EFFECTS OF CREDITS ACCESSIBILITY FOR SMALL HOLDER FARMERS IN RWANDA: EVIDENCE FROM IRISH POTATO GROWERS IN MUSANZE DISTRICT

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Abstract

The provision of credit to farmers is widely perceived as an effective strategy for promoting the adoption of improved technologies by rural farm households. It is believed that access to credit promotes the adoption of risky technologies through the relaxation of the liquidity constraint as well as through the boosting of households risk bearing ability. The study aimed to analyse the effects of credits accessibility for small farmers in Rwanda: Evidence from Irish potato growers in Musanze District, Northern Province in Rwanda. Multistage sampling techniques were used to select 212 respondents using a structured questionnaire. Descriptive statistics (Frequency, Percentage, Means and Standard deviation) were used to characterize farmers and T-test were used to compare means of credits users and non-credit users. Statistical Package for Social Sciences (SPSS 16.0), STATA 13.0 and Ms Excel were used to analyse data. An econometric model was applied to estimate the data using STATA version 13. Propensity score matching (PSM) model was used to analyse determinants and effects of credits accessibility for smallholder farmers in Musanze District, Rwanda. The key findings from Propensity score matching model revealed that the seasonal NPK usage in Irish potato production ranges from 163Kg/ha to 188.89Kg of NPK and the effect increased from 10.91Kg to 39.63Kg for treated and control group using NNM, KM and RM. The study results also concluded that the yearly cost needed to buy NPK was 70,685Frws/ha (82.67USD) and the mean difference was ranged from 95,491Frws/ha (111.69USD) to 102,979Frws/ha (120.44USD). For pesticides use, the seasonal quantity of pesticides used was ranged from 4.69Kg to 5.96Kg/ha per season and seasonal mean difference was ranging from 0.181Kg to 1.63Kg. The total cost invested in pesticides purchasing value was 28, 989Frws (33.91USD) with the mean difference ranging from 12,232Frws (14.31USD) to 14,117Frws (16.51USD) between treated and control groups. The study findings showed that seasonal Irish potato production was ranging from 7295.12 Kg/ ha (7.3tons/ha) to 8113.25kg/ha (8.11ton/ha) and the mean difference for credits users and non credits users was varying from 790.40Kg/ha to 871.79Kg/ha in 2017A and from 691.31Kg/ha to 1091.99Kg/ha in season of 2017B. Moreover, the study findings concluded that the seasonal farmer's revenues from Irish potato production was ranging from 1,216,962Frws/ha (1423.35USD) to 1,230,585Frws/ha(1439.28USD) and the mean difference as program impact for credits users and non credits users was varying from 181,001Frws/ha (211.70USD) to 313,787Frws/ha (367.00USD) in 2017A and in 2017B, the mean difference (program impact) ranged from 313,787 Frws/ha (367.00USD) to 375,569Frws/ha (439.26USD). Therefore, future studies should also focus on the spill over effects of credits program interventions among the low and high-income households participating in such credits schemes.

Key Words: 1USD= 855Frws, *Credits accessibility, Propensity score matching, Small holder farmers, Rwanda*

1. INTRODUCTION

According to [1], the provision of credit to farmers is widely perceived as an effective strategy for promoting the adoption of improved technologies by rural farm households. [2] reviewed factors that affect technology adoption, and they highlight access to credit as a key determinant of adoption of most agricultural innovations. It is believed that access to credit promotes the adoption of risky technologies through the relaxation of the liquidity constraint as well as through the boosting of households risk-bearing ability.[1] reported that credit access had a higher impact on the adoption of hybrid maize among credit constrained households in rural Malawi. [3] posits that lack of credit access may affect farm productivity because farmers facing binding capital constraints would tend to use lower levels of inputs in their production activities. Improved access to credit facilitates optimal input use and therefore could have a major impact on productivity. Thus, access to credit allows farmers to satisfy their cash needs induced by the agricultural production cycle and consumption requirements.

