 

# Rice Commercialization in Mngeta Kilombero District, Tanzania: Policy Implications for Inclusive Poverty Reduction

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*The research was funded by the United Kingdom (UK) Foreign, commonwealth Development office (FCDO) formerly known as Department for International Development (DFID) which supported the Agricultural Research Programme in Africa (APRA) consortium*

**Abstract**
Agricultural commercialization is sought for its effect on productivity, income and livelihood improvement. Rising agricultural commercialization also contributes to employment, foreign currency and government revenue through taxes. It may however have various undesirable outcomes. Rising commercialization from area expansion may increase the smallholders' vulnerability if they sell part or all of their land. Meanwhile, intensification can have negative effects from increasing use and poor handling of agrochemicals. This paper used pooled cross section data on rice commercialization from Mngeta division in Kilombero valley, Tanzania;

collected in two waves (2017 and 2019), to assess commercialization levels among different farmer categories and its impact of on livelihoods and social inclusion. The paper addresses three basic questions; Are commercialization levels dynamic over time? Do commercialization levels differ across farmer categories? Is rice commercialization poverty reducing at all levels? The analysis compares across farmer categories, the effect of commercialization influencing factors and the subsequent effect of rice commercialization on livelihood outcomes. The findings show that commercialization is happening through intensification and extensification but it is not yet on a steady increasing trend and both options have sustainability implication. Meanwhile, poverty reduction is observed across all farmer categories due to rice commercialization and diversified livelihood options, however it is only significant above the fourth quintile (>60% with a social difference). Gender, age and cultural norms are identified as exclusion barrier that need to be addressed in order to enhance inclusion of those benefiting less from agricultural commercialization processes. These finding inform village, district and national level decision makers as they strive to overcome inclusion barriers
**Keywords:** Commercialization, inclusion, diversification, rice, poverty reduction, Kilombero, Tanzania
**DOI:** 10.7176/DCS/12-7-04
**Publication date:**September 30th 2022

## 1. Introduction
### 1.1 Background
Agricultural commercialization is sought by governments and development partners because it has been associated with agricultural intensification and productivity improvements (Gebreslassie et al., 2015; Djurfeldt, et al., 2019). Commercialization is expected to raise farmers' income and lead to subsequent livelihood improvement (Hagos & Geta, 2016; Ochieng, et al., 2019). However, agricultural commercialization is highly dynamic, affected by a wide range of biophysical, technological, socio-cultural, economic, institutional and policy related factors that change overtime (Louw et al., 2008; Gupta et al., 2019; Pingali et al., 2019). These changes may have positive or negative impacts on agricultural commercialization and livelihoods. The negative impacts being more pronounced among women, youths and the elderly, who tend to be more vulnerable and resource poor members within communities (Doss & Morris, 2001; Ajani & Egbokwe, 2013). Hence, not everybody benefits from agricultural commercialization processes.

Agricultural commercialization pathways have been defined in terms of farming scale – small, medium or large (Ogochukwu & Westhuezen, 2020; Omotilewa et al., 2021); interaction among farmers – out grower, contract farming or cooperative (APRA, 2016) or intensity of resource use (Sekyi, et al., 2021; Pingali & Rosegrant, 1995). The pathway chosen by each household depends on the opportunity space available to them, which is a function of their resource endowment as well as their own ingenuity and dexterity to use them. Such opportunities are also influenced by larger drivers such as resource governance, institutional arrangement, market development and accessibility, population growth, climate change and other context specific factors (Binswanger & Rosenzweig, 1986; Oya, 2007; Pingali et al., 2019). Hence the impacts of commercialization are likely not homogenous among farmers' groups (Cazzuffi, et al., 2020). Some farmers may be able to use such opportunities to step up or even step out into non-agricultural enterprises. Other farmers simply hang in there due to various constraints they are facing, hoping things may improve in future, while others fail to sustain within agriculturally based livelihoods, forcing them to step down; sometimes, moving into destitution (Dorward, 2009).

This paper is motivated by the fact that such different categories of farmers may require different interventions to enhance the benefits they derive from agricultural commercialisation. For instance, the relationship between the level of productivity and commercialization can be positive or negative. Higher productivity (intensification) is expected to increase commercialization and it may present an incentive to adopt more productive technologies and stimulate further commercialization (Andersson 2012; Djufeldt et al., 2019). Increased income is expected to have an impact on welfare in terms of reduced poverty, increased food security among other impacts (Zhoul et al., 2013; Hagos & Geta, 2016). Increasing marketed surplus and higher commercialization can also be obtained from area expansion (extensification). Under both commercialization pathways however, price volatility and other risks associated with factor and product markets may undermine such gains (Pingali & Rosegrant, 1995; Khamaldin et al., 2013). Differences in resources endowment, entrepreneurial skills and risk aversion distinguish the productivity and commercialisation pathways pursued by each farmer (Andersson, 2012).

Most studies have used cross sectional data to assess the impact of agricultural commercialization on livelihood outcomes. This paper uses longitudinal data (two waves) to assess the dynamic influence of rice commercialization and other factors on livelihood outcomes among farmers in Mngeta division, Kolombero district in Tanzania where the Kilombero Plantation Limited (KPL) is also located. This large scale farm (5,800 ha) was expected to have positive technological and market spill-over effects to smallholder farmers in their vicinity. It is on this basis that the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) development program was launched in 2010 as a public-private partnership (ppp) initiative, dedicated to ensure food security, reduce poverty, and spur economic development in Tanzania's Southern Corridor. Kilombero is one of the clusters under this initiative, with a particular focus on smallholder support and development of viable commodity value chains (Bergius et al., 2017; Mongula & Makundi, 2020; Hartmann, et al., 2021) rice being the most important.

This paper addresses three main questions; (i) Are commercialization levels dynamic over time? (ii) Is rice commercialization poverty reducing at all levels and for all farmer categories? (iii) What are the policy implications of rice commercialization for inclusive poverty reduction? Addressing these questions is deemed important because rice commercialization can be a key strategy that smallholder farmers use, combined with other agricultural activities (crops and livestock) and non-farm activities including employment, for livelihood improvement. The rest of this paper is organised in three sections. In the next section we present the conceptual framework followed by the methodology in section 3. Section 4 presents the findings and discussions. The final part presents the conclusions and recommendations including policy implications.

