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Impact of Improved Groundnut Variety Adoption on Groundnut Productivity of Smallholder Farmers in North Western Ethiopia

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Abstract
The main objective of this study was to investigate the impact of improved groundnut varieties adoption on groundnut productivity of smallholder farmers in North Western Ethiopia. The study applied descriptive statistics and propensity score matching methods (PSM) to describe demographic, socioeconomic and institutional characteristics and to measure the impact of groundnut productivity increment at smallholder farmers' level respectively. Total 137 groundnut producers were taken using systematic and random sampling methods. The result of descriptive statistics showed that the adoption rate of improved groundnut by varieties were 41.61% and Babile_1 is more adopted one in the study area. The PSM result revealed that adoption of improved groundnut variety showed statistically significance and positive effect on groundnut productivity which brought 38.55% of increment in groundnut productivity. This research suggests that adoption of improved agricultural technologies are a means of poverty reduction as well as ensuring economic welfare of smallholder farmers. Therefore, Go, NGO, policy maker and planners should be focused on the expanding and addressing of these improved agricultural technologies over all the part of country.
Keywords: Adoption, impact, improved groundnut variety, *groundnut productivity* and PSM
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1. Introduction

Oil seeds are the major cash crops which are grown by smallholder farmers and investors in Ethiopia. It is the main export commodity, source of foreign currency and income earning next coffee (Abadi, 2018). Sesame, *Neug*, and Groundnut are among the oil seed that accounted 87.6% of the oil seeds cultivated areas during the 2018/19 cropping season which is 43.73%, 34.32% and 9.55% of the cultivated areas were covered by sesame, Neug and Groundnut respectively. In the same year, 29.93%, 37.82%, and 16.98% of the total oil seeds production was shared by Sesame, *Neug*, and Groundnut respectively (CSA, 2018). More than 3.35 million smallholder farmers are based their livelihood on oil seed production(CSA, 2018).

Groundnut is a legume crop which improves soil fertility by fixing atmospheric nitrogen and save fertilizer cost in subsequent crops(Harfe, 2016). This is an option for smallholder farmers who are unable to purchase inorganic fertilizer due to concurrent increment of fertilizer price (Simtowe *et al.*, 2010). In many countries, groundnut used as oil seed, food and animal feeds as well used as raw material for industries. It contains digestible protein (25 to 34%), cooking oil (44 to 56%), and vitamins like thiamine, riboflavin and niacin. Its cake and haul ms (straw stem) are used for livestock feed(Simtowe *et al.*, 2010) .

It is South America origin and introduce into Ethiopia in 1920s, which is now grown over all the warm climate low land area of the country(Haji and Zekeriya, 2016). It is mainly grown in eastern Harerghe, Metekel, Gamogofa, Illubabor, West Gojam, North Shoa, North and South Wello, East and West Wellega, and Western Tigray zone (CSA, 2018). According to the CSA report on area and production of crops, more than 521,326 private peasant holding households have been grown groundnut in 80,841.57 hectares of land in the 2017/18 cropping season leading to a total production of well over 1.45 million Quintal (CSA, 2018). According to the same report, Oromia region constitutes the largest proportion of groundnut production areas accounting for 63% (328, 283 ha) and Benishangul Gumz is the second largest contributor in terms of ground nut production areas (20,033.19 ha).

