The sub Saharan Journal of Social Sciences and Humanities (SJSSH)
ISSN: 2619-8894 (Online), 2619- 8851 (Print)

Contribution of Round Potato Production on Smallholder Farmers' Wellbeing in Meru District, Tanzania

[1]Thomas M. Lyatuu and John N. Jeckoniah[2]

[1]Sokoine University of Agriculture, Department of Policy, Planning and Management. Email: lyatuuthomas@gmail.com
[2]Sokoine University of Agriculture, Department of Development and Strategic Studies. Email: jjeckoniah@sua.ac.tz

Received: February 19, 2023; **Accepted:** August 7, 2023; **Published:** December 29, 2023

Abstract: *Round potato is an important food and cash crop for increasing smallholder farmers' well-being. The paper analyses factors associated with potato farmers' well-being and assesses the contribution of round potato production on smallholder farmers' well-being in Meru District, Tanzania. The study involved 341 potato farmers (122 project participants of the potato project and 219 non-project participants). The study adopted a cross-sectional research design, multi-stage, and simple random sampling techniques; purposive sampling was used to select active groups of potato farmers, and non-project participants were selected using simple random techniques. Content analysis was used to analyze the qualitative information collected from FGD and Key Informant Interviews (KIIs). Correlation analysis was used to determine factors associated with potato farmers' income. Propensity Score Matching (PSM) was used to estimate the impact of round potato production on smallholders' farmers' income by comparing the Average Treatment Effects (income outcomes/indicators) on the Treated (ATT). The results showed a positive and significant correlation between income and production (yield) ($p<0.001$), the project participants had better well-being than their non-participants' counterparts. The round potatoes project interventions influenced smallholder farmers' well-being. It is recommended to actors engaged in the promotion of round potatoes production and productivity for improved well-being including LGAs, NGOs, development partners, research institutions and policymakers to ensure; the availability of improved seeds and other proper agro-inputs (fertilizers and pesticides), aces to extension services and loans.*

Keywords: *Round potatoes, smallholder farmers, wellbeing, potato project, impact assessment*

1. Background Information

Round potato is one of the horticultural crops which are alternative sources of income and food for a large population in different countries in the world (Santosa, 2019; Juliawati *et al.*, 2021). Potatoes are used as a cash crop and a source of starch for industrial uses in many countries in the world (Ramani and Mouille, 2019). Currently, about one-third of the global potato production is produced in Asian countries as a cash crop, especially for raw materials in agro-processing industries (FAOSTAT, 2020). Potatoes production in Indonesia has made a very large contribution to economic development (Juliawati *et al.*, 2021). Round potatoes are grown by smallholder farmers as a cash crop for income generation and employment opportunities in most developing countries such as Egypt and South Africa (FAO, 2008a; FAO, 2008b). In Sub-Saharan African countries, the area cultivated for potatoes doubled from 655,447 hectares in the year 1998 to 1.47 million hectares in the year 2018 (Krijger and Waals, 2020). In Eastern Africa, the demand for round potatoes and their products is increasing, and the crop has a high potential to double smallholder farmers' income as it is used for foodstuff and raw materials for agro-industrial production (Namwata *et al.*, 2010; Korir, 2018).

In Tanzania's Southern highlands and Northern zones, round potatoes are grown for more than one season per year as the main source of income compared to other crops grown. Mpogole *et al.* (2012) have argued that potato production is more profitable than other cereal crops grown in Njombe, Mbeya, and Nkasi districts. Also, in the Southern highlands of Tanzania, round potatoes showed a positive significant impact on income for smallholder farmers and are the most profitable cash crop (Mende *et al.*, 2014). Moreover, the potato crop is among the main cash crops produced in large quantities in the Northern Highlands of Kilimanjaro and Arusha regions (Nyunza and Mwakaje, 2012). The majority of smallholder farmers in the Meru district cultivating potatoes as the main cash crop as a source of income, still faced challenges of low income from round potatoes (MDC, 2017; FAO, 2018). By recognizing that, different stakeholders including Kilimo Trust and Research Community and Organizational Development Associates (RECODA) have joined hands with other Arusha consortium