## 2.0 Conceptual Framework

Several authors (Hagos & Geta, 2016; Ochieng et al., 2019) reported that agricultural commercialization improves livelihoods due to higher income earned. However, income is not a good indicator of livelihood and wellbeing (Kirui and Njirau, 2013; Ogut and Quam, 2018), since the cost of translating income into wellbeing varies across households depending on individual attributes and availability of services within localities (Sen, 1999). Alkire et al. (2016), proposed that poverty should be measured using the Multi-poverty index (MPI), an indicator that comprises; assets, health, education and a household's nutrition attributes. The MPI is adopted as the indicator to assess and compare livelihood outcomes of rice commercialization (Annex 1), after controlling for some household and community factors. We assume that differences in commercialization pathways among farmer categories will lead to differences in livelihood impacts. The study hypothesized that commercialization impacts would differ across farmers depending on their distance from KPL, which interacted with surrounding farmers through employment (casual and permanent). The KPL also supported a training programme that had a credit component to enhance the adoption of sustainable rice intensification (SRI) technologies. Farmers were trained to follow a set of agronomic practices that include seed selection, spacing, water management and regular weeding (Katambara, et al., 2013; Samant, 2017). Farmers who belonged to these SRI groups were sampled as a specific stratum for comparison with non-members. Villages were also expected to differ in their commercialization outcomes according to their electricity status since electrification attracts processors who invest in machinery that improve the quality of milling, thereby improving the farmers' returns (Isinika et al., 2020). Farmers who benefit from technological and market spill over effects from KPL were expected to attain higher livelihood improvement over time.

## 3. Methodology

### 3.1 The study area

The study was conducted in Mngeta division, Kilombero district in Morogoro region. The district was purposively selected because Kilombero Plantation limited (KPL) – a large scale farm (5,800 ha) – is located in Mngeta division, making it possible to test for spill over effects to surrounding small scale farmers (SSF) as well as medium scale farmers (MSF). The study area is also an important rice producing district in Tanzania. In this area rice is the most important economic activity for over 80% of the population (Kato, 2007; Msuya, Isinika & Dzanku, 2018). This paper uses data that was collected in two waves (2017 and 2020 for 2019 the crop season) under the Agricultural Policy Research in Africa (APRA) to assess farmers' commercialization pathways and livelihood outcome.

Kilombero valley is a floodplain, covering about 11,600 km$^2$ suitable for paddy/rice production. The other crops include maize, bananas, cassava, vegetables, cocoa and teak tree species meant for timber. Cattle, goats, sheep and local chicken are key livestock kept in the study district. Livestock numbers have increased, especially after 2010, following immigration of pastoralists and agro-pastoralists seeking pastures in the flood plain (Mwamfupe, 2015). This has also increased the use of animal drawn technology, which provided farmers the option to increase rice productivity and subsequent commercialization through the extensification pathway.

Nevertheless, expanding rice production within the flood plain has raised environmental concerns in terms of water pollution, and pesticides effects (Walsh, 2012; Mlay et al., 2022). Meanwhile, electrification of rural villages in recent years has encouraged farmers to expand and intensify rice production because it has improved the quality of processing as diesel single pass milling machine have been replaced by more efficient electric two pass mills (Alemu et al., 2021), thereby facilitating commercialization along the rice value chain via improved processing, storage, communication and transfer of payment. Similar findings have been reported elsewhere (Dinkelman, 2011).

Farmers were classified according to farm size as SSF – cultivating < 5 ha, MSF – cultivating 5 – 20 ha or large scale farmers having > 20 ha. This stratification has been adopted by the Ministry of Agriculture as well as other researchers (Jayne *et al.,* 2016; Wineman et al., 2020). In the original sample (2017) sixteen out of 537 respondents had farms between 21 and 200 ha, putting them in the large-scale category. However, relative to KPL, which has 5,800 ha, even these farms, exceeding 20 ha, were for the purpose of this study classified as medium scale.

### 3.2 Survey Design

A two-stage sampling design was used to select villages and farmers. In the first stage, by stratified sampling, ten villages were selected from within a 30 km radius of KPL representing three strata according to their electricity status. The number of villages was limited to ten due to budgetary constraints. Four villages came from the first stratum where electricity was present during the first wave of data collection in October 2017. Another four villages came from the second stratum, where electricity was expected to be installed by 2018 – one year before collecting the second wave of data, scheduled for 2019. These were referred to as switch villages. The last two villages were selected from the third stratum, where there would be no electricity by 2019. The four villages selected for the first stratum are; Chita, Itongoa, Mngeta and Mchombe. The switch villages in the second stratum are; Makutano, Nakaguru, Mkusi and Njage. In the third stratum we have Ijia and Luvilikila villages where there would be no electricity by 2019 when the second wave of data was to be collected.

During the first wave 537 households were selected from a population of 7,156 households. From each village, respondents were selected proportional to its size, such that larger villages had more respondents. Within each stratum, once the required sample size for each village was established, farmers were selected randomly, followed by post-stratification to fit them in into their respective categories (SSF and MSF) as described earlier. As stated earlier, the entire population of SRI members present in a village was sampled because their number was limited. During the second wave, the sample of SSF and MSF was increased raising the sample size was increased to 807 households, due to high attrition of the first sample (31%) attributed to seasonal migration of farmers, a common in this area. About 23.5% and 19.7% (around one fifth) of farmers use rented land during 2017 and 2019 respectively (Isinika et al., 2020). The sample composition is summarized (Table 1).

**Table 1. Sample composition after post stratification**

| **Household Characteristics** | | **2017** | | **2019** | |
|---|---|---|---|---|---|
| | | **Number** | **%** | **Number** | **%** |
| Electricity status | With Electricity | 223 | 41.5 | 667 | 82.7 |
| | Without Electricity | 314 | 58.5 | 140 | 17.3 |
| Gender of household (HH) head | Female | 66 | 12.3 | 129 | 16 |
| | Male | 471 | 87.7 | 678 | 84 |
| Farmer category | Small scale farmer (SSF) | 357 | 66.5 | 622 | 77.1 |
| | Medium scale farmer (MSF) | 74 | 13.8 | 94 | 11.6 |
| | Sustainable rice intensification (SRI) | 106 | 19.7 | 91 | 11.3 |
| | Whole sample | 537 | 100 | 807 | 100 |

### 3.3 Commercialization and livelihood indicators

It was expected that inclusive agricultural commercialization processes would close the gap between farmer categories, measured by indicators of productivity, production, share of sale and livelihood. On this basis, the wider APRA study tested the influence of rice commercialization on livelihood impacts including poverty, food security and dietary diversity for women of reproductive age (APRA, 2016). Normally, the household commercialization index (HCI) – an aggregate share of all crops sold – is used to determine the level of crop commercialization. However, in this study area rice accounts of over 90% of the crops grown, covering about 75% of all the plots and land under crops. On this basis, a case was previously made to use the rice commercialization index (RCI) – a share of rice that is sold per household – instead of the HCI (Isinika et al., 2020). This paper focuses to test two hypotheses based on which policy recommendations are made. Firstly, the RCI is used to test the dynamism of rice commercialization over time, responding to the question, are there significant differences in rice commercialization between the two waves (2017 and 2019). We use descriptive data only to compare the commercialization levels between the two intervals. The determinants of rice commercialization were already established using the first wave data and qualitative analysis revealed that these did not change significantly during the two year interval. They include; years of schooling of the household head, total land owned, access to extension services, use of inputs (organic inorganic fertilizer, herbicides and tillage serves) and non-farm income. These had a significant positive influence on rice commercialization ($p<0.1$ – $0.01$). The household size and age of the household head had a significant negative influence ($p<0.05$) on rice commercialization. The SSF were likely to be less commercialized than MSF and SRI members (Isinika et al., 2021