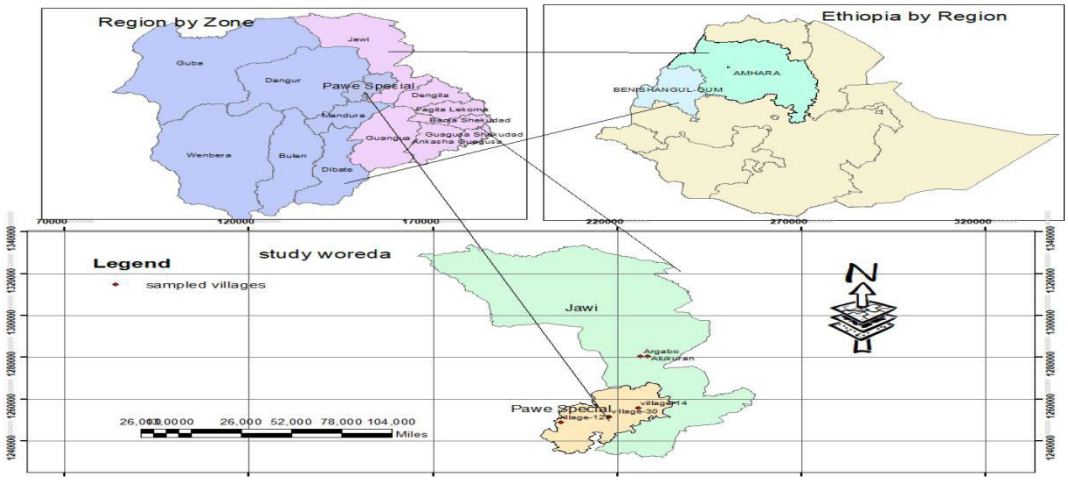
Pawe research center played vast role on improving the adoption rate of improved groundnut varieties as well as its associated agronomic technologies through demonstration practices to improve groundnut productivity of smallholder farmers in North western Ethiopia particularly Metekel and Awi zones of Benshangul Gumuz and Amhara Regional States respectively. However, the importance of adopting improved groundnut in terms of enhancing groundnut productivity of smallholder farmers is not studied yet. This might be undermine the effort of releasing new groundnut varieties, hinder the adoption rate as well as decreased groundnut productivity and associated benefits from the sector. Therefore, this research has been intended and conducted in the study area to solve these problems.

2. Research Methodology

2.1 Description of the study area

The study conducted in Pawi district, Metekel zone Benshangul Gumuz region, North Western Ethiopia. The district is found at 567 Km to North West direction far away from Addis Ababa with geographical location at $36^0$27'21.88''- $36^0$28'22.95'' longitude and latitude of $11^0$20'04.93''-$11^0$17'50.43''. It covers an area of 63,400 hectare with estimate population of 59,127(50.76%male) inhabitants (PDAO, 2018). The farming system of the district is characterized as mixed crop-livestock farming system dominated by cereal and pulses crops. Among the pulses, soybean takes a lion share in terms of production and area coverage (CSA, 2018). The district is bounded in East and North by Jawi district, in South by Mandura district, in West by Dangur districts. It is characterized as warm humid low land area with high rain fall. The district has 20 kebeles and the climate of the area is hot humid and characterized by unimodal rainfall pattern with high and heavy rainfall that exceeds from May to October. The area receives mean annual rainfall of 1586.32 mm and it has an altitude of 1120 m with mean annual temperature of 16^0c to 32^0c which ranges 12^0c to 40 ^{0}c (Miruts, 2016).

The study conducted in Jawi district, Awi zone Amhara region, North Western Ethiopia. The district is found at 602 Km to North West direction far away from Addis Ababa with geographical location at $36^0$29'17.58'' longitude and latitude of $11^0$33'22.68''. It covers an area of 515,400 hectare with estimate population of 122,259(53.08% male) inhabitants (JDAO, 2018). The farming system of the district is characterized as mixed crop-livestock farming system dominated by cereal and pulses crops. Among the pulses, soybean takes a lion share in terms of production and area coverage (CSA, 2018). Jawi district is bounded in East by Dangla district, in South by Dangur and pawi district, in West by Quara districts and in North by Alefa Taqusa district. It is characterized as warm humid low land area with high rain fall. The district has 25 kebeles and the climate of the area is hot humid and characterized by uni-modal rainfall pattern with high and heavy rainfall that exceeds from May to October. The area receives mean annual rainfall of 1250 mm and its altitude ranges from 700 to 1500 m.a.s.l with mean annual temperature of 16^0c to 320c which ranges 12^0c to 40 ^{0}c Jawi district agricultural office (JDAO, 2018).



Fig$_1$ Map of Study Area

2.2 Sampling method and sample size determination

Awi and Metekel zones are the potential groundnut producers in Amhara and Benshagul Gumuz region respectively in North West of Ethiopia which were our target area. First pawi and Jawi districts were selected randomly from Metekel and Awi zones respectively. Next sample of groundnut producers were selected using systematic and random sampling technique methods. The total sample size was taken based on the following formula(Cochran, 2007).