Thus, agricultural credit refers to an undertaking by individual farmers or farm operator to borrow capital from intermediaries for the farm operations. The socioeconomic characteristics of both male and female farmers have been noted to have a significant effect on gender access to credit. Again, certain acceptable traditional and cultural norms of the society have been noted to serve as constraints to gender access to credit (Doss, 1999). He further opined that access to credit may be limited by the perception that agriculture is characterised by risks and uncertainties. Small households farming help people in weak economic positions to gather resources and carry out social and economic activities (Develtere, 2008).Thus; they upgrade people under conditions where it would otherwise be impossible for individuals to attain any positive advancement small households farming ensure the fullest possible participation in the development process of all population groups in a case connected to the credits from a financial institution. It is contended that agricultural farming, being close to the feelings of the people, has the ability to mobilize resources and people to help them within the rural community (OECD, 2008). They provide an essential support to farmers themselves and intervene for national poverty reduction policy. Small households farming is a crucial element that contributes to the achievement of the Millennium Development Goals[4]. This sector also provides an opportunity for poor people to raise their incomes. According to the UN (2011) cited in [5], the 1995

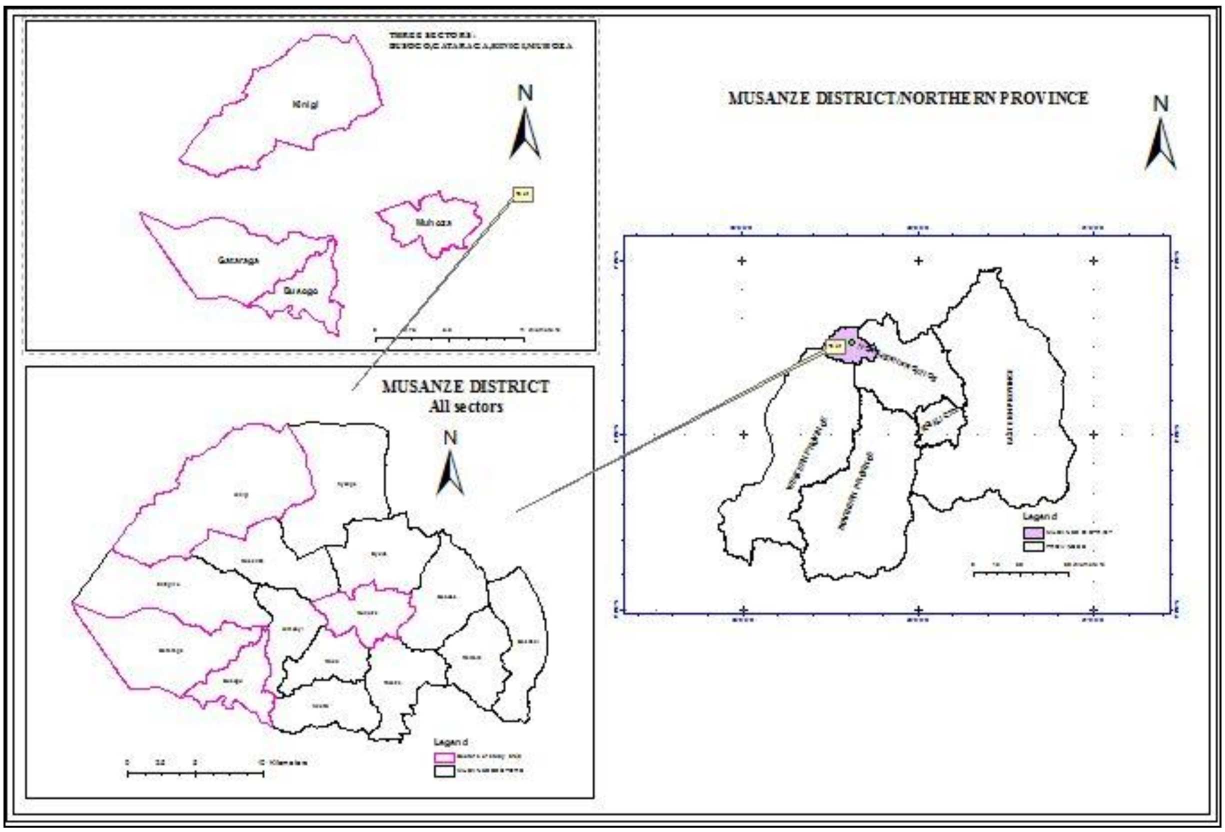
Copenhagen World Summit for social development recognized the role of farming in reducing poverty. As small households farming offer a potential resource to tackle poverty; countries established policies for creating a favourable environment to support such kind of small household farmers (ILO, 2005) cited [6].

