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COMMERCIALISATION PATHWAYS: IMPLICATIONS ON SMALLHOLDER RICE FARMERS' PRODUCTIVITY AND WELFARE IN MBARALI DISTRICT, TANZANIA

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Abstract

This study aimed at evaluating the most effective commercialisation pathway (smallholder and inclusive) and its impacts on productivity and welfare on smallholder rice farmers in the pathways versus rain-fed farmers in Mbarali District. Output and input commercialisation indices (CCI and ICI) and propensity score matching were used for data analysis. The overall output commercialisation was more than half of the produced rice (CCI=59%) but the use of improved inputs in the study area was low (ICI = 27%). The proportion of rice sold was higher in the inclusive pathway (80%) relative to smallholder pathway (70%) and rain-fed scheme (41%). Total factor productivity ranged between 1.17 - 1.21 and 0.98 – 1.02 in the smallholder and inclusive pathways respectively more than that in the rain-fed scheme. In terms of welfare, inclusive pathway was better-off relative to the two groups. Therefore, both smallholder and inclusive pathways should be adopted to explore the synergies.
Keywords: *Commercialisation pathways, Productivity, Welfare, Smallholder, Propensity Score Matching.*
JEL Codes: D24, O12, O21, I31, Q13, Q18

1. Introduction

Transforming the agricultural sector from low productivity to high productivity commercialisation has been a critical policy of concern in most of Sub Saharan African (SSA) countries. Agricultural sector plays a critical role in SSA since more than 70% of the population (about 904 million) live in rural areas, 43% live under poverty line of US $ 1.90 per day, 22% of the population are food insecure and over 75% of the poor are smallholders whose primary source of livelihood is agriculture (IFAD, 2012; Zhou *et al.*, 2013; World Bank, 2016). In Tanzania, 81% of the population live in rural areas where 31.3% are under poverty line relative to 15.8% in urban areas (MoFP-PED, 2019). The World Economic Forum (2015) estimated that, growth generated from agriculture is 2- 4 times more effective at reducing poverty than the growth in other sectors in SSA.

In Tanzania, agriculture is dominated by smallholder farmers where 91% of cultivated farms are considered to be small scale (up to 5ha) and account for about 80% of food production (Jayne *et al.,* 2016; URT, 2016). They are characterized by rain fed agriculture (95%), low use of improved inputs specifically fertilizer where farmers apply only 7 – 9kg of nutrients /ha which is very low relative to Malawi (27 kg), South Africa (53 kg) and China (279 kg) and far less than the 2006 Abuja declaration commitment of increasing fertilizer use to at least 50 kg nutrients/ha (Masso *et al*., 2017; URT, 2016; Nkuba *et al*., 2016). This in turn has led to low productivity particularly in staple foods including rice whose average productivity is 2 tons/ha relative to global average of 4.3 tons/ha (Zhou *et al*., 2013). As in other parts of SSA, Tanzania has encountered low improvement of cereal crops in terms of productivity.

To overcome this poor performance of the sector, transformation of the agricultural sector from smallholder subsistence to commercial oriented agriculture is inevitable. Agricultural commercialisation is process by which subsistence/semi-subsistence oriented production is transformed into market oriented production through increased productivity and greater surplus that enhance the rise in output and input markets participation based on principles of profit maximisation. (Von Braun, 1995; Pingali & Rosegrant, 1995). There are different pathways that agricultural commercialisation can take. Different scholars (Newsham *et al.,* 2018; Oya, 2012; Jayne *et al.,* 2014) have identified four pathways of commercialisation: (i) Estate/plantation/large-scale commercial farming involving large land holding, growing a single cash crop, involves high mechanisation and relies on hired labour. (ii) Out grower/contract farming – farmers produce and sell output to a buyer based on pre-agreed arrangements. (iii) Medium-scale commercial agriculture – farmers with land holding ranging from 5 – 100 ha and (iv) Smallholder pathway- owning less than 2 ha, rural, depend on family labour and sell surplus. In view of these pathways, during 2010, an initiative called the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) was established as a pathway to commercialize agriculture in Tanzania and further fuel KILIMO KWANZA initiative (SAGCOT, 2013; Herrmann, 2017). This is an inclusive smallholder and medium/ large scale agribusiness model that aimed at increasing smallholders' productivity, income and welfare through adoption of modern technology (high-yielding seeds, fertilizer, machinery and good agronomic practices) and markets by linking them with medium/large scale commercial farmers (SAGCOT, 2013; West & Haug, 2017). Despite the efforts made by the government of Tanzania to commercialize agriculture through the establishment of the SAGCOT, crop productivity particularly for rice is still low on average at 2 tons/ha and 26.4% of rural farmers are still faced by basic needs poverty (URT, 2016; MoFP-PED, 2019). Previous studies have mostly focused on determinants, levels, processes and outcomes of agricultural commercialisation on employment, profitability, income and nutrition (Von Braun, 1995; Hailua *et al*., 2015; Okezie *et al*., 2012; Mitiku, 2014).

Moreover, no study took into consideration on which commercialisation pathway should be adopted particularly in Tanzania. This study therefore aimed at addressing this gap by providing the empirical evidence that will inform policy in Tanzania on the pathway that should be adopted to shape smallholder commercialisation and livelihood. The study specific objectives were:-

i. To determine the extent of smallholder rice commercialisation in the area.
ii. To evaluate the impacts of smallholder and inclusive commercialisation pathways on productivity of smallholder rice farmers in the pathways versus rain-fed farmers.
iii. To evaluate the impacts of smallholder and inclusive commercialisation pathways on the welfare of smallholder rice farmers in the pathways versus rain-fed farmers.

