

## Impact of Contract Farming on Productivity and Food Security Status of Smallholder Maize Farmer's Households in Kano and Kaduna States, Nigeria

Buhari Nazifi<sup>1,\*</sup> 

Aminu Suleiman<sup>2</sup> 

Muhammad Baba Bello<sup>2</sup> 

Muhamad Sabiu Suleiman<sup>2</sup> 

<sup>1</sup>Federal University Dutsin-ma, Department of Agricultural Economics, Katsina, Nigeria

<sup>2</sup>Bayero University, Faculty of Agriculture, Department of Agricultural Economics and Extension, Kano, Nigeria

\*Corresponding Author: buharinazifi6@gmail.com

### Abstract

This study analyzed impact of contract farming on productivity and food security status of smallholder maize farmer's household in Kano and Kaduna States, Nigeria. A multistage sampling technique was used to collect data from 466 smallholder maize farmers with the use of a-structured questionnaire. Descriptive statistics, household dietary diversity scores (HDDS), and propensity score matching were used to achieve objectives of the study. Result of descriptive statistics shown that, average age of contract participants was 39years; with farming experience of 20years and had an average farm size of 2.39 hectare. On the other hand, non-contract participants had an average age of 37years and average farming experience of 18years with a farm size average of 2.34hectare. HDDS result revealed households participating in contract farming to have mildly better food security status with an average dietary diversity score of 5.16, against non-contract participating farmers that have 3.15 household dietary diversity score average. PSM result for the impact revealed that contract farming had positively ( $P < 0.01$ ) impacted on maize yield (ATT=1.7ton/ha), and food security status of the participating household (ATT=0.893). Therefore participation in maize contract farming increases productivity and reduces food insecurity status of smallholder maize farmers; it can therefore be recommended that contract farming can be used as an instrument to reduce food insecurity and poverty among rural farming household.

**Keywords:** Contract farming, Propensity Score Matching, Food Security

### Introduction

Maize (*Zea mays*) is a staple food for a large part of the population around the Globe and is of great socio-economic importance in the Sub-Saharan Africa (FAO, 2013). It is one of the most heavily cultivated cereal crop globally, and one of the main cereals crops of west Africa and the most important cereal food in Nigeria (Onuk, Ogara, Yahaya & Nannim, 2010). Maize is grown in many parts of Nigeria but the northern part dominates all other regions. Murphy, (2010) indicated that growing maize by smallholder farmers can overcome food insecurity in their households. These smallholder farmers make up to 80% of farmers in Nigeria, they produced substantial percentage of food consumed by Nigerians particularly maize crop, however these

farmers are producing below their capacity that result to food insecurity among their households because of numerous challenges they experience such as limited access to modern agricultural production technology; inadequate agricultural credit; lack of access to extension service; small land holding and poor access to market (Mgbenka, Mbah & Ezeano, 2015).

Product supply chain for agricultural goods have become increasingly globalized, as a result greater number of smallholder farmers in Sub-Saharan Africa (SSA) are now participating in the chain, which is mostly through contract farming (Armah, Schneider and Gugerty, 2010). These make it to become one of the first steps in the transition from subsistence to commercial agriculture as an

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Orcid: Buhari Nazifi: <https://orcid.org/0000-0001-6985-8396>, Aminu Suleiman: <https://orcid.org/0000-0002-8801-1876>, Muhammad Baba Bello: <https://orcid.org/0000-0003-1536-1338>, Muhamad Sabiu Suleiman: <https://orcid.org/0000-0002-3531-1867>

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intermediate sector between the agricultural and manufacturing sector. It is also basically an arrangement that establish agreement between processing/marketing firms and smallholder farmers for production and supply of food and commercial crops base on predetermine future quality and price (Bellamere and Novak, 2017). Models of contract farming play major role on welfare of smallholder farmers by increasing their crop productivity through delivering better technology, coordinating producer's and consumer's market along with strong grass-root linkages (Iro, 2016).

Contract farming in Africa and Asia is mainly promoted by private sector with little support from public institution. In Nigeria there are few emerging evidences of contract farming (Miet and Katrein 2017; Fawale and Thomas 2014; Iro 2016; Oluesegun, 2016). The existing once are mostly owned by the private companies/individuals as an out grower schemes and few by the Government such as Anchor borrowers Scheme; that is aim at giving input credit to facilitate the production of staple and cash crop in the country. The most notable out-grower schemes for maize in Nigeria especially northwest axis were Bunkasaman, Manomalinks, Olarm, WACOT, Babbagona and Afex-Agra among others. These firms operate using various contract farming models that are usually in the form of centralized, nuclear estate, multipartite, informal and intermediary models. Each of these models provide services to the farmers that include access to credit; extension service, agricultural production inputs; training on good agronomic practices, farm supervision, storage facilities and ready markets for harvested crop.

Several studies conducted world-wide has shown positive impacts on indicators of farmers' welfare; others do not find such effect, most of the studies conducted in developing countries on contract farming impact revealed increasing income of the farmers with the exception of few studies like that by Ragasa, lambrach and Kufoalar in (2017) that revealed decreasing income of the farmers. Studies specifically conducted on contract farming impact on food security in developing countries are limiting with the exception of recently conducted studies that includes one by Bellamere and Novak, in 2017 that analyzed the impact of contract farming on food security using Period of hunger as proxy in Madagascar; which is a subjective assumption of food security and the other by Adebisi *et al* in 2019, that studied the impact of contract farming on the households' food security of farmers using calorie intake as proxy to food security, this gives an avenue to researchers in developing countries to explore contract farming impact on food security at other food security dimension such as food consumption score, household dietary diversity score and body mass index, etc.