In a bid to alleviate the problem associated with credit acquisition by farmers, the Rwandan government is promoting the use of financial institutions as organizations that could help enhance the development of small-scale farmers and other communities in Rwanda through offering credits. In sub-Saharan Africa, like Rwanda, the number of people under the low standard of socio-economic living conditions dominates the majority of the entire population [7]. Thereby, the agricultural farming sector dominates the overall national economy. Since 1985 in Rwanda, the number of people under the index line of poverty has never been below 50% in the country (MINECOFIN, 2012:9) cited in [8]. The causes of the aforementioned issues among others include lack of assets, lack of employment, unorganized labour, and failure of transfer mechanisms to meet basic needs [9]. The government has committed itself to provide a supportive legal environment for small households farming. On other hand credits to small households farming plays a vital role or significant to them in the case given to favourable conditions and used effectively. The researcher will analyze the credit accessibility and its availability to small households farming. Study conducted abroad confirmed that there is a need of funds to carry out timely purchases of cash inputs such as fertilizer, quality seeds, herbicides and pesticides into agricultural production, as well as to buy capital equipment like hoes, cutlasses and water pumps has long been regarded as one of the critical constraints inhibiting increased food productivity in smallholder agriculture [10]. But no specific study conducted in Rwanda aimed at analysis of the determinants and effects of credits accessibility for smallholder farmers in Rwanda**.** Specifically, the study was guided by the following specific objectives:

- Effects of credits accessibility on smallholder farmers' capacity to purchase inputs in Musanze district
- Effects of credits accessibility on smallholder farmers' production in Musanze district
- Effects of credits accessibility on smallholder farmers' revenues in Musanze district

2. Methodology used

The study was Musanze district of Northern Province of Rwanda during seasons of 2017A and 2017B to analyse the determinants and effects of credits accessibility for small farmers in Rwanda: Evidence from Irish potato growers in Musanze District. Multistage sampling techniques were used to select 212 respondents using a structured questionnaire. Descriptive statistics were used to characterize farmers and T-test was used to compare means of respondents. Econometric methods were employed to estimate the data using STATA version 13. Propensity score matching model was used to determinants and effects of credits accessibility for smallholder farmers in Musanze District**,** Rwanda.



Fugure1: Map showing the study area.

2.1 Application of Propensity Score Matching (PSM)

Based on Background and objective of the developed in 1, the PSM regression model was used to estimate propensity score matching for borrowers and non- borrowers households in the study area, the reason for the selection of the model was based on the fact with the access to credits and without access to credits whereas PSM model will be in respect because it ensures normal distribution of error terms and reduces errors of biases. The dependent variable in this model is a binary variable/ dummy variable where a farmer will be prompt to access credits or not.

The potential outcome framework is used to assess the determinants and effect of credits accessibility among smallholder farmers in Rwanda. Under the potential outcomes framework, each population unit with an observed outcome y has *ex-ante* two potential outcomes: an outcome when receiving a treatment and an outcome when not receiving a treatment. Here the treatment is a farmer is a farmer accessed credits in crop production system j. Let D_j be the binary variable indicating the being the farmer with production j with $D_j=1$ indicating the farmer accessed credit and $D_j=0$ indicating non counter factual by a population unit. Also, let $y_1 \equiv g(d_j^1, z)$ and $y_0 \equiv g(0, z)$ be the potential outcomes corresponding to the two mutually exclusive states of farmer accessed credits and their counter parties (non- users of credits), respectively. For any population unit, the causal effect of accredits accessibility on the outcome y is defined as $y = y_1 - y_0$. However, the two potential outcomes cannot be observed at the same time. With the observed outcome y given by $y = D_j y_1 + (1 - D_j) y_0$, we can only observe either y_1 or y_0 depending on whether D_j equal 1 or 0, thus making it impossible to measure $y_1 - y_0$ for any population unit. However, if we let Y be the random variable defined in some probability space (Ω, $\sum$, P) reflecting the distribution in the population of the outcome represented by the outcome variable y^1, then the average causal effect of adoption in the population, $E(Y1 - Y0)$ (with E being the mathematical expectation operator), can be determined. Such a population parameter is called the average treatment effect (ATE) in the literature. One can also estimate the mean effect of the credits users on the sub-population group: $E(y_1 - y_0 \mid D_j = 1)$, which is called the average treatment effect on the treated and is usually denoted by ATT. The average treatment effect on the *untreated*: $E(y_1 - y_0 \mid D_j = 0)$, denoted by ATU is another population parameter that can be defined and estimated. The population means impact parameters ATE, ATT, ATU can generally be identified under some statistical independence assumptions between the population distributions of the treatment status variable D and the two potential outcomes Y_1 and Y_0 (possibly conditional on some observed random vector X of covariates). Two alternative statistical independence assumptions are made to identify ATE, ATT and ATU [11]