The next sections are arranged as follows. Section two gives an analysis of literature relevant to this study, section three comprises the methodology that was used in this study.

Section four gives the results and discussion while section five consists of conclusion and policy recommendations.

2. Commercialisation Pathways

Different regions in the World have adopted different models towards agricultural commercialisation. Some including the south East Asian region transformed the agrarian sector through smallholder commercialisation during the period of green revolution in 1960s (Asfaw *et al*., 2012) while other countries including Brazil have succeeded through investing in large scale commercial farming. Other commercialisation pathways that have been widely adopted particularly in SSA include out grower/contract farming and currently through the rise of medium scale commercial farming (Leavy & Poulton, 2007).

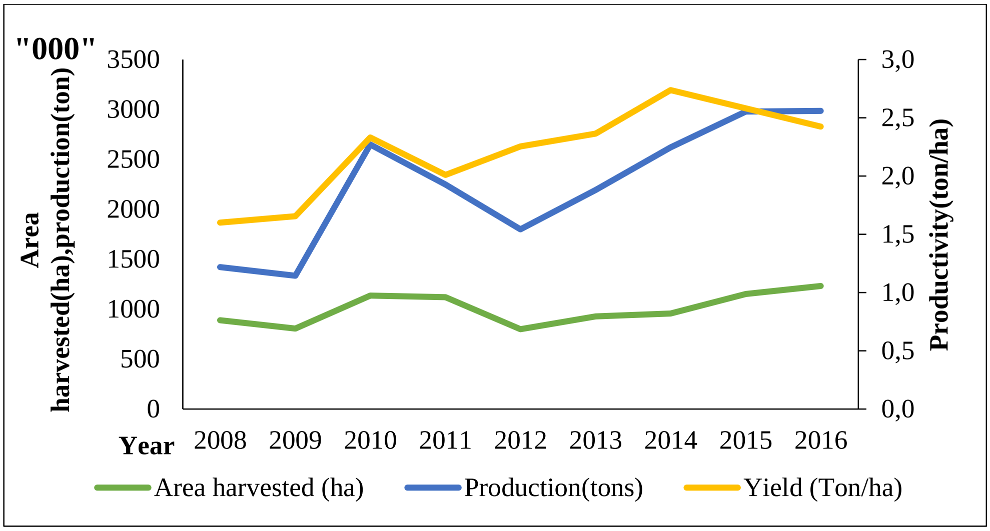
Unlike South East Asia where smallholders stand as vital route in the transformation process brought by their efficiency in the use of resources including family labour, intensification and production mediated to the market (Rigg *et al*., 2016), efforts that have been devoted to transform smallholder agriculture in SSA including the CAADP and in particular Kilimo Kwanza “Agriculture First” initiative in Tanzania have not led to expected impacts and the region still realizes production below its potential (Byerlee & Deininger, 2013). This can be explained by agronomic factors (low use of inputs, climate change, low tech-know how) and policy issues that are not mediated towards the market (market controls) and lack of clear focus to smallholder farmers in sub Saharan Africa (Van Donge *et al*., 2012).

It is argued that large scale agricultural investments-plantations model (LSAIs) should then be the priority for poverty alleviation and economic growth (Otsuka, 2013; Oya, 2012; Henley, 2012; Bellemare, 2012), since they are the source of technology transfer, employment and produce towards the markets (Kleemann, 2015). However, it is also argued that, plantations give low wage employment to few people while leaving the majority, affect local food production through dispossession of land from smallholders as well as diverting labour from smallholders. For example, Adewumi (2013) argued that, there was an efficiency level of 90% on the frontier by farmers within inclusive investments as compared to less than 50% by farmers outside the investment after adoption of new technology in Nigeria. Contrary to these positives of the model, the model is also argued to lead to social differentiation by including only top tiers of smallholders endowed with resources, leads also to food insecurity due to over reliance on cash crops rather than food crops (Wang *et al*., 2014). The current available literature is still inconclusive on which model is suitable in bringing about the expected outcomes.

2.1 Rice production in Tanzania

In Tanzania, rice is the second most important food grain after maize and is a priority crop in the second Agricultural sector development Program (ASDP II), and in the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), with annual consumption per capita of 25.4 kg (RCT, 2015). The rice sector is 90% dominated by smallholder farmers who produce both local varieties and it employs about 1.5 – 2 million people in the country (RCT, 2015).

About 25% of total rice produced in Tanzania comes from Mbeya (Mbarali and Kyela districts) and Morogoro regions. Despite the potential for rice production in the country due to availability of irrigable land (29.4 million hectares), the sector is still faced with various challenges including over dependence on rainfall, inadequate financing and low productivity which is averaged at 2 ton/ha and the noted increase in production has been attributed to area expansion (RCT, 2015; URT, 2016) as shown in Figure 1.



Source: FAOSTAT, 2017

Figure 1. Rice production, harvested area and productivity trend in Tanzania (2008 - 2016)

3. Methodology

3.1 Study Area

The study was carried out in Madibira scheme – a smallholder commercialisation pathway in Madibira ward, Kapunga scheme – an inclusive smallholder-Medium/large scale pathway and the rain-fed smallholder farmers located in Itamboleo ward of Mbarali district. The district lies within the Usangu basin which is potential for rice production and is characterized by extensive irrigated rice schemes consisting of both smallholder and medium/large scale farmers. The economy of Mbarali district depends on agriculture sector which employs over 80% of the inhabitants in the district.