Secondly, we use the MPI, to test the influence of rice commercialization on livelihood impacts. We begin by testing whether livelihood changes (improvement or deterioration) were homogenous across farmer categories. As already stated, the MPI is a weighted index representing different aspects of livelihood as summarized in Annex 1. The farmers were categorized on the basis of gender, age and commercialization levels. Comparison was also made for indicators that relate to input use, quantity of paddy harvested and yields. The influence of electrification on the RCI and MPI is measured by the distance to the nearest large electric mill — a proxy that captured the farmers' response via productivity improvement (intensification) and area expansion (extensification). Descriptive analysis compares the input use and commercialization outcomes across farmer categories and between the two waves. The results are presented and discussed below.

### 3.4 Influence of rice commercialization on livelihood impacts

We use the MPI to assess the determinants of welfare outcomes using a pooled probit model as indicated by equation 2, which is obtained from the index model presented in equation 1.

$$Y_{it}^{*} = X_{it}\theta + \epsilon_t \quad \text{.................................................... .........} \quad (1)$$

Where:

$Y_{it}^{*}$= a continuous latent variable reflecting the level of household well-being in year t

$x_t$ = RCI and control variables influencing y* in year t

$\epsilon_t$ = idiosyncratic error terms assumed to be independent, identical and normally distributed

θ = parameters to be estimated.

A pooled fractional probit model is chosen because it is better for handling an unbalanced sample between two waves as is the case in this study. Such models allow for quantification of correlated random effects (CRE) or average marginal effects (CAMF) for heterogeneity of the dependent variable given the covariates (Wooldridge, 2019). The CRE approach can also be applied to non-linear models without modification for unbalanced panels. Other researchers, such as Goetz (1992) have used the endogeneity switching model to overcome selectivity bias due to unobserved variables affecting market participation. Meanwhile, Muricho (2017) used a Double huddle model to estimate welfare impacts of commercialisation using the CRE framework. But, the pooled fractional probit model that is presented in equation (2) is preferred for its simplicity (Wooldridge, 2019) and is used in this study.

Let $Y_{it}$ be the observable well-being status of a household, presented as a dummy variable assigned a value of 1 or zero, then,

$$P_{(Y_{it}=1)} = \theta(X_{it}\beta) \text{.......................................................................} \quad (2)$$

Where:

$\theta(X_{it}\beta)\Phi(x_{it}\theta)$= is the normal cumulative distribution function leading to a probit model

The choice of variables for this model was informed by similar previous studies as well as specific local conditions. Such studies, assessing the influence of agricultural commercialization on livelihood impacts, have included demographic factors, physical and financial capital, social capital and transaction cost as covariates (Muricho, et al., 2017). Similar variables have also been used by Muricho (2015) as well as Ogutu and Qaim (2018) among others. The main focus in the current study is to determine the influence of rice commercialization on household welfare outcomes after controlling for other factors. The variables used in the probit model (equation2) with corresponding expected signs are presented in table 2.

**Table 2. Variables used in estimating the welfare outcome equations**

| Variable | Description | Expected sign |
|---|---|---|
| Year of survey | Dummy variable assigned a 1 if second wave | -/+ |
| Youth | Dummy for age category, 1 if household head is below 35 years old zero otherwise | -/+ |
| Education | Years of schooling | - |
| Gender | Status of household head a dummy variable assigned a 1 if female and 0 otherwise | + |
| Household size | Number of people in a household | + |
| Electricity | Dummy variable assigned a one if the village has electricity. Electricity opens opportunities for additional sources of income and provision of social services | - |
| Total land holding (ha) | Number of hectares used to produce paddy and other crops | - |
| Total household income (100,000 TZS) | Total income for the household aggregated from all sources | - |
| Q2_RCI | Second commercialization quintile (RCI 21-40%) | - |
| Q3_RCI | Third commercialization quintile (RCI 41-60%) | - |
| Q4_RCI | Fourth commercialization quintile (RCI 61-80%) | - |
| Q5_RCI | Fifth commercialization quintile (RCI 81-100%) | - |

| Variable | Description | Expected sign |
|---|---|---|
| Farmer type 1 | Dummy variable assigned a 1 if MSF and zero otherwise. | - |
| Farmer type 2 | Dummy variable assigned a 1 if SRI members and zero otherwise | - |

## 3. Results and Discussion

### 3.1 Sample description

The sample comprised of 537 and 807 households in 2017 and 2019 respectively (Table 1). The proportion of households with electricity increased from 41.5% in 2017 to 82.7% in 2019 because the three switch villages had been connected as envisaged. Correspondingly, the proportion of villages without electricity decreased from 58.5% to 17.3% during the same interval. The sample was dominated by male headed households (MHH) accounting for 87.7% in 2017 but the proportion of female headed households (FHH) increased slightly from 12.3% in 2017 to 16% in 2019. In terms of farm size and use of technology, the sample is dominated by SSF whose proportion increased from 66.5% to 77.5% in 2019 leading to a slight decline of MSF from 13.8% to 11.6%. The proportion of SRI members also decreased from 19.7% to 11.3% due to attrition and an enlarged sample size, since all SRI members in selected villages were sampled during the first wave.