partners in implementing a round potatoes project (CHIPS-Calories and Household Incomes from Potatoes Sub-sector). The project aimed at enhancing smallholder farmers' incomes and sustaining potato productivity for smallholder farmers, hence their improved well-being. Despite the efforts and area being a good agroecological zone in the Northern part of Tanzania for round potato production, there is limited empirical evidence on the impact of round potato production on smallholder farmers' well-being. In this study, the level of farmers' income accrued from round potato production was used as a proxy indicator for their level of well-being. Therefore, this study contributes knowledge to fill the knowledge gap by determining factors associated with potato farmers' well-being and comparing the well-being of potato farmers who are project participants with that of non-project participants in Meru District.

2.0 Methodology

The study was conducted in Meru District Council in Arusha Region, Tanzania. The district was purposefully selected because it's among the districts in Tanzania which is actively participating in potato production, the district has good soil and favourable climatic conditions for potato production. Furthermore, in the district, there are NGOs which have established an intervention project to improve potato production and productivity hence a good case for the comparison. The wards involved in the study were Songoro, Nkwarisambo, Seela-Singisi, and Ngwandua. The study involved a total of 341 potato farmers (122 project participants of the potato project and 219 non-project participants). A cross-sectional research design was adopted; given the nature of this study and its objectives, the research design was considered appropriate as it enabled the description as well as the determination of relationships between variables. Also, it is cost-effective and saves time over longitudinal design as recommended by Omair (2015). Multi-stage random sampling approach was used to select a representative sample of potato smallholder farmers in the Meru District. Purposive sampling was used to select active groups of potato farmers from the project area. A representative sample size was proportionally selected from each group using systematic sampling to select individual farmers. Non-project participants were selected using simple random sampling from a list of non-round potato farmers in the study area. Quantitative and qualitative data were collected using a structured questionnaire and an interview checklist which are useful to provide triangulation of information (Creswell, 2013).

Data analysis for quantitative data was computed using the Statistical Package for Social Sciences (SPSS). Descriptive statistical analysis including frequencies, percentages, statistical means, and standard deviations were computed to establish the characteristics of the study populations. Correlation analysis was used to determine factors associated with potato farmers' income. Pearson correlation was used to determine the levels of correlation and significance between the dependent variable (income/gross margin) and independent variables (head of household sex, years in school, main occupation, household size, application for loan, education level, access to extension services, other crop cultivated, years of experience, access to inputs, seed availability, the area cultivated, and access to market information) measured at dummy or continuous scale. Results were interpreted according to Cohen and Holliday (1982), cited by Bryman and Cramer (1992) that, regardless of positive or negative signs, correlation coefficients are interpreted as follows: below 0.19 is very low, 0.20 to 0.39 is low, 0.40 to 0.69 is modest, 0.70 to 0.89 is high and 0.90 to 1.00 is very high.

Propensity Score Matching (PSM) was used to measure the impact of an intervention on improving round potato production on smallholder farmers' well-being by comparing the Average Treatment Effects (income outcomes/indicators) on the Treated (ATT) which helped to construct the propensity scores of a control group and treatment group by using estimate differences in income between treatment group (project participants) and control (non-project participants) (Pan and Bai, 2015). The propensity score is defined as an analytical method that can be used in impact evaluation research by comparing a treatment and a control group in a project, given pre-tested characteristics (Pan and Bai, 2015). It consists of four steps: propensity score estimation, evaluating the quality of matching, selecting a matching algorithm, and outcome analysis. Content analysis was used to analyze the qualitative information collected from FGD and Key Informant Interviews (KIIs).