3.2 Research Design, sampling and data collection

The study used quasi-experimental design, utilizing cross sectional survey data collected from rice farmers in Mbarali District in May/June 2018. Since participating in the smallholder and medium/large scale commercialisation is voluntary, random allocation to treatment or control group is not possible (White & Sabarwal, 2014). A comparison group that is similar as possible to the treatment group in terms of baseline characteristics was established. The comparison group captures what would have been the outcome if the program had not been implemented (Caliendo & Kopeinig 2005). Thus, three groups consisting rain-fed rice farmers was used as a baseline (treatment 1), rice farmers participating in the smallholder pathway (treatment 2) and smallholder rice farmers in Kapunga inclusive pathway (treatment 3) were evaluated using both ANOVA and Econometric analysis. The study used two stage probability sampling. At first, a random selection of wards producing rice were selected. In this stage, a list of rice farmers participating in both smallholder and inclusive commercialisation pathways were established from the Madibira and Kapunga Agricultural and Marketing Cooperatives respectively. A list of rain-fed farmers found in Itamboleo ward was also established. Then, proportionate probability sampling was established based on strata that were identified. A total sample of 256 smallholder farmers were interviewed in this study of which 90 were farmers participating in the smallholder pathway, 110 were rain-fed farmers and 56 were farmers in the Kapunga inclusive commercialisation pathway.

3.3 Analytical Framework

Objective 1: To Determine the Extent of Smallholder Rice Commercialisation in the Area

Following Von Braun (1995), this objective was addressed by the use of both crop (rice) output and input commercialisation indices (CCI and ICI) as described below;-

$$\mathrm{CCI}_i = \frac{\sum_{i=1}^{n} S_y}{\sum_{i=1}^{n} Q_y} * 100;\ \mathrm{Q}_y \geq \mathrm{S}_y;\ 0 \leq \mathrm{CCI} \leq 100 \quad (1)$$

Where CCI_i = Crop (rice) commercialisation index of i^{th} house hold growing rice, S_y = Value of rice sold in monetary terms and Q_y is the monetary value of total quantity of total rice produced. Similarly, from input side, input commercialisation index (ICI) is given by;

$$\mathrm{ICI_i} = \frac{\sum_{i=1}^{n} M_x}{\sum_{i=1}^{n} Q_y} * 100;\ \mathrm{Q}_y \geq \mathrm{M}_x;\ 0 \leq \mathrm{ICI} \leq 100 \quad (2)$$

M_x is the gross value of crop inputs acquired from the market and Q_y is the gross value of total rice produced. With reference to the work by FAO (1989), households whose CCI_i ≥50% are commercial oriented, 25%≤ CCI_i<50% are in transition and those with CCI_i < 25% are subsistence oriented.

Objective 2: To Evaluate the Impacts of Smallholder and Inclusive Commercialisation Pathways on Productivity of Smallholder Rice Farmers in the pathways versus Rain-fed Farmers in the Study Area.

The decision to participate in either of the commercialisation pathway is modelled using random utility framework (Becerril & Abdulai, 2010).

$$Z_i^* = \alpha + X_i'\beta + \varepsilon \ \text{ With } Z_i = \begin{cases} 1\ if\ Z_i^* > 1 \\ 0\ Otherwise \end{cases} \quad (3)$$

Where z^* is a latent binary variable for participation, Z_i= 1 if a household participated in either of the pathway and $Z_i = 0$ if the household did not participate. The conventional approach commonly used to measure the impacts of an intervention in this case, participation in either of the commercialisation pathway on smallholder rice farmers' productivity and welfare would be through the use of an Ordinary least square (OLS) comprising of a dummy variable given by;-

$$\mathrm{Y}_i = \theta \mathrm{X}_i + \beta \mathrm{Z}_i + \mu_i \quad (4)$$

Where Y_i is the average outcome variable of household i, X_i is a vector of household socio-economic characteristics and Z_i is a dummy variable taking the value of 1 for participants and 0 for rain-fed farmers. However, the use of OLS in impact evaluation would yield biased estimates since the model assumes that participation in an intervention is exogenously determined while it is potentially endogenous (Herrmann & Grote, 2015). Assignment into treatment is not always random, but maybe due to purposive placement into the program or self –selection. To solve this problem, a counterfactual group was established through the use of propensity score matching (Caliendo & Kopeinig 2005). Propensity score (P) is the conditional probability of being assigned to a particular treatment given a vector of observed covariates X_i to facilitate causal inference (Dehejia & Wahba, 2002). It is given by;-

$$P(X) = P(Z_i = 1|X_{ij}) \tag{5}$$

Where Z (0, 1) is an indicator for exposure to treatment and X_{ij} is a matrix of covariates influencing the outcome variable, in this case productivity. Following Rosenbaum and Rubin (1983), binary logit models were used for both smallholder scheme and Inclusive Scheme using rain-fed rice farmers as control group to estimate the propensity scores P(X). The logit model (Gujarati, 2004) can be described as:-

$$\ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_0 + \sum_{j=1}^{k} \beta_i X_{ij} + \varepsilon_i \tag{6}$$

Where P is the propensity score, X_{ij} = is a matrix of observed values influencing participation and productivity based on economic theory and literature review, j is the response category and ε_i is the matrix of unobserved random effects. The model can further be specified as;

$$Z_i = \alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+ \ldots +\beta_7X_7+\delta_1D_1+\delta_2D_2 + \ldots + \delta_5D_5+ \varepsilon \tag{7}$$

Where X_1 is age of household head, X_2 is education level of household head, X_3 is the household size, X_4 is the farm size, X_5 is the distance to the market place, X_6 is off-farm income, X_7 is the net income from rice, and D_1, D_2, D_3, …. D_5 are dummies for sex, access to improved seed, access to extension services, access to market information, and producer/marketing organisational membership respectively. The response probabilities can be obtained by equation 8 given by,

$$P_i = \frac{\exp(\beta_0 + \sum_{i=1}^{k} \beta_i X_{ij})}{1+\exp(\beta_0 + \sum_{i=1}^{k} \beta_i X_{ij})} \tag{8}$$