$n = Z^2 (PQ)/e^2$ ---------- 1

Where

n - Is number of sample size is greater than 10,000

Z - Is 95% confidence limit i.e. 1.96

p - Is 0.3 (proportion of the population to be included in the sample i.e 30%)

q – Is 0.7 proportion of the population not to be included in the sample i.e 70%)

e - Is margin of error or degree of accuracy desired (0.05)

According this formula 137 sample households were taken from two districts. The sample distribution is illustrated as follow.

Table 1 Smallholder Groundnut producers by Districts

District	# of sample unit selected	Share of sample in %
Jawi	49	35.77
Pawi	88	64.23
Total	137	100

Source: Survey data (2020)

2.3 Types and method of data collection

This study used both primary and secondary data. primary data were collected by trained enumerators through face to face interview with sample of groundnut producers whereas secondary data were collected from published and unpublished documented of zonal and district administrative offices.

2.4 Methods of data analysis

This study was used propensity score matching model which is a good estimator of impact evaluation in case of cross sectional data. According to (Khandker, 2010) impact evaluation is the act of studying whether the changes in well-being are indeed due to the intervention or not. To estimate the probability of participation versus non-participation, PROBIT model was used. According to (Gujarati, 2009) in estimating the PROBIT model, the dependent variable is adopter and non-adopters of improved groundnut variety which takes a value of 1 if they produce improved groundnut and it takes 0 if they were produced local groundnut.

The mathematical formulation of PROBIT model is as follows:

$$Pi = \frac{e^{Zi}}{1 + e^{Zi}} \text{--------} 2$$

Where: -

Pi = i^{th} household probability of producing improved groundnut variety which takes 1 whereas local groundnut producers takes 0

$$Zi = \alpha + \beta Xi + Ui \text{ --------} 3$$

Where I= 1, 2, 3 … N

α = Intercept

β = regression coefficient to be estimated

Xi = Explanatory variables

Ui = a disturbance term

The effect of household's adopting improved groundnut variety on a given outcome(Y) is specified as $Ti = Yi(D = 1) - Yi(D = 0) \text{----------} 4$

Where Ti = a treatment effect (effect due to adopting improved groundnut variety),

Yi = is the outcome on the i^{th} household

Di = is whether the i^{Th} household has got the treatment or not

2.5 Definition of variables and its measurement used in the Model

The impact of adopting improved groundnut varieties on groundnut productivity under smallholder farmers are determined by different covariant that included in the model. These covariant that included in the model has its own definition and measurement.The definition and its measurements of the covariant that included in the model was hypothesized to influence improve groundnut variety adoption and their expected effects are described as follows.

Table 2 Summary of covariant used in the study

Variables	Measurement	Expected Sign
Sex	Dummy, Male/Female	±
Age	Continuous, years of old	+
Education	Continuous, class of completed	+
Farm experience	Continuous, years of farming	+
Family size	Continuous, number person live together	-
Model farmer	Dummy, Yes/No	+
Member of leadership	Dummy, Yes/No	+
Social contact	Dummy, Yes/No	+
Access to Financial service	Dummy, Yes/No	+
Annual income gained	Continuous, in ETB	+
No. Extension contact	Continuous, in Number	+
Groundnut Area	Continuous, land allocated in ha	+
Labor force(ME)	Continuous, active labor force in ME	+
Other crops Area	Continuous, land allocated in ha	-
Place of sell	Discrete, Farm gate, keble and district	+
Method of sell	District, Immediately, piece by piece and by store to some extent	+

Source: Survey data (2020)

3 Results and Discussion

3.1 Demographic and socioeconomic characteristics of sampled households' for dummy and discrete variables

91.24% of the sample households were male head and 8.76% of them were female headed households. 37.23% and 4.38% of the total sample households' were male and female household headed that adopted improved groundnut variety respectively. The result of chi2 statistics revealed that sex of household has no influence on adopting of improved groundnut variety. Majority of sample households were not model farmers (69.34). 14.60% and 16.06% of sample households reported from the adopter and non-adopter respectively as model farmer. The result of chi2 statistics revealed that being model farmer has no influence on adoption of improved variety. This is because improved groundnut variety is disseminated and cultivated by most of smallholder farmers in study area in the last one and half decade. The findings is similar with (Welay and Desalegn, 2019)

