	1120821.32	1109510.64	1247351.80	1142378.71
Income from milled rice	238519.13	244498.25	118901.13	215252.03
Income from rice bran	0.00	33.76	0.00	20.68
Income from broken rice	1892.45	3524.36	527.13	2584.73
Total Revenue(TR)	**1361232.90**	**1357567.02**	**1366780.07**	**1360236.15**
Ploughing cost	54790.32	61064.10	45011.63	56431.94
Harrowing cost	56516.13	59645.30	42976.74	55384.82
Cost of borrowing land	81225.81	99572.65	0.00	74178.01
Cost of seeds	38915.32	43162.45	39413.36	41629.09
Cost of Planting fertilizer	61426.08	25594.53	65517.44	40398.00
Cost of topdressing fertilizer	97125.84	106429.16	79477.91	98851.64
Cost of Insecticides	3088.71	137.18	6216.28	1984.82
Cost of Herbicides	16445.48	13563.95	16118.60	14606.76
Cost of pesticides	4125.16	845.64	4953.49	2302.72
Harvesting	130451.61	131854.70	74534.88	118722.51
Transport	49653.23	59215.81	47372.09	54997.38
Storage	36911.29	17128.21	26831.40	22523.56
Cost of Sacks	25567.42	23333.85	22050.00	23407.33
Total Intermediate Costs (TIC)	**656242.40**	**641547.53**	**470473.83**	**605418.58**
Nursery preparation	13951.61	11345.30	20546.51	13839.79
Transplanting	70496.77	84318.80	101279.07	85893.72
Planting Fertilizer application	4474.19	2034.19	5825.58	3283.77
Top Dressing application	6277.42	6239.32	5488.37	6076.44
Herbicide application	5370.97	5989.32	5372.09	5750.00
Pesticide application	2903.23	641.03	2744.19	1481.68
Insecticide application	1000.00	123.93	1872.09	659.69
Weeding	47677.42	43585.47	47406.98	45109.95
Bird scaring	967.74	45017.09	88081.40	47562.83
Irrigation labor	548.39	504.27	1744.19	790.58
Loading and offloading	14483.87	14497.86	12936.05	14143.98
Drying labor	15941.94	22793.59	17867.44	20572.51
Levelling labor	4774.19	9307.69	0.00	6476.44
Total Labor Costs (TLC)	**256879.03**	**250581.20**	**253889.53**	**252348.17**
Total Variable Cost (TVC)	913121.44	892128.72	724363.36	857766.75
Gross Margin (GM)	448111.47	465438.30	642416.72	502469.40
Cost of renting land	0.00	70000.00	50000.00	54136.13
Irrigation cost	34000.00	78800.00	68000.00	69097.38
Total Fixed Costs (TFC)	**34000.00**	**148800.00**	**118000.00**	**123233.51**
Total Costs (TC)	**947121.43**	**1040928.72**	**842363.36**	**981000.26**
Net Profit (NP)	**414111.47**	**316638.29**	**524416.71**	**379235.89**
Profit Margin (PM) %	**27.18**	**19.23**	**35.21**	**24.12**
Raturn On Investment (ROI)	**0.47**	**0.33**	**0.64**	**0.42**
Operating Expenses Ratio (OER)	**0.70**	**0.69**	**0.56**	**0.66**
Benefit To Cost Ratio (BCR)	**1.47**	**1.33**	**1.64**	**1.42**
Break-even yield	1990.54	2248.52	1513.05	2035.91
Break-even price	354.61	378.17	364.65	371.31

3. Findings and Discussion

3.1. Smallholder rice farmers benefit-cost analysis

The findings on revenues as presented in Table 1 indicate that the average revenue of 1 360 236TZS was obtained by smallholder rice farmers per acre. This means that on average the sales from paddy, rice, rice bran and broken rice amounted to an average of 1 360 236TZS per acre for every farmer. The findings are comparable with the average revenue of 1 218 270 TZS observed earlier among smallholder rice farmers reported by Ref. [15]. The findings of this study differ from the average revenue of 2 030 000 TZS reported by Ref. [22] in the profitability analysis of Ofada rice production in Nigeria.