Equation 8 is intrinsically linear because the logit model is linear in X_i. It shows that the probability of participation in either of the commercialisation pathway P lies between 1 and 0 and they vary non-linearly with X_i. The partial effects for continuous variables to account for the causal – effect can be calculated using quotient rule as;

$$\frac{\partial P_i}{\partial X_i} = P_i(1 - \mathrm{P})\beta_j \tag{9}$$

The partial effects for discrete variables was calculated as the difference of mean probabilities estimated for the respective discrete variable. Then, the covariates in each block were matched using the nearest neighbour matching since it is a most straight forward estimator among other estimators. Furthermore, kernel matching estimator was used. The average treatment effect on the treated (ATT) which is the average difference in outcome between the matched control and the treated group was then estimated using equation 10, 11 and 12 (Hailua *et al.*, 2015; Rosenbaum and Rubin, 1983). Let Y_1 be the productivity when the household is subject to treatment (Z=1) and Y_0 be the same variable when the household did not receive treatment (Z=0), then the observed productivity outcome can be given by;

$$Y = ZY_1 + (1-Z)\,Y_0 \quad (10)$$

$$ATT = E\,(Y_1 - Y_0 \mid Z_i = 1) = E\,[E\{Y_1 - Y_0 \mid Z_i = 1, P(X)\}] \quad (11)$$

$$ATT = E[E\{Y_1 \mid Z_i = 1, P(X)\} - E\{Y_0 \mid Z_i = 0, P(X)\} \mid Z = 1] \quad (12)$$

Where, ATT is the average difference in productivity between smallholder rice farmers receiving treatment relative to rain-fed, P(X) are the propensity scores, and Z_i is an indicator for treatment which equals 1 if individual received treatment and 0 otherwise. From equation 10, we can only observe the outcome variable of participants E ($Y_1 \mid Z_i = 1$), but we cannot observe the outcome of participants if they had not participated E ($Y_0 \mid Z_i = 1$).

Objective 3: To Evaluate the Impacts of Smallholder and Inclusive Commercialisation Pathways on Welfare of Smallholder Rice Farmers in the Pathways versus Rain-fed Farmers in the Study Area.

Propensity score matching was also used as in objective two. Welfare was measured by the use of food consumption score (FCS), access to health insurance, value of durable assets owned like farm implements and income unlike previous studies (Amare *et al.*, 2012; Asfaw *et al.*, 2012) that have used single measure of welfare. The household food consumption score was measured by the frequency of food group consumption for the last 7 days before the survey which reflects on food security and nutritional adequacy. Other measures included household access to health insurance fund and household total annual income from all sources.

4. Results and Discussion

4.1 Descriptive Results

Table 1 and 2 present the descriptive statistics of socio-economic characteristics of sample respondents of the three treatments: rain-fed/reference farmers, smallholder commercialisation pathway and the inclusive (small-medium/large scale) pathway farmers. From the descriptive statistics in Table 1, the average age of the sample respondents (household heads) was about 44.2 years. The difference in age between the three comparable groups was insignificant implying that the household heads age was almost the same although respondents in the rain-fed group had higher average age relative to the respondents in the two groups. The observed average age implies that most farmers were still in their productive age in the country (15 – 64 years).

The sampled respondents had an average family size of about 5.8. Households in the two pathways had large family size relative to rain-fed farmers. About 86% of sampled respondents were males (Table 2). Similarly, about 81.7% of the respondents had formal education. The literacy rate was higher in the smallholder pathway (91%) followed by respondents in the inclusive pathway (82.1%) and 73.6% in the rain-fed scheme. The difference in the literacy rate among the three groups was significant in all the education levels. Education helps farmers to make informed decisions and respond to market dynamics through the acquired skills and exposure (Ochieng et al., 2015).

The average cultivated farm size was 2 ha, where farmers in the smallholder and inclusive schemes cultivated 2.2 ha and 2.5 ha respectively relative to 1.6ha for rain-fed farmers. The difference was significant implying that smallholder farmers in either of the commercialisation pathway cultivated larger parcels of land compared to rain-fed farmers partially due to mechanisation. An increase in farm size helps farmers to produce surpluses thereby stimulating higher levels of commercialisation (Martey *et al.*, 2012).

Table 1.Household, Farm and Land Characteristics

Variable	Rain-fed group (n=110)	Smallholder Pathway (n=90)	Inclusive Pathway (n=56)	Total sample (N=256)	F	Prob>F
Age of the household head	44.6	43.6	44.1	44.2	0.20	0.82
Family size	5.56	5.92	5.93	5.8	1.15	0.32
Land and farm characteristics						
Farm size (ha)	1.60	2.50	2.20	2.00	5.70	0.00***
Distance to input market(km)	3.50	2.70	2.60	3.00	11.33	0.00***
Distance to output market	2.40	2.30	1.50	2.10	13.24	0.00***
Land productivity (t/ha)	1.85	4.31	4.37	3.27	125.6	0.00***
Total factor productivity(tfp)	2.20	2.49	2.03	2.26	1.89	0.15
Output commercialisation Index	0.411	0.69	0.76	0.586	119.1	0.00***
Input commercialisation Index	0.283	0.28	0.23	0.270	2.83	0.06*
Household welfare indicator						
Food consumption score	52.4	66.90	63.50	59.90	64.88	0.00***
Value of assets(“0000”Tsh)	264.4	854.50	809.60	591.10	4.57	0.01**
Annual income(“0000”Tsh)	225.30	961.03	881.60	626.22	29.70	0.00***

Notes: *= Significant at 10%; ** = Significant at 5%; ***= Significant at 1%.