The institutional factors like access to financial services have no statistically significance among adopters and non-adopters of improved groundnut variety. Only 37.23% of sample households 15.33 adopters and 21.90% non-adopters were access to financial service. This is due to limited of outreach of rural finance in study area. The chi2 result showed that there is no statistical significance between adopter and non-adopters. This is due to poor saving habit as well as few amount money is saved in financial institution. This indicates that, even the saved money is not good enough to purchase improved agricultural technologies.The findings are similar (WelayTesfay, 2019)

Social and institutional factors like member of any community leadership and social contact has positive effects on the adoption of improved groundnut variety. 25.55 %(13.87 adopter and 11.68 non-adopter) and 43.07 %(32.12 adopter and 10.95 non-adopter), of the total sample households were member of any community leadership and has social contact. Chi 2 results showed that member of community leadership and social contact has positive influence and statistically significance at 10% and 1% respectively. It is obvious that being member of any community leadership help to distinguish the importance of improved technology. Social contact in this case communicated with many people and gathering a lot of information relevant to groundnut production and its variety which helped and encouraged to adopt improved groundnut variety. The findings is similar with (Regasa Dibaba *et al.*, 2018; Welay and Desalegn, 2019)

Table 3 Summary of statistics for Dummy or Discrete variables

Dummy/Discrete Variables	Adopter	Non-Adopter	Total sample	X^2
Sex				0.38
Male	51	74	125	
Female	6	6	12	
Are you Model farmer?				0.90
Yes	20	22	42	
No	37	58	95	
Access to Finance				0.006
Yes	21	30	51	
No	36	50	86	
Member of any community leadership?				**3.11***
Yes	19	16	35	
No	38	64	102	
Social contact				**46.36*****
Yes	44	15	59	
NO	13	65	78	

Source: Survey data (2020)
*, **, *** Statistical Significance level at 1, 5 and 10% respectively

3.2 Demographic and socioeconomic characteristics of sampled households' for Continuous variables

Among the continuous variables age, farm experience and number Of extension contact was not showed statistically significance. Adopters of improved groundnut varieties were expected older, experienced in farming; have more extension contact with Development Agents. However, both the adopters and non-adopters were almost similar in these variables. That is why the T-test value result showed statistically insignificance. Family size has positive effect on the adoption of improved groundnut variety. The T-test results showed that it has all of these variables were statistically significance at 1% where as Education level of household head, labour force in man equivalent and groundnut outputs have statistically significance at 10%, 1% and 5% respectively. The findings is similar with (Regasa Dibaba *et al.*, 2018; Welay and Desalegn, 2019)

Table 4 Summary of statistics for continuous variables

Continuous Variables	Adopter	Non-Adopter	Total sample	T-test Value
Age	43.14	41.98	42.46	-0.60
Farm experience	21.04	19.45	20.12	-0.92
Education	**3.02**	**1.96**	**2.40**	**-1.99***
Labor force(ME)	**1.94**	**2.28**	**2.14**	**1.74***
No. Extension contact	25.92	18.36	21.51	-1.32
Groundnut output	**2226.32**	**1595**	**1857.66**	**-3.12*****
Family size	**4.93**	**5.86**	**5.47**	**2.45****

Source: Survey data (2020)
*, **, *** Statistical Significance level at 1, 5 and 10% respectively

3.3 Adopter and non-adopter sampled households' by location

Improved groundnut variety is more adopted in Pawi district(30.66%) than Jawi district (10.95%). 41.61% of the sample household head were Adopter whereas the rest 58.39% were non adopters. The chi2 test showed that there is statistically significance between the two districts in the use of improved groundnut varieties (Table 5). This is due to the high contact with researchers and Pawi district is nearest than Jawi district to the Pawi research center.The findings is similar with (Welay and Desalegn, 2019)

Table 5 Adopter and non-adopter by District

Districts	Sex of HHs		Total	%	Improved Soybean producers		% Adopter	% Non-Adopter
	Male	Female			Adopter	Non Adopter		
Pawi	76	12	88	64.23	42	46	30.66	33.58
Jawi	49	0	49	35.77	15	34	10.95	24.82
Total	125	12	137	100	57	80	41.61	58.39

Source: Survey data (2020) Pearson chi2 = 3.80 and Pr = 0.051

3.4 Improved groundnut variety adoption by variety preference

In this study, local and maniputer variety considered as unimproved groundnut variety while Babile_1, Babile_2 and Babile_3 varieties are considered as improved groundnut varieties that released recently by Ethiopia Institute of Agriculture Research. Among the improved groundnut variety 20.44%, 13.14% and 8.03% of Babile_1, Babile_2 and Babile_3 varieties were adopted by sample households in study area. The result of chi2 statistics showed that there is statistical significance among improved groundnut preference to adopt the variety.