2.1 Computing Propensity Score Matching

The first step involved estimating propensity scores for probabilities of each potato farmer (project participants and non-project participants) given their observed characteristics (independent variables) to create a counterfactual group. The independent variables were (head of household sex, years in school, main occupation, household size, application for loan, education level, access to extension services, other crop cultivated, years of experience, access to inputs, seed availability, the area cultivated, and access to market information) measured at dummy or continuous scale. Another step involved checking overlap/balance; the distribution of the observable characteristics in the propensity score should be the same for both project and non-project participants to ensure comparing comparable groups. The third stage involved choosing the matching algorithm; the robustness of findings was checked by using two matching algorithms namely Nearest Neighbour Matching (NNM) and Mahalanobis Distance Matching (MDM). Nearest Neighbour Matching is based on the nearest propensity scores between project participants and non-

project participants group, while the Mahalanobis Distance Matching is an effective multivariate distance metric that measures the distance between a point and a distribution from propensity score between project participants and non-project participants. The last step was to compute outcome (income) analysis (Estimating the Average Treatment Effects on the Treated). The Gross Margin (GM) was used as a proxy for income attributable to round potatoes production. The Gross Margin is given by equation 1.

$$GM_i = \sum_{i=1}^{n}(TR - TVC) = \sum P_y Y - \sum P_x X_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

GM = Gross Margin,

TR = Total Revenue of selling round potatoes,

TVC = Total Variable Costs of producing round potatoes,

Y and X_i = Quantities of the round potatoes sold, and inputs used respectively and

P_y and P_x = Price of round potatoes and inputs

Therefore, ATT on profit was given by equations 2 and 3

$$ATT = (E((P_1 Y_1 / Z=1) - P_x X)) - E((P_0 Y_0 / Z=1) - P_x X))) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$ATT = E(GM_1) - E(GM_0) \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

GM_1 and GM_0 = Gross Margins for project participants and non-project participants respectively.

E = mathematical expectation operator, i.e., the population average of a random variable.

3.0 Results and Discussion

3.1 Socio-economic Characteristics of Potatoes Farmers in Meru District

A total of 341 potato farmers (122 project participants and 219 non-project participants of the potato project) were interviewed in the survey. Out of them, 169 (49.6%) were male and 172 (50.4%) were female. Among the respondents, 68.6% were aged 36 to 65, indicating energetic and active engagement of farmers in different agricultural activities. Also, the findings showed that 79.8% of the farmers interviewed had attended primary school up to standard seven, indicating that they had good literacy. Most of the respondents (82.4%) were married. The land owned by many of the respondents (60.4%) ranged between 0 to 1 acre. The average land size was 1.35 acres with minimum and maximum sizes of 0 and 6 acres respectively. Many of the farmers (88.3%) depended on crop production as their main occupation and 91.8% depended on crop production as their main source of income in the household. The average household size was 4.5 people with a minimum of 1 person and a maximum of 10 persons, this average household size is well comparable with the national average household size of 4.8 in Tanzania (URT, 2013; MDC, 2017) and indicates that the farmers interviewed had reasonable labour for farm activities.

Table 1: Descriptive analysis of socio-economic characteristics of respondents (n=341)

Characteristics	Category	Frequency	Per cent
Sex of respondent	Male	169	49.6
	Female	172	50.4
Age of respondent (years)	18-35	80	23.5
	36-65	234	68.6
	65 above	27	7.9
Marital status	Divorced	2	.6
	Married	281	82.4
	Separated	6	1.8
	Single	23	6.7
	Widow	20	5.9
	Widower	9	2.6
Education level	No formal education	5	1.5
	Adult education	3	.9
	Class four	23	6.7
	Standard seven	272	79.8
	Form two	2	.6
	Form four	33	9.7
	Form six	2	.6
	Diploma	1	.3
Size of land (acres)	0-1	206	60.4
	2-3	123	36.1
	4-6	12	3.5