The breakdown of costs in rice farming per acre is illustrated in Table 1. On average, rice farmers incurred a total cost amounting to 981 000 TZS which was the summation of Total Variable Costs (857 766 TZS) and Total Fixed Costs (123 233 TZS). Total Variable Costs were the summation of TIC and TLC while Total Fixed Costs were the sum of irrigation costs and land rent costs paid to the co-operative society at the beginning of every season. The highest costs were experienced in Madibira while the lowest costs were in UWAWAKUDA. These results on TC differ from [16]'s earlier estimates of 621 348 TZS, 753 520 TZS by [22], and 562 000TZS by [47], but they are broadly similar to earlier 846 470 TZS estimated by [10]. The most interesting finding was that; the average TLC was estimated to be 252 348 TZS. The findings of the current study are different from those reported by [18,47]. A possible explanation for these results is the use of machines in most of the activities reported in previous studies being done by humans including ploughing, transport, and harvesting.

The findings in Table 1 show that, UWAWAKUDA farmers had a Profit Margin (35%) higher than the overall average (24%). This means that farmers in UWAWAKUDA were selling their produce at a high-profit level compared to the rest of the farmers. This is due to the fact that; UWAWAKUDA worked closely with a research institute and is situated about 21 km from the main road where most input suppliers and traders were found. These results are informed by Porter's Diamond model of competitiveness which postulates that supportive and related industries such as research institutes enhance the competitiveness of a firm. Also, UWAWAKUDA had the lowest transaction costs in terms of transport (47,372 TZS) which supports the TCT which explains the effect of transaction costs on profit levels. The overall results differ from the estimates of 45% in Ethiopia and Nigeria [20,48]. The findings in Table 1 show that the overall mean Return on Investment (ROI) per farmer was 0.42 which means that, for each 1TZS invested in rice production; a farmer received 0.42 TZS as a gross margin. Thus, from the overall profitability analysis result, irrigation scheme rice farming is a profitable enterprise in the study area. This is an indication that smallholder rice farmers in the study area were able to meet the demand, wishes and needs of the markets as explained in the second attribute of Porter's Diamond model of competitiveness.

The overall average BCR of 1.422 shown in Table 1 indicate that the expected benefit exceeds the expected Total Costs. This means that the Total Costs have to rise by 42.2% before the ratio would be reduced to a break-even point. The Gross Margin of rice has been calculated by deducting the total variable cost from the total return which was 502469TZS per acre as shown in Table 1. This indicate that, after deducting all the variable costs associated with producing one acre of rice, farmers are left with a profit of 502 469 TZS. This is a positive sign for the farmers, as it suggests that rice farming is a profitable venture for them, at least in the short term.

Results on break-even analysis show that the break-even price in paddy was found to be 371.31 TZS per kilogram whereas the break-even yield was 2035.91 kg per acre. This means that the smallholder rice farmers need to sell their paddy at a minimum price of 371.31 TZS per kilogram (kg) in order to cover their total costs and break even. Similarly, the break-even yield was found to be 2035.91 kg per acre, which means that the farmers need to produce at least 2035.91 kg of paddy per acre in order to cover their total costs and break even. If they produce less than this amount, they will not be able to cover their costs and will incur losses.

Therefore, smallholder rice farmers should take advantage of this profitability by investing the money into other economic activities for improved livelihood. The findings compare well with those reported by other studies [11,16,20,49]. Other scholars [10,15] have also reported high returns among smallholder rice farmers.

3.2. Profit distribution among smallholder rice farmers

The findings on profit and loss among smallholder rice farmers in the study area as presented in Table 2 ranged from −469600 to 1008500 TZS. In UWAWAKUDA, 10 (11.64%) smallholder farmers had profits at > 95 percentile, while only 5 (2.14%) farmers in Madibira and 4 (6.45%) in Kapunga were found at the same level. The results entail that the proportion of UWAWAKUDA farmers in

Table 2
Descriptive statistics for profit/loss percentiles.