The first one is the unconditional independence assumption: The population distribution of D is independent of that of Y_1 and Y_0. Under this assumption, ATE, ATT and ATU are identified by the mean difference of observed outcomes of credits user and counterfactual: $MD = E(Y \mid D = 1) - E(Y \mid D = 0)$ and this is easily estimated by its sample analogue. The second assumption is the *conditional independence* assumption also called "selection on observables", whereby the population distribution of D is independent of that of conditional on some observed component X of the vector $(a^*_{(N)}, Z)$ of exogenous and endogenous random variables whose values do not depend on a_N Under this assumption the conditional mean treatment effects are all identified by the conditional mean difference of observed outcomes $MD(X) = E(Y \mid X = x, D = 1) - E(Y \mid X = x, D = 0)$ and ATE, ATT and ATU are identified by the mean of MD(x) over x in the full population, the subpopulation with D =1 and the subpopulation with D=0, respectively [11].

3. Results and Discussion

3.1Presentation of Econometric Findings

In this study, econometric data analysis is clearly applied to estimate the determinants and effects of credits accessibility for small farmers in Rwanda using PSM. Initially, the logistic regression econometric model has been used to estimate the potential socioeconomic and institutional factors that affect households' access or not to access credits. Next step, to estimate the impact of credits accessibility on the capacity to afford inputs for Irish potato production, on Irish potato yield and expected revenues compared to non-loan borrowers of small-scale households using the different ATT three estimation algorithms (NNM, KM and RM). To do all these different econometric estimates we used STATA version thirteen (STATA 13). To estimate the propensity scores to match the outcomes of adopter with non-adopter households it is used logistic estimation model.

3.1.1 Effects of credits accessibility on smallholder farmers' capacity to purchase inputs

3.1.1.1 Inorganic fertilizer use in Irish potato production (NPK use)

When panel data are not available or when there is additional need to account for baseline differences between treatment and control groups, PSM or propensity score weighting can be applied. For PSM, participants are matched to non-participants using propensity score matching via psmatch2 estimator. Several matching methods have been developed to match participants with non-participants of similar propensity scores. These include Nearest Neighbour Matching, Stratification and Interval Matching, Caliper and Radius Matching and Kernel Matching, among others. Based on propensity scores matching logarithms, table 4.8 summarizes the total quantity of inorganic fertilizers (NPK) use during the Irish potato production and their effect among the treated and untreated groups. In a season of 2017A, the research findings showed that the average total quantity of NPK used was 163Kg/ha and mean difference was 10.91Kg; -3.34Kg and -19.97Kg using NNM, KM and RM for treated and control group. The negative sign indicates that control group applied too much fertilizer than treated group implying the negative effect of the credits technology adoption after the run of Psmatch 2 estimator with Kernel and Radius matching and all quantity were not statistically significant using NN, KM and RM matching logarithms. In the next farming season of 2017B, the findings from the PSM model indicated that the quantity of NPK used was 188.89Kg and the mean difference between the treated and control groups varied from 34.035Kg; 39.63Kg and 38.91Kg using NN, KM and RM matching logarithms and all variables were not statistically significant at 5% level of significance. The study results also showed that the average treatment effect of the treated of the total cost invested in NPK purchasing was 170,685Frws/ha and the mean difference (program) impact was ranged from 102,979Frws/ha; 96,481Frws/ha and 95,491Frws/ha using NNM, KM and RM matching algorithms respectively and all estimates were statistically significant with 3.63**, 3.32** and 3.66** at 5% level of significance respectively.

Table 1: Inorganic fertilizer use in Irish potato production (NPK use) in Musanze district

Parameters (NPK)	Sample	Treated	Controls	Difference	S.E.	T-stat
			Nearest Neighbour Matching (NNM)			
2017A	Unmatched	163.1081	192.9167	-29.8086	35.15942	-0.85
	ATT	163.1081	152.1997	10.90841	53.64153	0.2
2017B	Unmatched	188.8937	141.4875	47.40619	37.17276	1.28
	ATT	188.8937	154.8583	34.03544	34.7258	0.98
TOTAL Cost NPK	Unmatched	170685.1	74877.5	95807.64	28878.44	3.32
	ATT	170685.1	67706.01	102979.1	28350.17	3.63
			Kernel Matching (KM)			
2017A	Unmatched	163.1081	192.9167	-29.8086	35.15942	-0.85
	ATT	163.1081	166.4485	-3.34039	48.69493	-0.07
2017B	Unmatched	188.8937	141.4875	47.40619	37.17276	1.28
	ATT	188.8937	149.2594	39.63425	32.82542	1.21
TOTAL Cost NPK	Unmatched	170685.1	74877.5	95807.64	28878.44	3.32
	ATT	170685.1	74203.72	96481.42	26579.76	3.63
			Radius Matching			
2017A	Unmatched	163.1081	192.9167	-29.8086	35.15942	-0.85
	ATT	163.1081	183.0805	-19.9723	47.35638	-0.42
2017B	Unmatched	188.8937	141.4875	47.40619	37.17276	1.28
	ATT	188.8937	149.9862	38.90748	32.30788	1.2
TOTAL Cost NPK	Unmatched	170685.1	74877.5	95807.64	28878.44	3.32
	ATT	170685.1	75194.28	95490.86	26119.92	3.66