Table 2. Social, Institutional, Access and Welfare Variables

Variable	Rain-fed group (n=110)	Smallholder Pathway (n=90)	Inclusive Pathway (n=56)	Total sample (N=256)	χ^2	Prob> χ^2
Sex (1=male, 0=female)	92(83.6)	74(82.2)	53(94.6)	219(85.5)	4.9	0.087*
Education level of the household head						
No formal education	29(26.4)	8(8.9)	10(17.9)	47(18.4)	10.1	0.01***
Primary education	43(39.1)	67(74.4)	23(41.1)	133(52)	28.2	0.00***
Secondary education	26(23.6)	13(14.4)	19(33.9)	58(22.7)	7.6	0.02**
Tertiary education	12(10.9)	2(2.2)	4(7.1)	18(7)	5.7	0.06*
Access/institutional variables						
seed (1=improved, 0=local)	28(25.5)	37(41.1)	22(39.3)	87(34.0)	6.3	0.04**
Access to irrigation(1=yes)	4(3.6)	90(100)	56(100)	150(58.6)	240	0.00***
Access to extension(1=yes)	60 (55)	65(73)	42(75)	167(65.7)	9.8	0.01***
Applied fertilizer(1=yes,0=no)	87(79.1)	85(94.4)	56(100)	228(89.1)	20.8	0.00***
Access to credit(1=yes,0=no)	12(10.9)	52(57.8)	22(39.3)	86(33.6)	49.8	0.00***
Access to market information(1=yes)	70(63.6)	67(74.4)	35(62.5)	172(67.2)	3.3	0.19
Cooperative member(1=yes)	1(0.9)	65(72.2)	49(87.5)	115(44.9)	154	0.00***
Access to health insurance(1=yes)	43(39.1)	45(50)	34(60.7)	122(47.7)	7.3	0.03*

Notes: *= Significant at 10%; ** = Significant at 5%; ***= Significant at 1%.; Figures in parentheses are percentages.

Total factor productivity expressed as returns to factors of production was 2.26 denoting increasing returns to scale. The average land productivity was 3.3 ton/ha where land productivity among farmers participating in the smallholder and inclusive schemes averaged at 4.3 ton/ha and 4.4 ton/ha respectively while for rain-fed farmers averaged at 1.86 ton/ha. The difference in distance to the nearest input market was found to be statistically significant implying that differences existed between the three groups. On the output market, the average distance to the nearest market was two kilometre from the farmer's residence. As distance to the nearest input or output market increases, market participation decreases (Hailua *et al.*, 2015). About 66% of rice farmers had access to extension services, Furthermore, of the sampled farmers (Table 2), only 34% had access to improved seeds.

For irrigation facilities, about 59% of the sampled respondents had access to irrigation facilities. Similarly, 89.1% of the respondents applied fertilizer in their rice fields. About 33% of the respondents had access to agricultural credits. Credit could be used to purchase inputs that may lead to an increase in productivity and thereby generate surplus production (Martey *et al*., 2012). About 67% of farmers in the study area had access to market information and it was not statistically different between the three groups. Furthermore, 45% of sampled farmers were cooperative members. Cooperatives/associations act as social networks in which farmers can have access to information related to production and marketing as well as social capital formation (Martey *et al.*, 2012; Camara, 2017).

Based on the food consumption score (FCS), the sampled households were food secure following World Food Program classification (WFP, 2008). However, the level of frequency of consumption of the food groups was higher (66.9 and 63.5) among farmers in the two pathways compared to those in the rain-fed group whose FCS was approximately 52.4. On the pattern of consumption, grains constituted the largest share of all food groups consumed in a week compared to other food groups in all the three comparison groups. On average, a typical household consumed food grains for six days a week. The food grains was supplemented by vegetables, oil/fats, pulses, root tubers and fruits which had also higher frequency of consumption in all the three groups (Figure. 2).

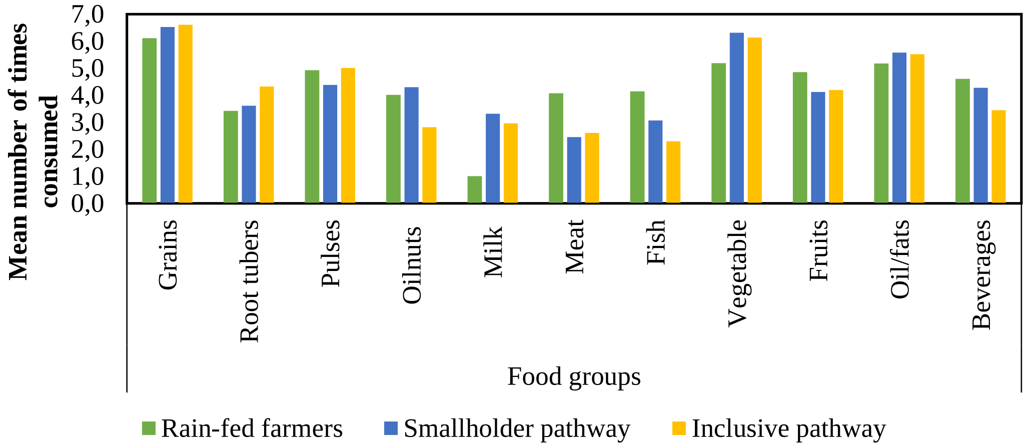


Figure 2. Weekly Food Consumption Pattern Among the Three Groups of Farmers

The frequency of consumption of the highly consumed food groups was higher in the inclusive pathway relative to the smallholder pathway and rain-fed farmers. However, the widely consumed food groups are those rich in carbohydrates and starch while foods rich in protein including meat, fish, milk and their products were consumed less frequently. This has health implications due to over reliance on monotonous starchy staples. For example, a typical household consumed milk once a week for the rain-fed farmers and three times for households in the commercialisation pathways. Furthermore, from the food consumption score estimates, 4.3% of respondents were food insecure (Borderline food consumption category; FCS= 28.5 -

42) while 95.7% were food secure households (Acceptable food consumption category; FCS>42) as shown in Table 3.