Table 6 Improved groundnut variety adoption by variety preference

Groundnut varieties	Districts		Total
	Pawi	Jawi	
Local	15	17	32
Maniputer	31	17	48
Babile_1	17	11	28
Babile_2	15	3	18
Babile_3	10	1	11

Source: Survey data (2020) Pearson chi2(4) = 10.62 Pr = 0.03

3.5 Identifying co-variate variables contribute to outcome variable

(Rosenbaum and Rubin, 1983) stated that Propensity score matching is the conditional probability of assignment to a particular treatment given vector of observed covariant. To identify the impact of improved groundnut variety adoption on groundnut productivity of smallholder farmers in North Western Ethiopia, sixteen covariant variables has been taken. Among these variables four of them affected the impact of improved groundnut variety adoption on groundnut productivity of smallholder farmers in North Western Ethiopia. Smallholder farmers who have more social contact showed statistically highly significance at 1% and positive effect whereas family size, member of community leadership and annual income earned was showed statically significance at 10% and has negative effect (Table 7). These significance variables revealed that it will be contribute its role on the enhancing of groundnut productivity of smallholder farmers' that drives due to the adoption of improved groundnut variety. Therefore to excluded its effect on the enhancing of groundnut productivity of smallholder farmers', these significance variable should be excluded from matching to control their contribution to outcome variables. Based on this, the significance covariant were excluded to estimate the impact.

Table 7 Identifying factors contribute to outcome variables (Probit regression)

Covariant	Coefficient	Std.Err	T-value	P-value
Sex	0.36	0.48	0.75	0.45
Age	0.01	0.02	0.49	0.63
Education	0.02	0.05	0.38	0.70
Farm experience	0.02	0.02	0.91	0.36
Family size	**-0.19**	**0.09**	**-1.90***	**0.06**
Model farmer	-0.26	0.41	-0.63	0.53
Member of leadership	**0.74**	**0.39**	**1.88***	**0.06**
Social contact	**1.81**	**0.31**	**5.86*****	**0.00**
Access to Financial	-0.26	0.32	-0.79	0.43
Annual income earned	**0.00**	**0.00**	**1.78***	**0.08**
No. Extension contact	0.00	0.01	0.72	0.47
Groundnut Area	-0.04	0.22	-0.18	0.86
Labor force(ME)	-0.22	0.19	-1.17	0.24
Other crops Area	0.06	0.11	0.56	0.58
Place of sell	-0.17	0.30	-0.56	0.57
Method of sell	0.15	0.19	0.77	0.44
Cons.	-1.67	1.23	-1.36	0.17

Source: Survey data (2020)

*, **, *** Statistical Significance level at 1, 5 and 10% respectively

3.6 Estimate the propensity score matching and identifying the common support region

The propensity score and common support region was identified using mini and maxi and trimming approaches (Caliendo and Kopeinig, 2008). moreover, (Leuven and Sianesi, 2018) recommended using both approaches in combination at the same time gives good match. Based on this criteria the common support region lies between

0.0294 and 0.8894 of propensity score. The sample household whose propensity scores out of this region is out of common support. According common support principle off support households' are discarded for matching process. Based on this criteria total 14 sample households out of 137 sample was discarded for further matching process. In addition to this, propensity of Adopters were distributed between 0.0294 and 0.9930 with a mean of 0.6885 whereas the Non-Adopters of propensity score were distributed between 0.0.0004 and 0.8894 with a mean of 0.2262 (Table 8). The findings is similar with (Welay and Desalegn, 2019, Tesfay *et al.*, 2018)