3.1.1.2 Use of pesticides by Average Treatment Effect on Treated (ATT)

The study assessed the impact of credits accessibility on pesticides usage using household agricultural income as the outcome variable. Thus, the Average Treatment Effect (ATT) was estimated using equations shown above in the region of common support (see figure 2). The ATT's were derived using three matching estimators, namely, nearest neighbour, radius, and kernel matching. The three matching estimators were used to check the consistency of the PSM results. In a season of 2017A, the findings revealed that the average total quantity of pesticides used was 5.96Kg/ha and mean difference was 1.63Kg; 1.07Kg and 0.59Kg and all covariates in the model were not statistically significant at 5% level of significance using NN, KM and RM matching logarithms. In the next farming season of 2017B, the findings also revealed that the average treatment effect (ATT) was 4.69Kg and the mean difference (program impact) after credits accessibility was ranging from 0.462Kg; 0.181Kg and -0.133Kg and were not statistically significant at 5% level of significance by using all three matching algorithms. The results from table 4.9 present findings from the PSM model that was estimated for comparison purposes of total cost invested in pesticides purchasing with the treatment effect model results. The propensity score matching results indicate that credits accessibility has a significant impact on capacity to buy pesticides as the ATT value was 28, 989Frws with the mean difference ranging from 14,117Frws; 12,563Frws and 12,232Frws and all covariates were statistically significant with T-statistics value of 2.31**, 2.22** and 2.2** at 5% level of significance respectively.

Table3. 2: Use of pesticides by the Average Treatment Effect on Treated (ATT)

Parameters (Pesticides)	Sample	Treated	Controls	Difference	S.E.	T-stat
Nearest Neighbour Matching (NNM)						
2017A	Unmatched	5.961712	5.677083	0.284628	1.415334	0.2
	ATT	5.961712	4.330556	1.631156	1.785821	0.91
2017B	Unmatched	4.69009	5.189583	-0.49949	1.111671	-0.45
	ATT	4.69009	4.228078	0.462012	1.536511	0.3
Total cost pesticides	Unmatched	28988.92	17002.92	11986	5624.474	2.13
	ATT	28988.92	14871.94	14116.98	6112.22	2.31
Kernel Matching (KM)						
2017A	Unmatched	5.961712	5.677083	0.284628	1.415334	0.2
	ATT	5.961712	4.887733	1.073979	1.638268	0.66
2017B	Unmatched	4.69009	5.189583	-0.49949	1.111671	-0.45
	ATT	4.69009	4.508696	0.181394	1.398597	0.13
Total cost pesticides	Unmatched	28988.92	17002.92	11986	5624.474	2.13
	ATT	28988.92	16425.81	12563.11	5665.805	2.22
Radius Matching						
2017A	Unmatched	5.961712	5.677083	0.284628	1.415334	0.2
	ATT	5.961712	5.370195	0.591516	1.598964	0.37
2017B	Unmatched	4.69009	5.189583	-0.49949	1.111671	-0.45
	ATT	4.69009	4.822885	-0.13279	1.362386	-0.1
Total cost pesticides	Unmatched	28988.92	17002.92	11986	5624.474	2.13
	ATT	28988.92	16756.63	12232.28	5550.848	2.2