3.2 Production and Income of Round Potatoes Farmers in Meru District

The findings as presented in Table 2 show that the average potato production in Meru District was 23 bags (each with 100kgs) per acre, a minimum of 7 bags, and a maximum of 105 bags per acre with a standard deviation of 0.93. These results differ from the qualitative data collected because, during key informant interviews and focus group discussions, the respondents reported potato yields had increased from 25-35 bags before the project (the year 2019) to 55-70 bags per acre after the project. Many of the participants elaborate more by acknowledging that, production was increased after project implementation compared to before project implementation. They said that the findings which show very low production and low income were due to the very poor-quality seeds supplied and distributed in the field year 2021 which was quite different (very poor quality) compared to the previous years. Due to those findings, researchers take into consideration the increase in potato production from 55-70 bags per acre in the study area. Findings also revealed the average income of potato farmers was TZS 264,321.29 per acre, with a minimum of TZS -616,000 and a maximum of TZS 3,966,000 per acre. The findings are different from Mende *et al.* (2014) who found an average potato farmers' gross income of TZS 722,250 with a minimum and maximum of TZS 8,000 and 12,000,000 respectively in Mbeya and Makete Districts. Similarly, the decline in potato production leads to a decrease in income for SHFs because of low sales. Therefore, the study revealed that the income of SHFs in the study area could be twice than calculated income considering the production increase of 55-70 bags elaborated by the majority of participants and key informants.

Table 2: Descriptive analysis of amounts of potatoes produced and income from them

Variable	Average	Minimum	Maximum
Production (Bags)	23.05	7.00	105.00
Farmers' income (TZS)	264 321.29	-616 000	3 966 000.00

3.3 Factors associated with potatoes farmers' income

The correlation results in Table 3 show that four out of ten independent variables (production (bags), area cultivated, cost of fertilizer and cost of seeds) were positively correlated significantly with the dependent variable (income). Other independent variables were not correlated significantly as shown in Table 3.

Table 3: Determine factors associated with potato farmers' income

Correlation between potato farmers' income and explanatory variables	n	Correlation coefficient (r)	p-value (two-tailed)
Age of respondent (years)	341	-.096^{ns}	.077
Years in school	341	.028^{ns}	.606
Household size (household member)	341	-.060^{ns}	.272
Number of visits made by extension officer	315	.049^{ns}	.386
Production (bags)	341	.657**	.000
Farmers experience (years)	341	.082^{ns}	.130
Area cultivated	341	.212**	.000
Cost of fertilizers	341	.217**	.000
Cost of pesticides	341	.014^{ns}	.789
Cost of seeds	341	.242**	.000

**** means significant at the 0.1% level, ** means significant at the 1% level, * means significant at the 5% level, and **ns** means not significant.*

Area cultivated: Area cultivated (acres) had a positive relationship with income (r = 0.212) at the significant level of ($p<0.001$). This implies that an increase in cultivated units of land was associated with an increase in farmers' income from potatoes. The findings also showed that the majority of the households owned an average land of 1.35 acres with a minimum of 0 and a maximum of 6 acres. Due to a lack of land for crop production farmers were forced to depend on the same piece of land to replace other crops in the next season. Participants of focus group discussants agreed as follows: *"Due to shortage of land we cannot leave our produce on the farm when waiting for the price to rise because we depend on the same farm to plant other crops, noting that other farms are rented for a short period for the owner to replace other crops next season"*. Despite being a major factor of production as stipulated by the majority of participants in focus group discussions, land scarcity led to low production as well as low income. The finding is in line with a finding by Juliawati *et al.* (2021); and Mersha *et al.* (2017) who found that farm size had a significant effect on potato farmers' income.

Cost of fertilizers: The findings in Table 3 show that the cost of fertilizer had a low positive association (r=0.217) with potato farmers' income at the significant level of ($p<0.001$). The positive correlation indicates that an increase in the use of fertilizers was associated with an increase in smallholder farmers' income. The majority of participants from the focus group discussion also explained the importance of fertilizers as a major input for potato production which contributes much to increase yield. They added by saying that fertilizers cost was constantly sold at high prices which led to underutilization of fertilizer, hence low yields. The findings are similar to the results by Mersha *et al.* (2017) and Juliawati *et al.* (2021) who found that the input costs for fertilizer had a positive correlation but were not significant with household income from potatoes.

Age of respondent: The age of the potato farmer had a negative association with income (r=-0.049) and was not significant ($p>0.05$). This indicates that an increase in farmers' age had led to a decrease in farmer's income from potatoes production. In the study area, the activities related to potato cultivation are related to young and active workers for income-generating activities. Since activities associated with potato production are very tough and therefore require young and energetic people. The finding is compared with Juliawati *et al.* (2021) found age of farmers had no significant association with the potato farmers' income in the Ijen district Indonesia. The finding also is different from Kabungo, (2008) who states age has a significant relationship with potato productivity in the Mbeya district of Tanzania.