**Table 3. Sample characteristics of household heads**

| Farmer category | Age | | Education | | Household size | |
|---|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | Mean | Median |
| With electricity | 48.2 | 47 | 6.6 | 7 | 4.9 | 5 |
| Without electricity | 45.8 | 44 | 5.5 | 7 | 6.2 | 6 |
| Difference | -2.4*** | -3*** | -1.1ns | 0ns | +1.3*** | +1*** |
| FHH | 48.7 | 47 | 5.0 | 7 | 4.3 | 4 |
| MHH | 47.2 | 46 | 6.4 | 7 | 5.5 | 5 |
| Difference | -1.5ns | -1ns | +1.4*** | 0 | +1.2*** | +1*** |
| SSF | 46.2 | 44 | 6.2 | 7 | 4.9 | 5 |
| MSF | 50.4 | 49 | 5.2 | 7 | 8.3 | 8 |
| SRI member | 50.9 | 50 | 7.3 | 7 | 5 | 5 |
| Difference | +4.7*** | +6*** | +1.1*** | 0ns | +3.4*** | +3*** |
| Whole Sample | 47.4 | 46 | 6.2 | 7 | 5.3 | 5 |

(***) Significant at ($p<0.01$); ns = Not significant

The sampled household heads had a median and mean age of 46 and 47.4 years respectively (Table 3). There was no significant age difference between household heads by gender but SSF were significantly younger ($p<0.01$) than MSF and SRI members while farmers in villages without electricity were significantly younger ($p<0.01$) than those in villages with electricity, probably because the former were mostly recent immigrants. In Tanzania, primary education up to seventh grade is compulsory. Hence, the median education level is seven for all farmer categories. However, the mean varies, being significantly lower ($p<0.01$) for MSF compared to SSF and SRI members. The mean for SRI members is highest, being above seven, which implies within this group there were more farmers with secondary and tertiary education, an important factor for technology and financial inclusion (Ajani & Egbokwe, 2013; Asuming, Osei-Agyei & Mohammed, 2019). The education level was significantly lower ($p<0.01$) for FHH compared to MHH, which may affect their inclusion for some technologies that require cognitive skills (Doss & Morris, 2001; Ajani & Egbokwe, 2013). The median household size was 5 but the mean was slightly higher at 5.3 because MSF had significantly larger families with a median and mean at 8 and 8.3 respectively compared to corresponding value of about five for SSF and MSF. Households in villages without electricity had significantly larger families because this is where most of the MSF resided. Also MHH had significantly larger families ($p<0.01$) than FHH, which may have labour shortage implications for the latter.

### 3.2 Changes in use of inputs and productivity

Agricultural commercialization involves increasing the use of purchased inputs leading to productivity improvement (Djurfeldt et al., 2019). For most of the analysis in this paper median values are used instead of means because it is less sensitive to extreme observations. There is a general decline in the median land holding as well as land under rice for most farmer categories with the exception of farmers in villages without electricity, whose median increased by 0.41ha (20%). Meanwhile, the median land of MHH, MSF and SRI members represent an insignificant decline or stagnation (Table 4).

**Table 4. Median size of land holding and area under rice**

| Farmer attribute | Total land (ha) | | | Area under rice (ha) | | |
|---|---|---|---|---|---|---|
| | 2016/17 | 2018/19 | % Change | 2016/17 | 2018/19 | % Change |
| (a)Electricity status | | | | | | |
| Without electricity | 2.02 | 2.43 | +20.3 ns | 1.62 | 1.62 | 0.00 |
| With electricity | 2.02 | 1.62 | -19.8** | 1.22 | 1.21 | -0.82** |
| (b) Gender of household head | | | | | | |
| MHH | 2.07 | 1.82 | -7.2 ns | 1.62 | 1.21 | -25.3** |
| FHH | 1.52 | 1.21 | -20.4* | 0.81 | 0.81 | 0.00 |
| (c) Farmer Type | | | | | | |
| SSF | 1.62 | 1.32 | -18.5*** | 1.21 | 1.01 | -16.5* |
| MSF | 8.90 | 8.10 | -9.0 ns | 7.70 | 6.48 | -15.8 ns |
| SRI | 2.43 | 2.43 | 0.00 | 1.62 | 1.82 | 12.3 ns |
| Whole sample | 2.02 | 1.62 | -19.8 *** | 1.41 | 1.21 | -14.2*** |

*Difference significant at * (10%); ** (5%); ***(1%); ns = not significant*

Overall, during the second wave, median land holding size and median area under rice declined by 19.8% and 14.2% respectively (Table 4), but, changes in the use of inputs and services are mixed. There was a significant decline ($p<0.01$) in the proportion of households using purchased seed and organic fertiliser across all farmer categories. The increase in the proportion of households using all the other inputs was significant ($p< 0.1 – 0.01$) with variation across farmer categories (Table 5). But the rate of using inorganic fertilizer (Kg/ha) decreased slightly. Reporting on the impact of the national agricultural subsidy in Tanzania covering eight years (2008-2016), Kinuthia (2020) similarly reported 59% of respondents reduced the use of fertilizer and seed due to high cost and low availability. Meanwhile, there was a significant ($p<0.05$) increase in the percentage of households as well as the rate (Lt/ha) of using herbicides, reflecting farmers' substituting away from more expensive labour during land clearing and weeding. Nonetheless, the percentage of households using hired labour, extension services and mobile money also increased, which reflect rising commercialization.

**Table 5. Change in the proportion of farmers using of inputs and services**

| Input | Agricultural season | | Change |
|---|---|---|---|
| | 2016/17 | 2018/19 | |
| Percentage of households using the input/ service | | | |
| Purchased seed | 21.8 | 13.5 | -8.3*** |
| Inorganic fertiliser | 14.7 | 17.1 | +2.4*** |
| Organic fertiliser | 2.4 | 0.3 | -2.1*** |
| Herbicides | 61.1 | 72.3 | +11.2** |
| Hired labour | 73.1 | 75.4 | +2.3*** |
| Tillage services | 89.5 | 95.1 | +5.6* |
| Extension services | 44.3 | 68.3 | +24*** |
| Mobile money | 76.7 | 83.4 | +6.7*** |
| Changes in the use of inputs per hectare | | | |
| Inorganic fertiliser (kg/ha) | 69.7 | 67.8 | -1.9 ns |
| Herbicides (lt/ha) | 3.3 | 4.1 | +0.8*** |

**-significant at 10%; ** significant at 5%; ***- significant at 1%; ns = not significant*

Agricultural inputs and services are used to improve productivity and production but the findings in Table 6 show that for the whole sample there was a significant drop in yield, the median declining by about 376 kg/ha (15.6%) between 2016/17 and 2018/19 season. The yield decline is also observed across all farmer categories with the exception of medium scale farmers. The decline was associated with the discontinuation in 2016 subsidy programme due to lack of funds (Gine et al., 2019). The yield in villages with electricity was slightly higher than in villages without electricity during both waves. The yield trends of major food crops in Tanzania has been mixed; some researchers reporting improvement during the subsidy programme (Ray, 2019) while others reported the subsidy had little impact on yields due to poor targeting and management (Aloyce, et al. 2014; Kato, 2007; Kinuthia 2020).