3.1.2 Effects of credits accessibility on smallholder farmers' crop production in Rwanda

The discussed effect on increased production were computed using the three matching algorithms namely, nearest neighbour matching (NNM), kernel matching (KM) and radius matching (RM) are shown below in table 4.10 and except for ATE and ATU, the ATT values were presented by types of matching logarithms (NNM, KM and RM) respectively. Results from the nearest neighbour, kernel, and radius matching methods are used to estimate average yield and mean difference as program impact on increased production from Irish potato growers in the study area. During the season of 2017A, the average Irish potato production was 8113.25kg/ha or 8.11ton/ha and the mean difference as program impact for credits users and non credits users in terms of production was 851.28Kg/ha; 871.79Kg/ha and 790.40Kg/ha using NN, KM and RM depending all estimates are statistically significant at 4.2**, 4.3* and 3.2* at 5% level of significance respectively. Furthermore, during the next farming season of 2017B, the average Irish potato production was 7295.12 Kg/ ha or 7.3tons/ha. The mean difference as the program impact between treated and control ranged from 1091.99Kg/ha; 745.97Kg/ha and 691.31Kg/ha between the credits users (Treated) and no credits users (controls) groups using NN, KM and RM and all those were statistically significant with 3.5**, 3.3* and 3.1* respectively at 5% percentage level of significance. Other reasons mentioned by the respondents were the type of seeds used and ability to control pests and wilting. Recent evidence suggests that the return to the wider economy may be quite high when compared with other sectors and our findings are supported by the results of [12], hence these findings are supported by the discussions of [13].

Table3. 3: Effects of credits accessibility on farmers' crop production in Rwanda

Parameters (Yield)	Sample	Treated	Controls	Difference	S.E.	T-stat
			Nearest Neighbour Matching (NNM)			
2017A	Unmatched	8113.248	7153.191	960.0564	657.6782	2.46*
	ATT	8113.248	7261.966	851.2821	695.3627	4.22*
2017B	Unmatched	7295.12	7168.085	127.0346	740.7886	2.17*
	ATT	7295.12	6203.134	1091.986	725.112	3.51*
			Kernel Matching (KM)			
2017A	Unmatched	8113.248	7153.191	960.0564	657.6782	4.46*
	ATT	8113.248	7241.461	871.7873	650.2248	4.34*
2017B	Unmatched	7295.12	7168.085	127.0346	740.7886	3.17*
	ATT	7295.12	6549.146	745.974	682.3948	3.29*
			Radius Matching			
2017A	Unmatched	8113.248	7153.191	960.0564	657.6782	4.46*
	ATT	8113.248	7322.849	790.3986	638.6443	3.24*
2017B	Unmatched	7295.12	7168.085	127.0346	740.7886	4.17*
	ATT	7295.12	6603.805	691.3147	671.4815	3.13*

3.1.4 Effects of credits accessibility on small holder farmers' revenues in Rwanda

Table 10 detailed the farm gross margin from the investment on Irish potato production project. In all farming season of 2017A&B, results showed that the average Gross farm income per hectare of the farmers was 1,216,962Frws/ha and 1,230,585Frws/ha in 2017A and 2017B using NN, KM and RM matching logarithms; based on propensity scores matching logarithms, the mean difference differ seasonality and according to matching logarithms. In 2017A, the findings showed that the mean difference ranged from 159,533Frws/ha; 181,001Frws/ha and 313,787Frws/ha respectively statistically significant with t-value of 2.91*; 2.15* and 3.22* at 5% level of significance respectively using NN, KM and RM matching logarithms; during the next season of 2017B, the average treatment effect (ATT) on the treated was 1,230,585 Frws/ha and the mean difference (program impact) ranged from 375,569Frws/ha; 337,817 Frws/ha and 313,787 Frws/ha respectively using NN, KM and RM matching logarithms and all estimates were statistically significant with t- statistics value of 2.4*; 2.1* and 2.3* at 5% percentage level of significant. The higher gross farm margin is a results of joint action of Irish potato cooperatives membership, credits accessibility, extension services and their collection centres which reduce local traders to buy their produce at unpredicted price and other subsidies to farmer groups and these findings conflict with the findings of [14], that high cost of seeds, fertilizer and labor are the major challenges in Irish potato industry in most developing African countries.

Table3. 4: Farm gross margin analysis based on ATT propensity score matching

Parameters (Revenues)	Sample	Treated	Controls	Difference	S.E.	T-stat
Nearest Neighbour Matching (NNM)						
2017A	Unmatched	1,216,962	995,523	221,439	141,452	3.57*
	ATT	1,216,962	1,057,429	159,533	175,998	2.91*
2017B	Unmatched	1,230,585	1,004,646	225,939	128,216	2.76*
	ATT	1,230,585	855,016	375,569	156,312	2.4*
Kernel Matching (KM)						
2017A	Unmatched	1,216,962	995,523	221,439	141,452	2.57*
	ATT	1,216,962	1,035,962	181,001	157,775	2.15*
2017B	Unmatched	1,230,585	1,004,646	225,939	128,216	1.76*
	ATT	1,230,585	892,768	337,817	143,252	2.1*
Radius Matching						
2017A	Unmatched	1,216,962	995,523	221,439	141,452	3.57*
	ATT	1,216,962	1,031,490	185,472	152,368	3.22*
2017B	Unmatched	1,230,585	1,004,646	225,939	128,216	2.76*
	ATT	1,230,585	916,798	313,787	136,988	2.3*