Household size: Despite that in smallholder farming (or peasants farming) the household is the primary source of labour for income-generating activities, the study discovered that family size had a negative association (r=-0.60) with farmers' income but was not significant ($p>0.05$). This indicates that the higher the number of household members the lower the smallholder farmers' income from potatoes, because a high number of household members may influence the household to engage in the production of different crops to raise income rather than sticking to one crop (round potatoes) as a source of income. However, the finding is different from the findings by Mwatawala *et al.* (2020) and Achike *et al.* (2012) who investigated profitability factors of potatoes and cocoa in Tanzania's Mbeya district and Nigeria's Ondo state respectively. They reported that the number of household members has a positive correlation with the smallholder farmers' income from potatoes. This difference might be due to the different production activities community involved within a particular area.

Farmers' experience: Farmer's experience had a positive association with potato farmers' income (r=0.003) but not a significant level ($p>0.05$). This indicates that experienced

farmers were in a better position to earn more income compared to inexperienced farmers because they have received some extension services, and exposure and overcome many field challenges related to pests and diseases. Therefore, farmers' experience was associated with the rise or fall in income of smallholder farmers. The finding is different from a finding by Mwatawala *et al.* (2020) who found that farming experience had a significant association with potatoes profitability.

Years in school: Years in the school of farmers had a positive association (r=0.025) with potato income and was not significant (p>0.05). Farmers who had spent more years in school had the possibility of increasing potatoes' income compared to farmers who had fewer years in school. It's expected that, the more the years of schooling the more the likelihood of acquisition of relevant knowledge and skills which help farmers to make planning and proper decisions on their agricultural activities. Also, more years in school give farmers the ability to read different extension materials, comprehend, and adopt new technologies. This finding is compared with the findings of Mwatawala *et al.* (2020) who found the level of the household head had a significant association with the productivity of round potatoes.

Number of visits made by extension services: The findings from the study revealed access to extension services had a positive association (r=0.49) with round potatoes income but not significant (p>0.05). The positive correlation indicates farmers' access to extension services is capable of applying the good agricultural practices attributable to increased production as well as their income. Access to extension services by using lead farmers through the RIPAT (Rural Initiatives for Participatory Agricultural Transformation) approach introduced by the project was revealed by the majority of participants as a good approach enabled to reach many farmers within a short time in the study area. The majority of participants explained that the adoption of the new improved technologies leads to an increase in production hence higher farmers' income. The finding is compared with Mersha *et al.* (2017), who showed extension services had a significant association with households' potatoes income.

Cost of pesticides: The cost of pesticides showed a positive correlation (r=0.014) with potato farmers' income but was not significant (p>0.05). This entails that an increase in the use of pesticides contributed to an increase in potato farmers' income. It was explained by the majority of participants that potatoes are one of the crops which need intensive supervision with the application of pesticides due to the climatic conditions of potato production. The results differ from that of Juliawati *et al.* (2021) who found that the cost of seeds had a negative correlation and was not significant in increasing potato farmers' income, this is probably due to the type and amount of pesticides used during diseases and pests management.

Cost of seeds: Seeds cost showed a positive association (r=0.242) with potato farmers' income at significant (p<0.001). This indicates that an increase in the use of improved seeds was associated with an increase in farmers' income from potatoes. This was another major input explained by the majority of participants saying that seeds determine the amount of yield expected from the farm. The findings differ from Juliawati *et al.* (2021) who found a negative association and no significance on potato farmers' income because farmers did not spend a lot of money to buy quality seeds for production instead, they used seeds from the last cropping season.