**Table 6. Changes in median yield (kg/ha) between 2016/17 and 2018/19**

| Farmer attribute | Agricultural season | | | | Change[a] |
|---|---|---|---|---|---|
| | 2016/17 | | 2018/19 | | |
| | n | Yield | n | Yield | |
| (a) Electricity status of village | | | | | |
| With electricity | 209 | 2594 | 637 | 2223 | -271*** |
| Without Electricity | 292 | 2223 | 136 | 1920 | -303* |
| (b) Gender of household head | | | | | |
| Male | 440 | 2426 | 660 | 2223 | -203* |
| Female | 61 | 2372 | 113 | 1914 | -458 ns |
| (c) Farmer type | | | | | |
| Small scale (SSF) | 326 | 2409 | 591 | 2223 | -186*** |
| Medium scale (MSF) | 73 | 1853 | 92 | 2099 | 247ns |
| SRI member | 102 | 2631 | 90 | 2223 | -408** |
| Whole sample | 501 | 2409 | 773 | 2223 | -376*** |

*[a]Independent sample non-parametric test was used to compare the median values;*
** significant at 10%; ** significant at 5% ; *** significant at 1%; ns = not significant*

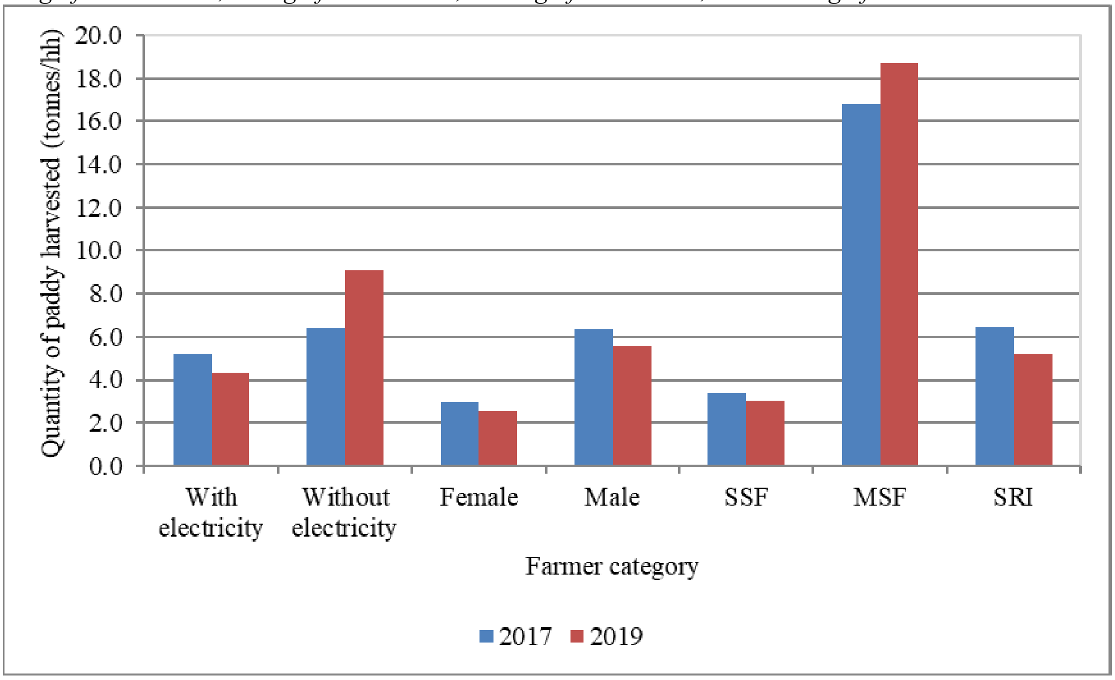


**Figure 1. Median quantity of paddy harvested per household**

The combined effect of decline in yield due to the decline in area under rice (Table 4) and reduction in inputs use (Table 6) led to a general decline in total volume of paddy harvested per household between the two-year interval (Figure 1) for all farmer categories except medium scale farmers whose total harvest increased, benefiting from area expansion as reported earlier.

### 3.3 Commercialization outcomes

Having examined the changes in inputs and yield, we now compare the commercialization levels attained by farmers in the panel sample between the two waves. The findings in Table 7 show that rice commercialization declined across all farmers categories, the sample mean declining significantly ($p<0.05$) from 59.9 in 2017 to 55.8 in 2019 ($p<0.05$). The decline was also significant for farmers in villages with electricity ($p<0.1$), MHH ($p<0.1$) and SRI members ($p<0.05$).

**Table 7. Test for significance of change in RCI (Panel sample)**

| **Farmer category** | | **Year** | | **Change** | |
|---|---|---|---|---|---|
| | | **2017** | **2019** | **RCI** | **%** |
| Electricity Status | With electricity | 60.2 | 55.2 | -5 | -8.3* |
| | Without electricity | 58.5 | 58.1 | -0.4 | -0.7ns |
| Sex of household head | Female | 53.1 | 49.4 | -3.7 | -7.0ns |
| | Male | 60 | 56.7 | -3.3 | -5.5* |
| Farmer category | SSF | 55.5 | 51.7 | -3.8 | -6.8ns |
| | MSF | 65.4 | 64.1 | -1.3 | -2.0ns |
| | SRI | 66.6 | 61 | -5.6 | -8.4** |
| Whole Sample | Sample | 59.2 | 55.7 | -3.5 | -5.9** |

*Significant at 10% ; ** Significant at 5%; *** Significant at 1%. n.s Not significant ,

The highest percentage decline was recorded among SRI members (-8.3%; $p<0.05$) compared to -6.8% and -2% for SSF and MSF respectively, which were not significant. Since only two data points are available, it is impossible to establish a trend because uncontrollable factors can affect production and commercialization positively or negatively between consecutive data waves. We therefore proceed to assess the effect of RCI variation on livelihoods changes for different categories of farmers.

### 3.4 Livelihood impacts

#### 3.4.1 Descriptive analysis

Pooled probit regression analysis was used to assess factors accounting for temporal changes in livelihood indicators, represented by the MPI, but we begin with descriptive analysis. The sample mean MPI decreased from 0.29 in 2017 to 0.19 in 2019 (Figure 3a), which represents significant livelihood improvement. Both values are below the poverty cut-off point of 0.33 and also below the mean of 0.275 for Tanzania (UNDP, 2019). The most significant decline was observed among SRI members (57.9%) followed by MSF (51.4%) and lowest among SSF (30%). A decline in the proportion of MPI poor households followed the same pattern (Figure 3b). Kinuthia (2020) similarly established that rice farmers in Tanzania had improved welfare throughout the interval from 2008 to 2012, which was attributed to the tradable nature of the crop. Comparison by gender showed that farmers in MHH experienced a significantly higher MPI decline (39.3%) as well as the decline in the proportion of MPI poor households (28.1%) compared to FHH, which calls for more efforts to enhance the inclusion of FHH to benefit from rice commercialization.