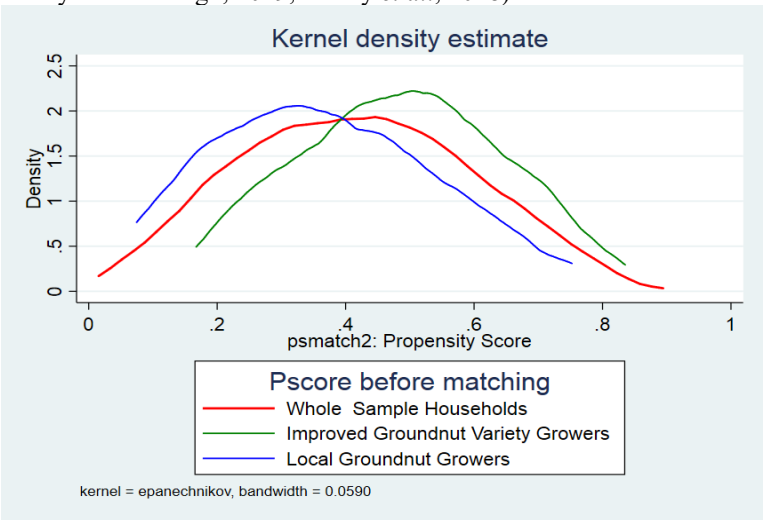
Table 8 Distribution of estimated propensity scores

Group	Obs	Mean	Std.dev	Min	Max
Improved groundnut producers	57	0.6885	0.2685	0.0294	0.9930
Local groundnut producer	80	0.2262	0.2285	0.0004	0.8894
Total Sample HHs	137	0.4575	0.2485	0.0149	0.9412
Sample HHs	Off Support	On support	Total		
Adopter	2	55	57		
Non-Adopter	12	68	80		
Total	14	123	137		

Source: Survey data (2020)

3.7 Propensity score distribution of the adopter and non-adopters

The propensity score of Adopter and Non-Adopter of improved groundnut variety was estimated by discarded off support and checking of sensitivity analysis in order to secure good estimate of ATT. As shown in figure$_2$ the propensity score distribution of the sample households is near to the normal distribution that lays in the left side of the distribution. It indicates there is considerable common support in between the Adopters and Non-Adopters. Moreover, it dipted that there is high chance of getting good matches and large number of matched sample size from the distribution as both distribution concentrated and skewed to the left.The findings is similar with (Welay and Desalegn, 2019, Tesfay *et al.*, 2018)



Figure$_2$ Total Sample Households Kernel density estimation of propensity score

3.8 Matching of Adopter and Non-Adopter

Matching of treated and untreated households was carried out to determine the common support region. The main criteria for determining the common support region is to discarded all observations whose propensity score is smaller than the minimum propensity score of Adopters and larger than the maximum of the Non-Adopters (Caliendo and Kopeinig, 2008). Based on this, common support is satisfied in the region of (0.0294-0.8894) for sample households (Table 9). This means that households with estimated propensity scores less than 0.0294 and greater than 0.8894 are not considered in the matching process. As a result 2 from Adopter and 12 Non-Adopter) were discarded and 123 sample households were identified to be considered in the estimation process. The figure$_3$ portrays the distribution of estimated propensity scores, with and without the imposition of the common support condition for Adopter and Non-Adopter respectively. Most of Adopters and Non-Adopters propensity scores were rounded around 0.0632 (Fig$_3$, Fig$_4$).

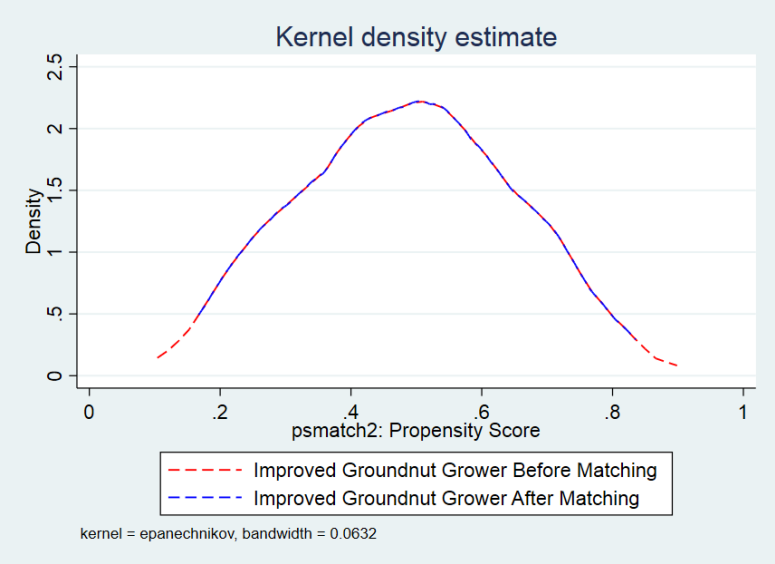


Figure3 Kernel density estimate of propensity score of improved improved groundnut producer with and without improved groundnut Intervention