3.4 Impact of Round Potatoes Production on the Well-Being of Smallholder Farmers

As explained in the methodology, the impact of potato production on smallholder farmers' well-being was analysed using Propensity Score Matching (PSM). The propensity score was calculated by regressing smallholder farmers on the predictors (independent variables) to find the probability of farmers participating in the project. Individual socioeconomic characteristics of project participants and non-project participants were used to form matched pairs of observation whereby similar individual characteristics were used to obtain a propensity score matching estimator by using the logit regression model. Table 4 shows the logit model was found to be a good predictor of participation as demonstrated by the results of $R^2 = 0.8257$ ($p > 0.5$) meaning that the model was a good fit. Secondly, the model had a chi-square static of 367.5 which was statistically significant at the 1 % confidence level. This implies that all the predictors that were included in the model could predict the probability of farmers' participation in the potatoes project.

Table 4: Probability of farmers for participation in the potatoes project

Participants	Coefficient.	P-value
Market information	2.357	0.003
Where sales potatoes	-0.102	0.985
Area cultivated	0.401	0.472
Availability of quality seeds	1.464	0.101
Availability of other inputs	3.601	0.000
Farmers experience (years)	-0.031	0.597
Other crop cultivated	0.547	0.595
Application to loan	3.367	0.000
Access to extension services	8.525	0.000
Household size	0.385	0.105
Main occupation	0.140	0.935
Years in school	0.064	0.239
Head of household sex	1.636	0.212
Age	0.022	0.443

Number of observations = 341, Chi-square = 367.25, Pseudo-R^2= 0.8257
Log likelihood= -38.751474
, **, * = 10%, 5% and 1% respectively.*

The findings in Table 4 show that project indicators; market information, application for loans, and access to extension services had a positive association and statistically significantly influenced farmers' participation in the potatoes project. Also, the area cultivated, availability of quality seed, availability of other agro-inputs, other crops cultivated, household size, main occupation, years in school, head of household sex, and age showed positive association but not statistically significant influenced farmer's participation in the potatoes project. This implies that the predictor variables included in the model are capable of predicting the probability of farmers' participation in the potatoes project with $R^2 = 0.8257$ ($p > 0.5$).

A common support graph was drawn in Figure 1 to test quality match for balance. The test helps to show the overlap of propensity scores between the treated and control groups. According to Dehejia and Wahba (2002), a good match of treated and control groups concerns a larger proportion of overlap. Figure 1 shows that the match was good and balanced due to the overlap of propensity scores between the treated and control cases.

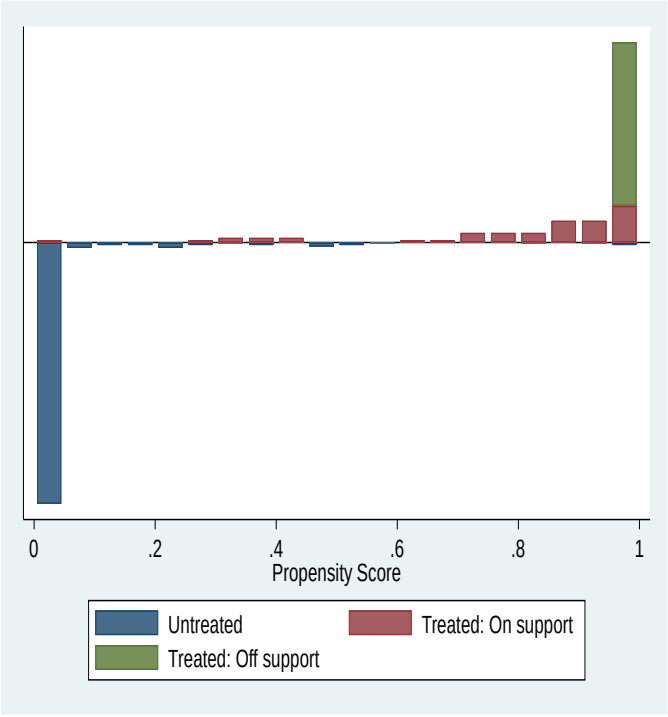

Figure 1: Common support graph

Findings from Figure 1 show the propensity scores for farmers' participation that were computed from the logit regression model. The smallholder farmers (counterfactual farmers) whose propensity scores for participation were different from the range of scores of common supports were dropped from the analysis to avoid the comparison of the uncompared group. Thereafter, the differences in income outcomes were then computed to compare project participants and non-project participants' farmers attributed to the project interventions.