A similar argument holds for farmers in villages without electricity where the MPI remained relatively high at 0.27 compared to 0.17 among famers in villages with electricity where the scope of livelihood options is wider (Davis, 2003; Cook, 2011). As discussed earlier, interventions in villages without electricity require the combined effect of institutional and infrastructure support to improve services (water, health, education and road infrastructure). The poor conditions of these services increase the MPI score of affected households (see Annex 1).

The significant livelihood improvement among MSF – represented by a decline of MPI poor households by 45.8% compared to 23.2% for the sample or 19% for SSF – may be attributed to several factors. Firstly, within the two-year interval, most of the MSF, as recent immigrants Kilombero valley (Mlay et al., 2022) had settled and improved their dwellings. Secondly, some villages experienced improvement in infrastructure provided as public goods (water, electricity, mobile phone connectivity and access to mobile money), thereby reducing production and marketing cost (Satish, 2007; Liu, 2021). Thirdly, qualitative analysis through FGD revealed that some of the changes occurred due to cross-interaction among different ethnic groups, inspiring cross-learning and adaptation to purge negative cultural practices and pursuit of improved livelihoods. For example, between 2017 and 2019; improvements of children's school attendance, quality of house floors, sanitation and access to electricity were higher for MSF compared to corresponding proportions for the whole sample (Annex 2) consistent with higher improvement in livelihood among them relative to other farmer categories.

Comparison by farmer categories (figure 4a) showed that the MPI declined for all farmer categories. Likewise, the proportion of MPI poor households declined for all RCI quintiles (figure 4b). The observed decline in MPI represented livelihood improvement despite a decline in rice commercialization, which may seem puzzling. These findings suggested that other income sources filled in the gap from the slight reduction in paddy sales and income. To verify this, we examined the components of total household income (THHI) presented in Table 8.

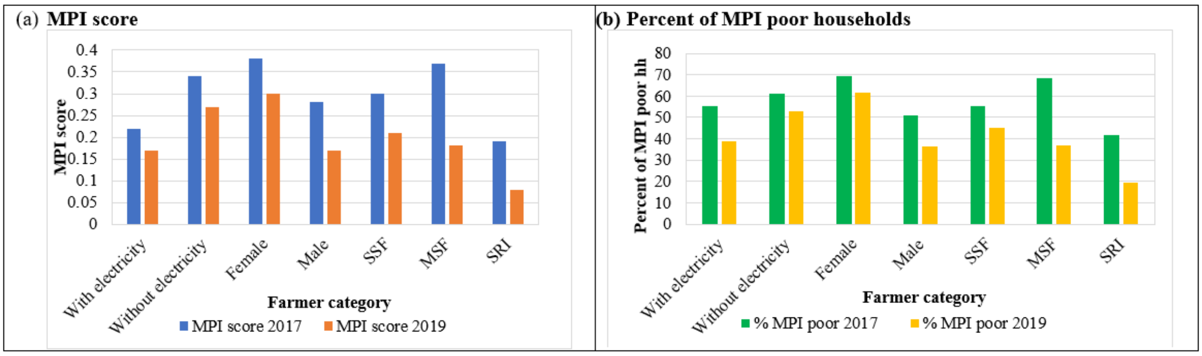


**Figure 3. Distribution of MPI by farmer category**

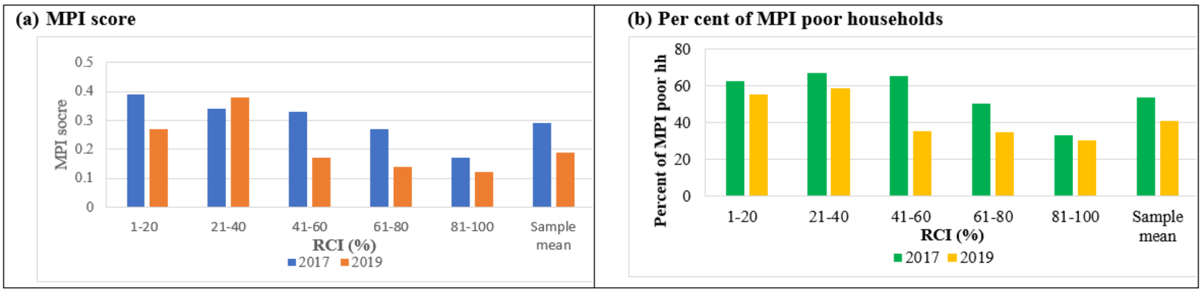


**Figure 4. Distribution of MPI by RCI**

**Table 8. Composition and change of total household income**

| Income source | Mean income* | | % Change in Income | Change in share of income (%) |
|---|---|---|---|---|
| | 2017 | 2019 | | |
| Crop | 1,348,294 (54.3%) | 1,657,748 (56.8%) | + 23* | +2.5 |
| Livestock | 329,665 (13.3%) | 327,315 (11.2%) | -0.7 ns | -2.1 |
| Total farm income | 1,641,612 (66.1%) | 1,985,063 (68.0%) | +20.9 ns | +1.9 |
| Non-farm income | 932,700 (37.5%) | 987,069 (33.8%) | +5.8 ns | -3.7 |
| Total hh income | 2,484,522 (100%) | 2,918,537 (100%) | +17.5 ns | - |

*Share of income in brackets (…%)

The mean THHI – comprised of income from crops, livestock and non-farm income – increased by 17.5% from TShs 2.48 million (USD 1,108.5) in 2017 to TShs 2.92 in 2019 (USD 1,265.7). The data suggests that the increase in THHI was driven by changes in income from crops, whose mean increased significantly ($p<0.1$) by 23% during the study period compared to only 5.8% for non-farm income and a slight decline (0.7%) for livestock income. Comparison of mean THHI across farmer categories showed that SSF had a lower increase (26%) compared to MSF and SRI members (34% and 32% respectively), which explains why the SSF had the lowest MPI decline, representing relatively lower livelihood improvement. A similar argument applies when comparison was made by gender where FHH experienced only 2.7% increase in total household income compared to 20.8% for MHH. Hence FHH experienced a lower level of livelihood improvement as the MPI declined by only 21% compared to 39% for MHH.

The crop income was dominated by rice, being 85% and 94% in 2017 and 2019 respectively, followed by bananas and cocoa. The median of many other crops including maize, groundnuts, soybeans, peas, cassava, potato, oranges, sunflower and garlic was zero, implying that more than 50% of the farmers earned no cash income from these crops since they are mainly produced for subsistence or they only serve as minor cash crops. While income from rice declined as reported earlier, both the mean and median income for bananas and cocoa increased. Although the number of households producing these crops remains small, being less than seven and two per cent for bananas and cocoa respectively, these proportions are expected to increase due to efforts by various organizations, including WWF to promote diversified livelihood options by distributing cocoa seedlings to avert on-going environmental decline (Msofe et al., 2019). Other studies have similarly reported crop and enterprise diversification as important to hedge against climate change and market related risks (Kiani *et. al*. 2021).