4.2.5 Distribution of propensity score density of the common support region

Figure 2, presents the results of the covariate balancing test to verify the hypothesis that both groups have the same distribution in covariates after matching. It presents the covariates' means, their t-test of differences in means as well as the percentage bias before and after matching, for all covariates, the matched sample means are almost similar for both the treatment and the control. The graph shows that no treated individuals are out off support the region indicating that all the treated groups accessed credits in Irish potato production get a appropriate match among the non credits users engaged in Irish potato production hence all the treated and the untreated individuals were found within the same region of common support. Also it indicates that two farmers' untreated users were found out of the common support region indicating that also all treated individuals have not received the associated untreated individuals. This shows that the whole assumption of common support was satisfied [15].

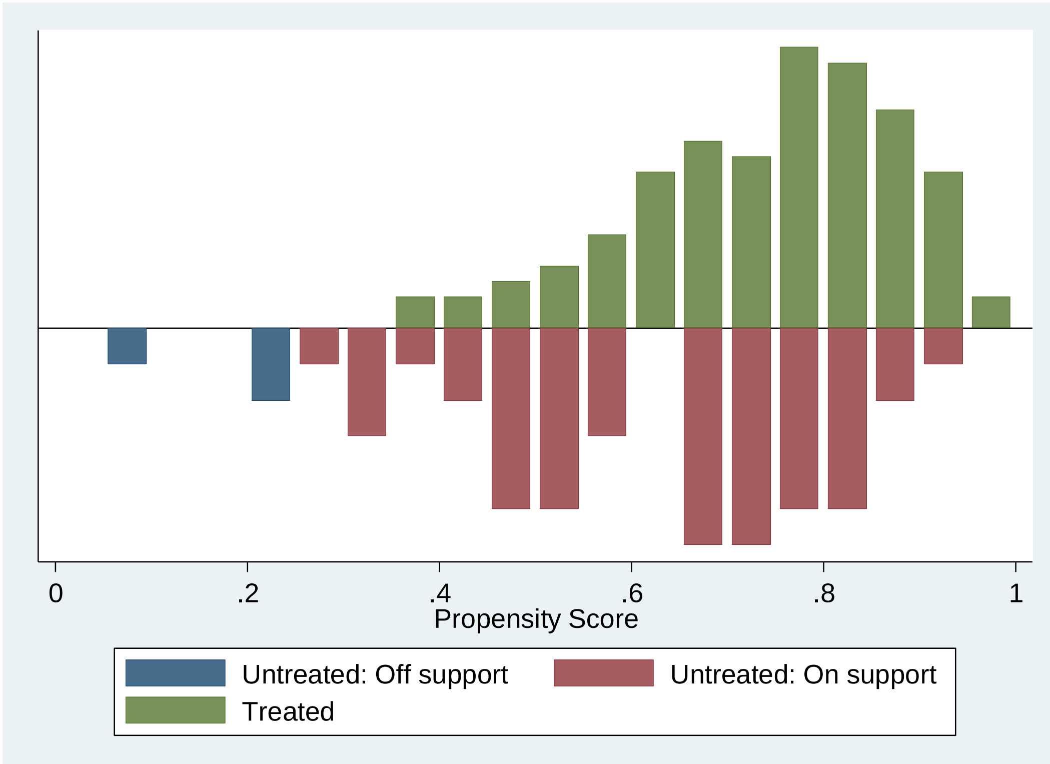


Figure2: Density distributions of the estimated propensity scores for the two groups

4. Summary, Conclusion and Recommendation

The study used the PSM model to estimate the effect of credits accessibility on farmer's capacity to purchase farm inputs. The study findings concluded that the seasonal NPK in Irish potato production ranges from 163Kg/ha to 188.89Kg of NPK and the effect increased from 10.91Kg to 39.63Kg for treated and control group using NNM, KM and RM. The study results also concluded that the yearly cost needed to buy NPK varied was 70,685Frws/ha and the mean difference (program) impact was ranged from 95,491Frws/ha to 102,979Frws/ha using NNM, KM and RM matching algorithms. For pesticides use, the seasonal quantity of pesticides used was ranged from 4.69Kg to 5.96Kg/ha per season and seasonal mean difference was ranging from 0.181Kg to 1.63Kg using NN, KM and RM matching logarithms. The total cost invested in pesticides purchasing value was 28, 989Frws with the mean difference ranging from 12,232Frws to 14,117Frws.