Nearest Neighbor Matching (NNM) and Mahalanobis Distance Matching (MDM) are used to find a subset of control units similar to treated units to arrive at a balanced sample where the distribution of covariates is the same in both treatment and control groups (Baser, 2006). In this study, as presented in Table 5, ATT used were NNM and MDM.

The NNM results revealed in Table 5 indicate that the smallholder farmers who participated in the project intervention had an average gross margin (income) of TZS 348,603.42 compared to the non-project participants who had an average of TZS 214,854.55, a positive significant difference income of TZS 133,748.87. Similarly, ATT in terms of income had a positive difference income of TZS 239,477.52 to that of the unmatched groups, whereby project participants and non-project participants had an average income of TZS 418,120.63 and TZS 178,643.11 respectively. MDM results presented in Table 5 show an average income of TZS 418,120.63 for project participants compared to an average income of TZS 251,270.49 for non-project participants a positive significant difference in income of TZS 166,85.13. Likewise, income for unmatched groups of project participants was TZS 418,120.63 and TZS 178,643.11 for non-project participants a positive difference in income of TZS 239,477.57.

Based on the findings, it is statistically proved that project participants had higher incomes than non-project participants. The project participants showed good opportunities by adopting good agro-practices including spacing, intensive supervision, proper management and application of inputs such as proper application of fertilizers, pesticides for diseases, and pest control which finally led to higher production than non-project participants. All of these were attributed to the increase in smallholder farmers (project participants) income as discussed above. The findings are compared with Juliawati et al. (2021) findings which showed that there is a difference in average income between partner and non-partner potato producers.

Table 5: NNM and MDM the effect of smallholder farmers' income on project participants (treated) and non-project participants (control)

Matching and Variable	Sample	Treated	Control	Difference	t-stat
Neighbour Matching Income Variable	Unmatched	418,120.631	178,643.114	239,477.517	3.66
	ATT	348,603.418	214,854.545	133,748.873	0.46
Mahalanobis Matching Income Variable	Unmatched	418,120.631	178,643.114	239,477.517	3.66
	ATT	418,120.631	251,270.492	166,850.139	0.54

The results of the ATT estimation show that the potatoes project had a positive impact on the potato farmers' income in Meru District. These findings are similar to the findings by Rifa'I and Samir (2019) in their study on the impact of seed varieties programme on the welfare of rice farmers; they used different matching approaches and obtained similar results. Also, their study showed that the new seed varieties programme had a positive and significant impact on the welfare of farmers.

4.0 Conclusions and Recommendations

Round potato production contributes to the well-being of smallholder farmers as it is the main cash crop and a major source of income for the majority of the smallholder farmers in Meru District. Improved round potato production has the potential to increase smallholder farmers' income which in turn gradually improves their well-being. The area cultivated, affordable price of fertilizer, improved round potatoes seed, and affordable price of seeds are key factors for increased production (yields), which is an important factor for the increase in potato smallholder farmer's income. Other factors such as extension services, farmers' experience, years in school, and the cost of pesticides are also associated with enhancing smallholder farmers' income from round potato production. Generally, project intervention in improving the production, productivity and marketing of round potatoes contributes to farmers' well-being.

It is recommended to actors engaged in the promotion of round potatoes production and productivity for improved well-being including LGAs, NGOs, development partners, research institutions and policymakers to ensure; the availability of improved seeds and other proper agro-inputs (fertilizers and pesticides), aces to extension services and loans. The intervention strategies, among other things should ensure on spreading of good agro-practices to other wards beyond project villages to enable the adoption of improved technologies and recommended agronomic practices.

References

Achike, A.I., Deedam, N.J. and Onoja, A.O. (2012). Profitability and yield determinants in Nigerian cocoa farms in Ondo State. *Journal of Sustainable Development in Africa*, 14 (4): 175-192

Baser, O. (2006). Too much ado about propensity score models? Comparing methods of propensity score matching. Value in Health, 9(6), 377-385.