Percentiles	Profits Groups (TZS)	AMCOS					
		Kapunga		Madibira		UWAWAKUDA	
		n	%	n	%	n	%
<5%	−469600 to −241449	2	3.23	16	6.84	1	1.16
5%–25%	−241450 to 166750	9	14.52	59	25.21	8	9.30
25%–75%	167000 to 625750	35	56.49	117	50.00	40	46.51
75%–95%	626000 to 835595	12	19.35	37	15.81	27	31.40
>95%	836000 to 1008500	4	6.45	5	2.14	10	11.64
Total		**62**	**100**	**234**	**100**	**86**	**100**

the extreme profits category was more than twice as large as that of farmers at Kapunga and Madibira. There was a higher proportion of farmers with extreme profits in UWAWAKUDA compared to the other AMCOS since the mentioned co-operative society was more formally organized and was able to provide farmer training from the co-operative extension and obtained seeds from the research institute at low costs. The findings are informed by the TCT that smallholder farmers made informed decisions and actively participated in the market due to minimum transaction costs.

At Madibira AMCOS, 75 (32.05%) farmers had profits/losses at less than 25 percentile as extreme loss among farmers. This means that the proportion of farmers in Madibira in the extreme loss category was more than twice as large as the UWAWAKUDA and among Kapunga smallholder farmers. However, 117 (50%), 40(46.51%) and 35 (56.49%) farmers in Madibira, UWAWAKUDA and Kapunga had their profits in the inter quintile range of 75%–95% (medium) of profits (Table 2). This means that at least half of smallholder rice farmers in every AMCOS had their profits at the medium level. The findings observed in this study compare well with those reported by [20,50] in Liberia and Ethiopia who reported a significant number of rice farmers with medium profits from rice farming respectively.

The Majority (88.5%) of smallholder farmers in the surveyed AMCOS made profits while 11.5% of farmers had negative profits (loss) as shown in Fig. 1. This result indicates that, on average, the smallholder farmers were able to generate a positive return on their investment in farming activities. This is a positive sign for the smallholder farming sector, as profitability is a key factor in ensuring the sustainability of farming operations. The findings are similar to those reported by [22,31] in Tanzania and Nigeria respectively.

3.3. Sensitivity Analysis

Sensitivity analysis results in Table 3 show that there is a relationship between total variable costs, output price, yield and the Gross Margin of smallholder rice farmers in the study area. Results indicate that smallholder rice farming was likely to be more sensitive to both price and yield than total variable costs. With a 10% increase in total variable costs, a smallholder rice farming resulted in a Gross Margin of 416 693 TZS which is a 17% decrease while a 10% decrease in the same variable, a smallholder rice farmer resulted in a Gross Margin of 588 246 TZS which is a 17% increase. The implication is that smallholder rice farmers' profitability is sensitive to changes in variable costs. The results of the present study corroborate those of [30] where a decrease or increase in total variable cost by 10% increases or decreases the Gross Margin by 11% in rain-fed upland rice production managed by smallholder farmers in Ethiopia.

The findings in Table 3 show that, a 10% (%) decrease or increase in output price brought a 27% decrease or increase in Gross Margin. A slight change in output price has a substantial effect on the profitability of smallholder rice farmers. This means that smallholder rice farmers' profit margins are significantly affected by changes in the price they receive for their rice. In particular, a 10% increase in the price they receive for their rice leads to a 27% increase in their Gross Margin, while a 10% decrease in the price they receive for their rice leads to a 27% decrease in their gross margin. Similarly, a 10% increase in yield leads to a 27% increase in their Gross Margin, while a 10% decrease in yield leads to a 27% decrease in their Gross Margin obtained by smallholder rice farmers. This means that smallholder rice farmers' profit margins are significantly affected by changes in the amount of rice they are able to produce per acre. Similar results were found in a study by Ref. [30] where a 10% decrease or increase in the price and yield of rice grain brought 18% decrease or increase in Gross Margin in smallholder rain-fed upland rice farming in Ethiopia.