The study used the PSM model to estimate the effect of credits accessibility on farmer's crop production for small scale farmers in Musanze district. The study findings concluded that the seasonal Irish potato production was ranging from 7295.12 Kg/ ha (7.3tons/ha) to 8113.25kg/ha or 8.11ton/ha and the mean difference as program impact for credits users and non credits users was varying from 790.40Kg/ha to 871.79Kg/ha using NN, KM and RM in 2017A and from 691.31Kg/ha to 1091.99Kg/ha in season of 2017B using NN, KM and RM. The study used the PSM model to estimate the effect of credits accessibility on farmers' revenues for small scale farmers in Musanze district. The study findings concluded that the seasonal farmer's revenues from Irish potato production was ranging from 1,216,962Frws/ha to 1,230,585Frws/ha and the mean difference as program impact for credits users and non credits users was varying from 181,001Frws/ha to 313,787Frws/ha using NN, KM and RM matching logarithms in 2017A and in 2017B, the mean difference (program impact) ranged from 313,787 Frws/ha to 375,569Frws/ha using NN, KM and RM matching logarithms respectively. The study focused on the direct impact of credits accessibility on farmer's capacity to afford farm inputs, crop yield variability and farmer's revenues. The study concludes that Irish potato production is a profitable Agri ventures and could contribute to economic development and social welfare of the farmers. However, considering that Irish potato is sold to traders and consumers in other areas within Musanze district and Rwanda as whole, there may be other indirect impacts. Therefore, future studies should also focus on the spill over effects of credits program interventions. The study also recommends that subsidy program for fertilizer use should be emphasized to scale up the fertilizer use intensity during Irish potato production. In addition, future research should also analyze the sources of income disparity among the low and high-income households participating in such credits schemes.

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REFERENCES

[1] F. Simtowe, *et al.*, "Determinants of moral hazard in microfinance: Empirical evidence from joint liability lending programs in Malawi," *African review of money finance and banking*, pp. 5-38, 2006.

[2] J. Fernandez-Cornejo and W. McBride, "Adoption of bioengineered crops (No. AER 810). Washington, DC: USDA," *Economic Research Service (ERS),* 2002.

[3] M. Petrick, *Credit rationing of Polish farm households: a theoretical and empirical analysis*: Studies on the Agricultural and Food Sector in Central and Eastern Europe, 2004.

[4] G. Donoso and J. Cancino, "Contribution of integrated water resources management towards the achievement of the Millennium Development Goals (MDGs)," *Economica Agraria,* vol. 14, pp. 65-78, 2010.

[5] G. Alleyne, *et al.*, "Embedding non-communicable diseases in the post-2015 development agenda," *The Lancet,* vol. 381, pp. 566-574, 2013.

[6] S. Haggblade, *et al.*, "The rural non-farm economy: Prospects for growth and poverty reduction," *World development,* vol. 38, pp. 1429-1441, 2010.

[7] I. Albert, "Family based land conflicts and social economic development: A case study of Karongi District," University of Rwanda, 2013.

[8] F. O. Akinyemi and C. Kagoyire, "The Rwanda Metadata Portal: A Web Catalogue Service," *IJSDIR,* vol. 5, pp. 382-401, 2010.

[9] N. KUMARASAMY, "PRODUCTION, POST HARVEST VALUE CHAIN AND EXPORT COMPETITIVENESS OF POTATO," TAMIL NADU AGRICULTURAL UNIVERSITY COIMBATORE, 2014.

[10] F. Ellis, *Rural livelihoods and diversity in developing countries*: Oxford university press, 2000.

[11] G. W. Imbens, "Matching methods in practice: Three examples," *Journal of Human Resources,* vol. 50, pp. 373-419, 2015.

[12] B. Awotide, *et al.*, "Impact of Access to Credit on Agricultural Productivity: Evidence from Smallholder Cassava Farmers in Nigeria," in *International Conference of Agricultural Economists, Milan, Italy, August*, 2015, pp. 9-14.

[13] A. Renwick, "The Importance of the Cattle and Sheep Sectors to the Irish Economy," *UCD Dublin,* 2013.

[14] W. Kaguongo, *et al.*, "Farmer practices and adoption of improved potato varieties in Kenya and Uganda," *Social Sciences working paper,* vol. 5, pp. 78-85, 2008.

[15] S. O. Becker, *et al.*, "Youth emancipation and perceived job insecurity of parents and children," *Journal of Population Economics,* vol. 23, pp. 1047-1071, 2010.