Table 3. Status of farmers' commercialisation and food consumption categories

Variable	Rain-fed/Ref-group (%)	Smallholder pathway (%)	Inclusive pathway (%)	Total (%)	χ^2
Output commercialisation index					
0 - 0.249	15(13.6)	1(1.1)	0(0)	16(6.3)	134.54***
0.25 - 0.499	71(64.5)	9(10)	1(1.8)	81(31.6)	
0.5 - 1	24(21.8)	80(88.9)	55(98.2)	159(62.1)	
Input commercialisation Index					
0 - 0.249	52(47.3)	45(50)	36(64.3)	133(52)	6.50
0.25 - 0.499	49(44.5)	36(40)	19(33.9)	104(40.6)	
0.5 - 1	9(8.2)	9(10)	1(1.8)	19(7.4)	
Food consumption category(FCC)					
Borderline	9(8.2)	2(2.2)	0(0)	11(4.3)	7.49**
Acceptable	101(91.8)	88(97.8)	56(100)	245(95.7)	

Note: FCC (0-28) =Poor consumption, FCC (28.5-42) = Borderline, FCC>42 = Acceptable (WFP, 2008); percentages in parentheses; **P >0.05, ***P>0.01.

Most of the food insecure households were found among the rain-fed farmers (8.2%) and the rest were in the smallholder pathway (2.2%) while there were no food insecure households among farmers in the inclusive pathway. On average, a smallholder rice farmer had a gross annual income of about 6.26 million Tanzania shillings. Farmers in the smallholder and inclusive pathways had higher income than rain-fed farmers by 7.36 and 6.56 million Tanzania shillings respectively.

Similarly, smallholder farmers in the smallholder pathway had more valued assets relative to the rest of the two groups though rain-fed farmers had the least valued assets of the three groups. On access to health insurance, about 47.7% of the sampled households had access to health insurance (either the National Health Insurance Fund or Community Health Fund insurer). Smallholders in the inclusive scheme had more access to health insurance (60.7%) compared to 50% and 39.1% of farmers in the smallholder scheme and rain-fed farmers respectively.

4.2 Rice Output and Input Commercialisation

From Table 1 and based on FAO (1989), rice in the study area is a commercial crop (CCI ≥ 50%) with commercialisation index of 59%. This implies that, on average, 59% of the total rice produced by smallholder farmers in the study area was sold. The crop was more commercialized among farmers in the inclusive smallholder-medium/large scale pathway where 80% of the rice produced was sold compared to 70% for smallholder pathway and 41% for rain-fed farmers. On the input side, results showed that, the extent of use of improved inputs was low in all the three groups since only 27% of the inputs used by farmers were purchased from the market while the rest of the inputs used were either low productive local inputs or retained inputs from previous year. This signifies less use of improved inputs purchased from the market, leading to low productivity caused by the use of low-productive retained seeds.

On the status of smallholder farmers' level of commercialisation, 62.1% of the respondents were commercial oriented, 31.6% were still in transition (likely to commercialize) while only 6.30% were subsistence farmers. Of the three comparison groups, 98.2% of smallholder farmers in the inclusive scheme, 88.9% of farmers in the smallholder scheme and 21% of rain-fed farmers sold more than 50% of total rice produced. This implies that, smallholders in the inclusive pathway were more commercialized than the smallholder pathway and rain-fed farmers. On the input side, only 7.4% of farmers used improved purchased inputs while 40.6% used both local/retained and purchased inputs and 52% used entirely local low productive inputs.

Based on farm size, 72.7% of the households cultivated less than 2 ha while only 3.1% cultivated more than 5 ha. Results show also a positive relationship between farm size and the degree of commercialisation. This implies that households with larger farms tend to produce and sell more relative to farmers with small farms due to economies of scale. These results are consistent with previous studies (Martey *et al.*, 2012). Figure 3 show the relationship between commercialisation and farm size.

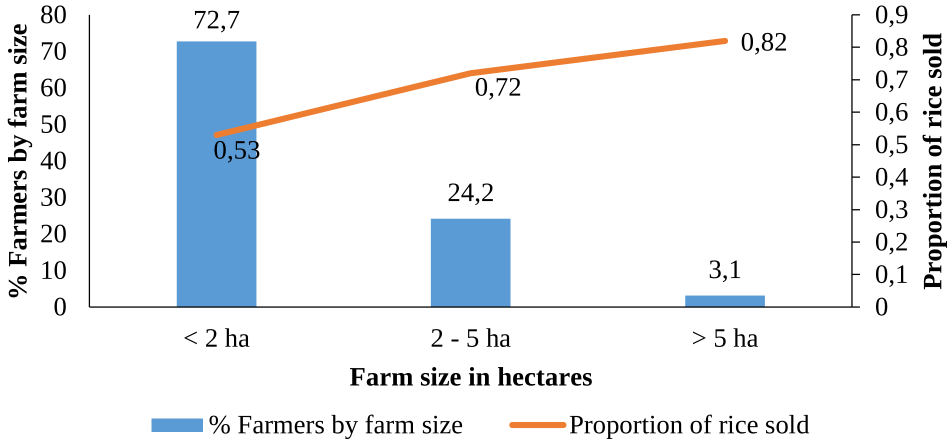


Figure 3. Degree of Agricultural Commercialisation by Farm Size

From the descriptive statistics, the three comparable groups are similar but they differ in some few characteristics. However, evaluating the impacts of commercialisation based on comparison of simple means from ANOVA and chi-square tests would yield biased estimates due to unobservable characteristics. In order to address the self –selection bias, PSM was used following previous studies (Hailua *et al.*, 2015; Amare *et al.*, 2012; Herrmann & Grote, 2015) as shown in section 4.3.