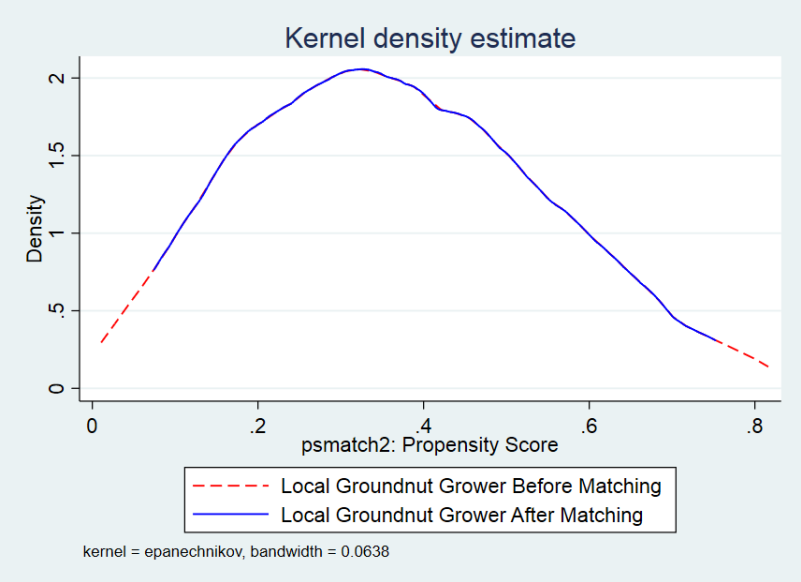


Figure4. Kernel density estimation of propensity score of local groundnut producer with and without improved groundnut Intervention

3.9 Choice of matching algorism

The best algorism selected based on the criteria of relatively numerous insignificant variables (Balancing test), smaller pseudo R^2 value and large matched sample size. The matching algorism that fulfills all these criteria was chosen as being the estimator of the impact. Except the kernel bandwidth of (0.01), all the matching algorism fulfills all mentioned above. Therefore radius bandwidth (0.25) has been selected randomly that satisfies lower pseudo R^2 (0.0964) value, well balanced covariant(12) and large matched sample size that were 55 Adopter and 68 Non-Adopters with a total of 123 sample households by discarding only 14 off support households' (Table 10).

Table 10 Performance of matching estimators for sample households

Matching estimator	Performance criteria		
	Balancing Test*	Pseudo R^2	Matched sample size
Kernel Matching			
With 0.01 band width	12	0.0964	105
With 0.1 band width	12	0.0964	123
With 0.25 band width	12	0.0964	123
With 0.5 band width	12	0.0964	123
Radius Caliper Matching	12	0.0964	123
With 0.01 band width	12	0.0964	123
With 0.1 band width	12	0.0964	123
With 0.25 band width	**12**	**0.0964**	**123**
With 0.5 band width	12	0.0964	123
Neighbor Matching	12	0.0964	123
1 Neighbor	12	0.0964	123
2 Neighbor	12	0.0964	123
3 Neighbor	12	0.0964	123
4 Neighbor	12	0.0964	123