Creswell, J.W. (2013). Research Design Qualitative and Mixed Methods Approaches 4th ed. SAGE Publications Inc., United State of America 342pp.

Field, F. 2018. Discovering Statistics Using IBM SPSS (5th Edition). London: SAGE Publications Ltd.

Hoetker, G. (2007). The use of logit and probit models in strategic management research: Critical issues. *Strategic management journal*, 28(4), 331-343.

Juliawati, T. A., Soetriono, J. M., & Aji, M. (2021, December). The Implementation of Farmer Partnership and the Factors Affecting Potatoes Farmers' Income in Ijen District, Bondowoso. In 1st International Conference on Sustainable Agricultural Socio-economics, Agribusiness, and Rural Development (ICSASARD 2021) (pp. 60-69). Atlantis Press.

Kharumnuid, P., Pandey, N. K., Devarani, L., Chauhan, J. K., Singh, R., Das, B., & Marbaniang, E. K. (2021). Potato production for nutritional security and doubling farmers' income.

Korir, C. K. (2018). Factors Affecting Value Addition of Irish Potatoes and Effects on Smallholder Farmers'income Generation in Bomet County, Kenya (Doctoral dissertation, University of Kabianga).

Krijger, K., & Waals, J. E. (2020). Potatoes virus Y and Potatoes leafroll virus management under climate change in sub-Saharan Africa. South African Journal of Science, 116(11-12), 1-7.

MDC (Meru District Council). 2017. Socio-Economic Profile.

Mende, D. H., Kayunze, K. A., & Mwatawala, M. W. (2014). Contribution of round potatoes production to household income in Mbeya and Makete districts, Tanzania.

Mersha, M., Demeke, L., & Birhanu, A. (2017). Analysis of Factors Affecting Potatoes Farmers' Gross Margin in Central Ethiopia: The Case of Holeta District.

Mpogole H, Mlambiti M. E and Kadigi R. M. J, (2012). Round Potatoes (Solanum tuberosum) Production in Southern Highlands of Tanzania: Are smallholder farmers becoming commercial? Journal of

Agricultural Extension and Rural Development. Vol. 4 (14), pp 385–391.

Mwatawala, H., Mwakijele, E., & Mpogole, H. (2020). Strategies for Enhancing Productivity and Profitability of Irish Potatoes in Mbeya District, Tanzania.

Namwata, B. M., Lwelamira, J. M. O. B., & Mzirai, O. B. (2010). Adoption of improved agricultural technologies for Irish potatoes (Solanum tuberosum) among farmers in Mbeya Rural district, Tanzania: A case of Ilungu ward.

Nyunza, G., & Mwakaje, A. G. (2012). Analysis of Round Potatoes Marketing in Tanzania.

Omair, A., (2015). "Selecting the appropriate study design for your research: Descriptive study designs," J. Health Spec., vol. 3, no. 3, p. 153. doi: 10.4103/1658-600X.159892.

Pan, W., & Bai, H. (Eds.). (2015). Propensity score analysis: Fundamentals and developments. Guilford Publications.

Ramani WB, Mouille B (2019) The contribution of potatoes to global food security, nutrition and healthy diets. Am J Potatoes Res 96:139–149.

RECODA, (2020). Irish Potatoes Value Chain Workshop for The Northern Zone of Tanzania. Research, Community and Organizational Development Associates, Box 10633, Arusha.

Rifa'i, A., & Samir, S. (2019). Impact of New Seed Varieties Programme on the Welfare of Rice Farmers in Indonesia: A Propensity Score Matching Approach. Journal of Agricultural Extension, 23(4), 144-156.

Santosa. M. (2019). Budidaya Kentang Datara Tinggi dan Dataran Medium Dilahan Tropis. UB Press. Malang. Hal 32-61.

URT (2013). 2012 Population and Housing Census Population: Distribution by Administrative Areas. NBS (Dar es Salaam) and OCGS (Zanzibar). 244pp.

Windmeijer, F. A. (1995). Goodness-of-fit measures in binary choice models. Econometric reviews, 14(1), 101-116.