Non-farm income also increased by 11.2% for the whole sample, again, MSF and SRI members experienced a significantly higher rate ($p<0.01$) of increase (25.1% and 26.5% respectively) compared to SSF (19.2%). Likewise, MHH reported 14.1% increase in non-farm income while FHH experienced 7.4% decline. Further analysis of non-farm income shows that for the whole sample there was a marginal increase of non-farm income (4.9%). The SRI members and MSF experienced significantly higher increase in NFI (Isinika et al., 2021), which then contributed to their livelihood improvement.

### 3.4.2 Determinants of livelihood indicators

Regression analysis (Equation 2) was used to assess factors that influence the variation in livelihood outcomes, using the MPI as an indicator. Estimation was done using robust probit regression analysis to correct for heteroskedasticity. The estimates are therefore unbiased (Wooldridge, 2019). The model's Wald Chi square values was significant ($p<0.01$) with a pseudo Chi2=0.15 representing good fit of the data set. All the coefficients have the expected signs hence they can be used for making statistical inference in the study area. Nine coefficients were significantly different from zero, beginning with those which had a negative coefficients ($p<0.01$) hence poverty reducing (Table 9). These included the dummy for the year of harvest where the marginal effect was (-0.123), implying the MPI score declined by 12.3% in 2019 relative to 2017. All marginal effects carry the same interpretation. Other negative and significant coefficients were; years of schooling of the household head, rice commercialization from the fourth and fifth quintile (RCI >60%). The coefficient for the third quintile (RCI>40%) was also negative but it was not significant. However, the coefficient for the second quintile was positive, hence poverty increasing. Qualitative analysis from focused group discussion revealed that such farmers engage in distress sales to meet urgent family needs. This implies for significant poverty reduction, farmers should be supported to attain commercialization levels at 60% or above. Other studies have established mean commercialization levels in the range of 30% or above (Bekele & Alemu, 2015; Muricho et al., 2017).

**Table 9. Determinants of MPI –Pooled Probit Results**

| Variable | Coefficient | robust s.e | Marginal effect (dy/dx) | Robust s.e |
|---|---|---|---|---|
| Constant | 0.825*** | 0.22 | - | - |
| Year dummy (1=2019) | -0.311*** | 0.098 | -0.123*** | 0.039 |
| Age (Youth=1) | -0.05 | 0.11 | -0.02 | 0.044 |
| Years of schooling of household head | -0.129*** | 0.018 | -0.051*** | 0.007 |
| Gender of household head (1=female) | 0.565*** | 0.121 | 0.224*** | 0.048 |
| Household size (count) | 0.081*** | 0.02 | 0.032*** | 0.008 |
| Electricity status of village (1=yes) | -0.148 | 0.105 | -0.059 | 0.042 |
| Total land (ha) | -0.006 | 0.013 | -0.003 | 0.005 |
| Total livestock units (TLU) | -0.01** | 0.004 | -0.004** | 0.002 |
| Non-farm income (100,000) Tshs | -0.16* | 0.097 | -0.064 | 0.038 |
| RCI quintile dummy 1 (1=Q2) | 0.264 | 0.167 | 0.105 | 0.066 |
| RCI quintile dummy 2 (1=Q3) | -0.172 | 0.143 | -0.068 | 0.057 |
| RCI quintile dummy 3 (1=Q4) | -0.26* | 0.142 | -0.103* | 0.056 |
| RCI quintile dummy 4 (1=Q5) | -0.405*** | 0.157 | -0.161** | 0.062 |
| Farmer type dummy 1 (1=MSF) | -0.289 | 0.102 | -0.115 | 0.072 |
| Farmer type dummy 2(1=RCI) | -0.291** | 0.157 | -0.115** | 0.051 |
| Log pseudo likelihood=(-607.92); n=1037;<br>Wald $X^2(15)=173.43$; $p< X^2=0.01$; Pseudo $R^2=0.15$ | | | | |

*=significant at 10%, **=significant at 5% and ***=significant at 1%

Comparison by farmer category show that SRI members had significantly lower MPI levels hence less poor compared to SSF, but the MPI difference between SSF with MSF was not significant, implying proximity in their poverty levels, despite the significantly higher commercialization levels attained by MSF. Qualitative analysis showed that MSF faced infrastructure related challenges since most of them lived in more remote villages, facing low access to amenities such as water, health facilities and cultural factors that reduced children's attendance to school. Younger farmers were also more likely to be less MPI poor but the coefficient was not significant. Meanwhile, FHHs and household size had positive coefficients representing poverty increasing effects and the coefficient for FHH was significant ($p<0.01$).

### 3.4.3 Sources Livelihood improvement

Cash income is necessary for livelihood improvement but there is no assurance of cause and effect because livelihood improvement within a household also depends on how that income is spent (Kirui and Njirau, 2013; Ogut and Quam, 2018). Analysis of poverty indicators that constitute the MPI, are reported in Table 10. To understand the sources of livelihood improvement, which reflect the optimistic stance presented by most of the respondents, especially MSF and SRI members (Isinika et al., 2021), we look at how components of the MPI indicator have changed between the two waves.

**Table 10. Sources of livelihood (MPI) improvement**

| Indicator of livelihood | Per cent change in MPI livelihood indicators | | | | | |
|---|---|---|---|---|---|---|
| | Sample | SSF | MSF | SRI | Female | Male |
| Food insecure | -4.1* | -3.3n.s | -6.2n.s | -2.9** | -1.8n.s | -5.4** |
| Health and nutrition (child mortality) | -3.1n.s | -3.8n.s | 5.6n.s | 9.4* | -3.1n.s | -3.2n.s |
| School age children out of school | -10.7*** | -8.2*** | -31.3*** | -23.1n.s | -13.9** | -10.3*** |
| Years of schooling (Non had ≥5 years) | -3.2** | -3.7** | -8.5* | -4.8n.s | -5.4n.s | -3.1** |
| House quality (represented by floor) | -11.2*** | -12*** | -28.2*** | -16.2n.s | -6n.s | -12.4*** |
| Sanitation | -18.3*** | -19.5*** | -25.7*** | -6.2*** | -6.6n.s | -20.2*** |
| Cooking fuel | -1.4* | -0.8n.s | -9.6*** | -8.8n.s | 0.6n.s | -4.8** |
| Electricity | -9.2*** | -6.3*** | -23.3*** | -17*** | 6.9n.s | -9.1*** |
| Drinking water | -0.8n.s | -0.8n.s | -9.9n.s | -9.1n.s | -6.6n.s | -5.9n.s |
| Asset | 4.5* | 3.5n.s | -2.2n.s | -5.7* | 2.4n.s | 10.5n.s |

*** Significant at 1%; ** significant at 5%; * Significant at 10%; n.s = not significant

The analysis shows that for the whole sample, there was significant improvement ($p<0.01$) in four areas; having better sanitation, improvement in the house floor, reduction of households having any child out of school and improvement in electricity. There was also significant improvement ($p<0.05$ – 0.1) in no children in the household having more than five years of education, improved nutrition and assets. There was no significant improvement in drinking water. The MSF recorded significant improvement in more indicators compared to the other farmer categories. Respondents used their income to acquire or upgrade amenities, which had previously placed them in lower wealth ranks. However FHH recorded the least significant improvement, reflecting gender exclusion to benefit from rice commercialization.