Source: Survey data (2020) *Indicates number of insignificance variables

3.10 Treatment Effect on the treated (ATT)

Average treatment effect(ATT) of improved groundnut varieties adoption was estimated using radius matching method with bandwidth of (0.25), is summarized as follow. The result showed that Adopter were produced 7.54 equivalent to 2,229.32 Quintal of groundnut yield on average while the Non-Adopters were produced 7.15 equivalent to 1,608.82 Quintal of groundnut yield on average which indicated statistically significance between them. That is the average groundnut productivity of Adopter is greater than the average groundnut productivity of Non-Adopters produced of groundnut. The result showed that probability of adoption decision of improved groundnut variety has positive effect and statistically significance difference between adopters and non-adopters in terms of groundnut productivity from given hectare of land. In general, the adoption decision of households for improving groundnut variety has generated 38.55% increasing in groundnut productivity of Adopters over Non-Adopters. Based on this result, adoption of improved groundnut varieties have positive effect, on increasing groundnut productivity of smallholder farmers from similar cultivated farm land in the study area. Over all the result is in line with finding of other researchers on the impact of soybean adoption by (Zemedu *et al.*, 2017), Impact of high yielding wheat variety adoption (Dibaba and Goshu, 2018) and impact of food security package loan on food insecure households' income and asset creation by (Tesfay *et al.*, 2018)

Table 9 Estimate of average treatment effects on gross farm income of smallholder farmers

Outcome variable	Sample	Adopter	Non-Adopter	Difference	SE	T-stat
Groundnut Yield	Unmatched	2,226.32	1,595	631.32	202.10	3.12***
	ATT	2,229.10	1,608.82	620.28	225.82	2.75***
	ATU	1,608.82	2,229.10	620.28		
	ATE			620.28		
Log groundnut Yield	Unmatched	7.54	7.15	0.39	0.12	3.38***
	ATT	7.54	7.17	0.36	0.13	2.92***
	ATU	7.17	7.54	0.36		
	ATE			0.36		

Source: Survey data (2020)

*, **, *** Indicates significance at 10, 5, and 1% respectively

3.11 Sensitivity of the estimated average treatment effects (ATT)

Sensitivity analysis was done with the assumption of other exogenous variables does not exist and influence the ATT obtained due to adoption of improved groundnut varieties. Based on this guidance sensitivity analysis was tested to check whether the unobserved covariant have effect on ATT. Sensitivity analysis is the final diagnostic that performed to check the sensitivity of the specification of the propensity score (Dehejia and Wahba, 2002). Moreover, sensitivity analysis was undertaking to detect the identification of conditional independence assumption (CIA) and was satisfactory or affected by the co-founder. The sensitivity test conducted in (Table 10) to check the ATT of gross farm income was affected by co-founder variables or not. According the test in (Table 10) ATT effect of groundnut productivity due to adoption of improved groundnut variety was not affected by co-founder. The significance level is unaffected even if the gamma value are relaxed in any desirable level, shows

that ATT is insensitivity to external change. The findings is similar with (Welay and Desalegn, 2019, Tesfay *et al.*, 2018)

Table 10 Sensitivity analysis of the estimated ATT

Gamma	Sigma (σ+)	Sigma (σ-)
1	0	0
1.25	0	0
1.5	1.1e-16	0
1.75	8.1e-15	0
2	3.5e-13	0
2.25	6.4e-12	0
2.5	6.7e-11	0
2.75	4.6e-10	0
3	2.3e-09	0

Source: Survey data (2020)

4 Summaries and Conclusion

The study was conducted at Pawi and Jawi districts in North western Ethiopia, with the purpose of estimate the impact of adopting improved groundnut varieties on enhancing of gross farm income of smallholder groundnut producers'. The result of descriptive statistics revealed that adoption of improved groundnut varieties was 41.61% which is moderate rate of adoption in the study area.

The Propensity score matching (PSM) result indicated that adopters of improved groundnut variety were earned higher gross farm income than the non-adopters in terms of gross farm income. Adopters were produced 2,229.32 Quintal of groundnut yield which is higher than the non-adopters were produced only 1,608.32 Quintal of groundnut yield which is lower than the adopters. The result showed that Adopters were produced 620.28 Quintal of groundnut yield difference over the non-adopters due to the adoption of improved groundnut variety. The finding of this paper indicated that adopter of improved groundnut variety has been brought 38.55% of increment in groundnut yield over the non-adopters as being adopter of improved groundnut variety. In general, adoptions of improved agricultural technologies have ability to ensure food security on users of improved technologies by increasing their productivity. Therefore, Governmental(GO) and non-governmental organization(NGO), policy maker and planners should be focused on the expanding and addressing of these improved agricultural technologies to all smallholder farmers that reduce poverty and ensure rural food security in Ethiopia.

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