4.3 Econometric Results

4.3.1 Determinants of Agricultural Commercialisation

Binary logit models (Mitiku *et al.*, 2014; Herrmann & Grote, 2015) were used to estimate the propensity of participation in the pathways.

The estimated logit models were both significant at 1%. Since the coefficients estimated in the logit model show only the direction (positive or negative) of the effects of the hypothesized covariates on smallholders' probability of participation in the commercialisation pathways, average marginal effects were further estimated to infer the extent of the effect of covariates on the treatment variable. From Table 4, the propensity scores indicates that most of the hypothesized variables that affect farmers participation in either of the treatment including age, family size, education level of the household head, sex, farm size, access to extension services and access to market information were insignificant. This implies that the comparable groups were similar in these covariates.

Cooperative membership, off-farm income and type of rice seed had positive significant effect on the probability of smallholders to participate in either of the commercialisation pathways while distance to the nearest market, negatively affected the probability of participation in the commercialisation pathways and the rain-fed scheme.

Table 4. Propensity Score Estimation of Covariates Affecting Treatment in Each of the Commercialisation Pathway with Rain-Fed Farmers as a Baseline Category

Variable	Inclusive pathway		Smallholder pathway	
	Coefficient	Marginal effect	Coefficient	Marginal effect
Age of household head	0.0212 (0.0490)	0.0006 (0.0013)	-0.0238 (0.0272)	-0.0023 (0.0026)
Education of household head	1.384 (0.874)	0.0366 (0.0223)	-0.507 (0.333)	-0.0484 (0.0313)
Household size	0.141 (0.321)	0.0037 (0.0084)	0.144 (0.170)	0.0138 (0.0162)
Farm size (ha)	0.522 (0.708)	0.0138 (0.0188)	0.201 (0.194)	0.0192 (0.0184)
Distance to market(km)	-2.895** (1.116)	-0.0765 (0.0270)	0.363* (0.176)	0.0347 (0.0162)
Off-farm income(Tsh)	3.91E-7* (1.75E-7)	1.03E-8 (4.30E-9)	-2.32E-7 (2.41E-7)	-2.22E-8 (2.30E-8)
Sex(1=male, 0=female)	5.310 (3.363)	0.1403 (0.0878)	-0.301 (0.741)	-0.0287 (0.0708)
Seed(1=Improved, 0=local)	-2.133 (1.783)	-0.0564 (0.0472)	1.177* (0.558)	0.1124 (0.0517)
Extension service (1=yes)	2.992 (1.929)	0.0791 (0.0511)	-0.168 (0.518)	-0.0161 (0.0494)
Market information(1=yes)	-3.275 (1.711)	-0.0865 (0.0433)	0.0991 (0.567)	0.0095 (0.0542)
Cooper member(1=yes,0=no)	13.48** (4.878)	0.3561 (0.1166)	6.163*** (1.133)	0.5890 (0.0892)
Constant	-9.623 (5.615)		-1.485 (1.606)	
N	166		200	
Pseudo R^2	0.8597		0.5456	
LR chi2(11)	182.45		150.19	
Prob > chi2	0.0000		0.0000	
Loglikelihood	-14.89		-62.53	
Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001				

The influence of cooperative membership on participation in commercialisation was positive and significant. Cooperatives act as social networks in which farmers can have access to information related to production and marketing as well as social capital formation (Martey *et al.*, 2012; Camara, 2017). This further helps farmers in reducing transaction costs. Being a member of a cooperative increases the probability of participation in the smallholder and inclusive commercialisation pathway by 42.8% and 80.2% respectively relative to rain-fed farmers[1]. Off - farm income also positively and significantly influenced participation in either of the treatment. An increase in the household's off-farm income by one Tanzania shilling, leads to an increase in the probability of participation in the inclusive commercialisation pathway by 1.03 x 10^{-6} % *ceteris paribus*. This is similar to the findings by Hailua *et al*. (2015) who found that having off-farm income positively influenced participation in commercial agriculture. The plausible reason could be, farmers tend to use off-farm income earned to invest in rice production aiming at increasing production volume and sales.

Furthermore, consistent with other studies (Ochieng *et al.,* 2016; Hailua *et al.,* 2015), an increase in distance to the nearest output market negatively and significantly affected participation in commercialisation. At the margin around the mean values, an increase in distance by one kilometre leads to a decrease in the probability of participation in the inclusive pathway by about 7.7%. This could be caused by higher transaction costs involved in accessing the output market as well as market information dynamics. Improved seed positively and significantly affected participation in the smallholder commercialisation pathway. For every one kg increase in the use of improved rice seed, the probability of participating in rice commercialisation increased by 11.9%. This could be brought as a result of high yielding type of improved rice seeds including SARO 5 a mostly used seed variety in the smallholder pathway relative to low yield local seeds due to its expected returns.