Livelihood improvement can also be explained by other changes, especially among agro-pastoralists. Being more recent immigrants, the two-year interval gave them time to improve their houses, sanitation and other amenities. Behavioural and attitude changes were reported to be happening due to interaction with other residents in the highly heterogeneous rural community in Kilombero valley. This means, while income improvement from agricultural commercialization and other sources is important, the spending pattern also made a difference. Hence, efforts to raise household income should go hand in hand with effort to influence expenditure patterns. Social networks and campaigns are important for accelerating such changes. These are complemented by institutional and infrastructure improvement facilitated by local, district and national institutions.

## 4.0 Conclusion

The purpose of this paper was to assess outcomes of rice commercialization options or pathways for different categories of farmers with a view of identifying factors that account for the exclusion of some farmer categories, especially women and youths. The analysis and discussion addressed three questions as presented earlier. These are revisited in view of the findings to provide policy implications.

Responding to the first question; Are commercialization levels dynamic over time? Comparison was made between the two waves and the analysis shows rice commercialization (RCI) declined across all farmer categories, being significant for the whole sample, SRI members, MHH and farmers in villages with electricity. The decline has been attributed to reduced area under rice, reduced rice yield, despite a marginal increase in the use of some inputs such as inorganic fertilizer, tillage services and hired labour. There was also a decrease in the use of other inputs, especially the proportion of farmers using purchased seed and organic fertilizer due to limited availability and affordability. There was however a significant increase in the percentage of farmers using herbicides as well as a higher median volume of herbicide used. The use of mobile money and extension services also increased significantly, the former being influence by electrification and improved communication infrastructure, which opened up opportunities for private investors to provide services that facilitated commercialization via improved processing, storage, communication and transfer of payment. According to these findings, rice commercialization in the study area is not yet on a steady rising path. Efforts to promote sustainable rice intensification and extensification should continue, while ensuring the initiatives are gender and age inclusive.

Assessing inclusivity for input use, FHH experienced a decline in land under rice, but there was a higher increase among FHH in the use of inorganic fertilizer, herbicides and mobile money even though their proportion remained lower than that of MHH. These changes indicate that FHH were catching up in the use of inputs, and this can be attributed to rising non-farm income and increasing access to extension services. These gains enabled FHH to purchase more inputs and services thereby stepping up to higher commercialization levels.

This identifies an area where support can be targeted to FHH.

However, barriers to access resources remain major limiting factors for their inclusion. Consequently, FHH harvested and sold significantly lower volumes of paddy/rice, leading to a significant decline in RCI. Similar constraints have been demonstrated in relation to youths. Hence, on-going initiatives to support FHH and youths to catch up in the use of technology should continue. The SRI members also experienced a significant RCI decline ($p<0.05$) because they lost the use of credit and advisory services previously provided by KPL farm, whose operation ceased in 2018. Efforts to link smallholder farmers with large investors should therefore foresee and plan for back up support to cushion them in case of institutional failure as it happened with KPL in this study.

Responding to the second question; is rice commercialization poverty reducing at all levels and for all farmer categories? The analysis shows there was significant ($p<0.01$) livelihood improvement especially among SRI and MSF despite a decline in rice commercialization. Livelihood improvement was attributed to increase in total household income by 17.1%, which was driven by income from other crops, especially bananas and cocoa as well as non-farm income, reiterating the importance of diversification at low commercialization levels. However, there was a lower poverty decline among FHH compared to MHH, which means many of the FHH experienced stagnation or stepping down, facing deeper poverty and depravation.

Nonetheless, rice commercialization remains important for livelihood improvement in the study area since it accounts for over 90% of the household income. It is however complemented by income from other crops, livestock and from non-farm sources. The increased income was used to improve factors that previously placed households at lower wealth ranks. It is evident that livelihood improvement or poverty reduction is associated with diversified livelihood sources, complemented by facilitation from the government and other development agencies to improve infrastructure (public goods), markets and governance. Institutions (both local and national) are important drivers that influence the rate of poverty reduction. In the study area, a gender gap is still evident in input use, yields, rice commercialization and livelihood indicators. Hence, more needs to be done through infrastructure improvement and institutional facilitation that enhance the inclusion women and youths to benefit more from on-going commercialization processes. The strategies should include improving enabling services for them to catch up through awareness raising, training and skills development such as in adopting SRI technologies which will enable more women to commercialize via rice intensification.

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**Annex 1: Multidimensional Poverty Dimensions**

| Dimensions of Poverty | Indicator | Description | Weight |
|---|---|---|---|
| Health | Nutrition | Any adult under 70 years of age or any child for whom there is nutritional information is undernourished. | 1/6 |
| | Child mortality | Any child under the age of 18 years has died in the family in the five-year period preceding the survey. | 1/6 |
| Education | Years of schooling | No household member aged 'school entrance age + six years or older has completed six years of schooling. | 1/6 |
| | School attendance | Any school-aged child is not attending school up to the age at which he/she would complete class eight. | 1/6 |
| Standard of living | Cooking Fuel | The household cooks with dung, wood, charcoal or coal. | 1/18 |
| | Sanitation | The household's sanitation facility is not improved (according to SDG guidelines) or it is improved but shared with other households. | 1/18 |
| | Drinking Water | The household does not have access to improved drinking water (according to SDG guidelines) or improved drinking water is at least a 30-minute walk from home, round trip. | 1/18 |
| | Electricity | The household has no electricity. | 1/18 |
| | Housing | At least one of the three housing materials for roof, walls and floor are inadequate: the floor is of natural materials and/or the roof and/or walls are of natural or rudimentary materials. | 1/18 |
| | Assets | The household does not own more than one of these assets: radio, television, telephone, computer, animal cart, bicycle, motorbike or refrigerator, and does not own a car or truck. | 1/18 |

Source: Adapted from UNDP 2019