4. Conclusions and Recommendations

The Gross Margin, Benefit Cost Ratio, Return on Investment and Break-even analysis results suggest that Smallholder rice growing under irrigation schemes managed by AMCOS is a profitable business that should be encouraged considering the changing consumer preferences in Tanzania. Farmers in UWAWAKUDA have been able to achieve higher profits than the rest of the farmers due to their close collaboration with a research institute and proximity to input suppliers and traders. Alongside profitability, smallholder rice farming was sensitive to changes in total variable costs, yield and output price as shown in the sensitivity analysis results. Since smallholder rice farming is a profitable business, the findings of this study suggest that its production could enhance self-sufficiency and foreign exchange earnings in Tanzania.

It is therefore recommended that AMCOS should build farmers' capacity on the proper use of inputs such as fertilizers and herbicides to reduce costs of production per acre. A well-managed program or mechanism that aims at increasing rice yield per area, and

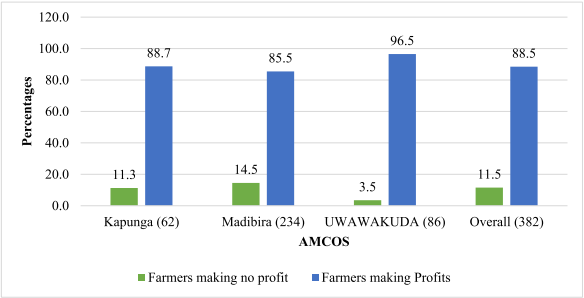

Fig. 1. Profit distribution among smallholder farmers.

Table 3
Sensitivity analysis of smallholder rice farming.

Item	Actual	TVC per acre		Price of rice/paddy		Yield of rice/paddy	
		10% Increase	10% Decrease	10% Increase	10% Decrease	10% Increase	10% Decrease
Total Variable Cost (TVC)	857767	943543	771990	857767	857767	857767	857767
Paddy yield sold (kg/acre)	2345	2345	2345	2345	2345	2579	2110
Unit price (TZS)	453	453	453	498	408	453	453
Value of paddy (TZS)	1142379	1142379	1142379	1256617	1028141	1256617	1028141
Rice yield sold (kg/acre)	278	278	278	278	278	306	251
Unit price (TZS)	841	841	841	925	757	841	841
Value of rice (TZS)	215252	215252	215252	236777	193727	236777	193727
Value of rice bran (TZS)	21	21	21	21	21	21	21
Value of broken rice (TZS)	2585	2585	2585	2585	2585	2585	2585
Total return	1360236	1360236	1360236	1495999	1224473	1495999	1224473
Gross margin	502469	416693	588246	638232	366706	638232	366706
% change in gross margin		−17	17	27	−27	27	−27

organizing markets and value addition should be introduced. This can be implemented through bulk procurement of inputs by the co-operative society or by organizing for the suppliers. A good practice of organizing input suppliers for easy access was observed in UWAWAKUDA, and hence it can be a derivative of other co-operatives. Further studies should be done to evaluate smallholder rice farmers' profitability in terms of NPV and IRR. The profitability of rice farming in the irrigation schemes could be enhanced and become more attractive by farmers seeking market information on output prices prior to selling and organizing group marketing. The study recommends policies that will improve linkages between farmers and co-operatives for better implementation of agronomic practices to improve farmers' yields. Also, a fair price policy should be designed by the Local government in collaboration with AMCOS to control price fluctuations in rice so that smallholder rice farmers can earn more profit from rice and invest in other economic activities for improved livelihood.

Author contribution statement

C. Mauki: Conceived and designed the analysis; Analyzed and interpreted the data; Wrote the paper.
J. Jeckoniah, G. D. Massawe: Conceived and designed the analysis; Contributed analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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