4.3.2 Impacts of Commercialisation Pathways on Productivity and Welfare

This section summarizes the results of the propensity score matching (Nearest Neighbour matching and Kernel Matching algorithms) estimated to evaluate the impacts of the two commercialisation pathways on productivity and welfare (Table 5) using rain-fed farmers as a reference group.

Table 5. Impacts of Commercialisation Pathways on Productivity and Welfare

Treatment	Inclusive pathway		Smallholder pathway	
Variable	ATT		ATT	
	NNM	KM	NNM	KM
Total factor productivity	1.02 * (0.42)	0.98* (0.39)	1.21** (0.73)	1.17*** (0.35)
Income("000000" TShs)	5.48*** (1.51)	5.42*** (1.11)	7.68*** (1.55)	7.65*** (1.43)
Food consumption score (FCS)	14.04*** (3.31)	13.59** (1.66)	12.21*** (9.21)	12.90*** (2.73)
Assets("000000"TShs)	6.65*** (1.24)	6.61*** (1.96)	-0.60 (3.21)	-0.66 (4.53)
Access to health insurance	0.36*** (0.55)	0.37*** (0.06)	-0.456*** (0.30)	-0.41*** (0.07)

Notes: * p<5%, ** p<10%, *** p<0.1%; figures in parentheses are standard errors, NNM=Nearest Neighbour Matching, KM= Kernel Matching, ATT= Average Treatment effect on the Treated.

Smallholder and inclusive commercialisation pathways significantly and positively impacted on productivity and welfare. Productivity was measured in terms of returns to factors of production expressed as the ratio of gross value of output to the sum of values of factors of production employed. Similarly, welfare was measured by several indicators including annual household income, food consumption score (FCS) and access to health insurance. Smallholder and inclusive commercialisation pathways were compared with the rain-fed farmers used as a reference group.

4.3.2.1 Impacts on Smallholder Rice Farmers' Productivity and Welfare

Total factor productivity index ranged between 0.983 and 1.02 for the inclusive and between 1.17 and 1.21 for the smallholder commercialisation pathways respectively more than that of rain-fed farmers. From these results, farmers in the inclusive pathway experienced almost a constant return to factors of production (returns ≈ 1) while farmers in the smallholder commercialisation pathway experienced increasing returns (returns >1). This implies that, farmers in the smallholder commercialisation pathway had more returns to factors of production relative to the other two groups of farmers.

4.3.2.2 Impacts on Smallholder Rice Farmers' Welfare

Using the income estimates from Table 5, the results shows that smallholders in the inclusive small-medium/large commercialisation pathway earned an annual income ranging between 5.42 and 5.48 million Tanzania shillings more than rain-fed farmers. Similarly, smallholders in the smallholder pathway earned an annual income ranging between 7.65 and 7.68 million Tanzania shillings more than rain-fed farmers. These results imply that both commercialisation pathways led to a significant increase in the household income but the impact was higher in the smallholder pathway relative to inclusive pathway. This is consistent with Hailua *et al*. (2015) study in Ethiopia who found that farmers participating in commercialisation projects had higher incomes than rain-fed farmers.

Similarly, farmers in either of the commercialisation pathways were more food secure than the rain-fed farmers. The weighted frequency of food consumption among farmers in an inclusive pathway ranged between 13.59 and 14.04 times more while it was between 12.2 and 12.9 times more in the smallholder pathway relative to rain-fed farmers respectively. This implies that, participating farmers had more economic ability of food access. The results are consistent with that found by Ochieng *et al.* (2015) in the Great Lakes Region (Rwanda and DRC) who found that, banana and legumes commercial oriented farmers were more food secure than rain-fed farmers. This could be explained by the fact that, commercial oriented households could easily purchase more food varieties to supplement their own production.

Furthermore, farmers in the inclusive pathway had more valued assets relative to non-participating farmers. On average, the value of assets owned by farmers in the inclusive pathway ranged between 6.61 and 6.65 million Tanzania Shillings more than the value of assets owned by rain-fed farmers. Similarly, about 36% of smallholders in the inclusive pathway had access to health insurance more than that of rain-fed farmers. Generally, the results do not confirm the postulated hypothesis that commercialisation has no significant impacts on productivity and welfare of smallholder rice farmers in Mbarali district.

5. Conclusion and Policy Recommendations

This study aimed at evaluating the most effective commercialisation pathway (smallholder or inclusive) and its impacts on productivity and welfare on smallholder rice farmers in the pathways versus rain-fed farmers in Mbarali District. The findings indicated that both smallholder and inclusive commercialisation pathways positively impacted on the extent of smallholder rice commercialisation, productivity and welfare. The overall level of rice commercialisation was more than half of what was produced (CCI=59). However, the extent of rice commercialisation was higher in the inclusive smallholder –medium/large scale pathway where 80% of rice produced was sold relative to 70% for smallholder farmers in the smallholder commercialisation pathway and 41% for rain-fed farmers. Similarly, smallholder production system is characterized by low improved input use with input commercialisation index of 27%. This is caused by high transaction costs involved in purchasing the inputs due to poor roads, unavailability and untimely delivery of inputs in the study area. Since each pathway brought some impacts relative to the other, investing in both commercialisation pathways is crucial to explore the synergies. Therefore, programs intending to increase smallholder agricultural productivity should put more focus on productivity enhancing inputs, establishment of producer and marketing cooperatives. There should be also an investment in irrigation facilities which provide incentives for farmers to increase investment in farm production since the risk associated with farm failure is reduced.

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[1] For log-lin models ($\ln Y_i = \beta_0 + \beta_1 D_i$), the semi-elasticity with respect to the dummy D_i regressor with value 1 or 0, was calculated by the formula $(e^{\beta 1} - 1)*100$ (Gujarati, 2004: 333).