#### **Methodology**

##### **Study area**

The study was conducted in Kano and Kaduna States Nigeria where maize production is dominant

and there exists evidence of contract farming operation. The local government in the states where there is evidence of contract farming in Kaduna state include Soba, Kubau, Furu, Lere and Igabi local Government while in Kano state the local governments includes Rano, Bunkure , Garunmalam, Warawa, kura Karaye Rogo and Shanono local government.

**Kaduna state** is located between latitudes  $11^{\circ} 32''$  and  $09^{\circ} 02''$  N and longitudes  $80^{\circ} 50''$  and  $06^{\circ} 15''$  E. There are two marked seasons in the State: the rainy (wet) season and the dry windy season. The wet season is usually from May to October with great variations in different areas of the state from 600mm to 1500mm. On the average, the State enjoys a rainy season of about five months. The length of the growing periods varies from 100 to 200 days. The dry season starts from November to April. Temperature in the state ranges between  $28^{\circ}\text{C}$  and  $34^{\circ}\text{C}$ . Farming is the main occupation of the people, with emphasis on the crops grown which include maize, sorghum, rice, millet, wheat, cotton, yam, cassava, pigeon pea, cowpea, soya bean and groundnut. They also grow vegetable crops like tomato, pepper, onion and carrot. Livestock is also important in the economy of the state and the livestock kept include cattle, sheep, goats and poultry.

**Kano state** is located between latitudes  $10^{\circ} 3''$  and  $12^{\circ} 37''$  N and longitudes  $7^{\circ} 3''$  and  $9^{\circ} 5''$  E (Ogungbile *et al.*, 1999). Kano State is the commercial nerve centre of Northern Nigeria. It has a total land area of 20, 760 square kilometres with 1,754,200 hectares of fertile agricultural land, of which 86,500 is exclusively Fadama land. About 75,000 hectares is made up of grazing lands (Olofin *et al.*, 2008). The dry season is usually from October to April, while the rainy season begins from April to September with an annual rainfall of 134.4mm Kano. Farming is the main occupation of the people, with emphasis on the crops grown which include maize, sorghum. They also grow vegetable crops like tomato, pepper, onion and carrot. Livestock is also important in the economy of the state and the livestock kept include cattle, sheep, goats and poultry.

##### **Sampling procedure**

Multi-stage sampling technique was employed for the study; it involve identification of Local Governments Areas (LGAs) where there are evidences of contract farming participation by smallholder maize farmers, first stage was random selection of communities with evidence of contract farming systematically. Second stage was selection of two communities from the list of contract farming participating communities through balloting; in the third stage raosoft sample size formula was used to determine sample size from sample frame of maize farmer's population of each community selected consisting of participating and non-participating maize contract farmers. Finally, in the fourth stage 233 contract farmers and 233 non-contract farmers were randomly selected systematically from the

sampling frame; making 466 respondents for the

study as shown in Table 1.

**Table 1.** Sampling Summary of Maize Farmers in Kano and Kaduna State

State	LGA	Communities	Selected Communities	CPF Frame	Sample CPF Size	NCPF Sample Frame-	NCPF Sample Size
Kaduna	Ikara	10	Saulawa	52	20	42	16
			Kurmin Kogi	54	21	54	21
	Makarfi	8	Mayere	35	14	40	15
			Dorayi	42	17	40	15
			Soba	12	67	27	77
	Bebeji	7	Awai	70	28	70	25
			Alkalawa	38	15	38	15
Kano	Rano	10	Damau	59	23	59	24
			Yalwa	37	15	47	19
	Bunkure	9	Doka	47	19	49	20
			Danhassan	40	16	28	13
			Barge	46	18	46	19
Total	6	56	12	587	233	590	233

Note: CPF= contract participating farmers, NCPF= non-contract participating farmers

Note: DDS stand for dietary diversity score.

### Method of data collection

Primary data were used for the study; the data were collected through the use of questionnaire administered to respondents by the researcher with the aid of trained enumerators. The data collected includes information on farmer's socio-economic characteristics, maize production data for 2018 cropping season, household food consumption pattern and challenges faced by the farmers participating in maize contract farming.

### Data analysis

Descriptive statistics was used to analyze data for socioeconomic characteristics of the farmers, Household dietary diversity score (HDDS) for food security measurement and propensity score matching for evaluating the impact of contract farming on food security of farming household and maize productivity

### Household dietary diversity score (HDDS)

Household dietary diversity score was used to measure food security status of contract and non-contract smallholder maize farmer's households following International Food Production Research Institute (2006). This type of metric captures the number of different kinds of food or food groups

that people eat and the frequency with which they eat them the score represents the diversity of intake; the scores have been shown to be significantly correlated with caloric adequacy measures (IFPRI, 2006). Coates *et al.* (2007) also recommended to use the mean score or distribution of scores for analytical purposes and to set program targets or goals.

### Procedure for calculating HDDS

- For each food group create a new binominal variable that has two possible values: 1=Yes: the household / individual consumed that specific food group and 0 = No if they did not consume that food.
- Sum all the binominal variables in order to create HDDS;
- The new variable will have a range from 0 through the maximum number of food groups collected (7)
- IFPRI proposes to use the following thresholds:
  - 6+: High = Good dietary diversity
  - 4.5 – 6: Medium dietary diversity
  - <4.5: Low dietary diversity

**Table 2.** Food groups for household dietary diversity score (HDDS) Measurement

Food groups used	Food Groups used for HDDS
Cereals and grain, roots and tubers	1. Cereals, roots, and tubers
Legumes / nuts	2. Pulses and legumes
Orange vegetables (vegetables rich in Vitamin A)	3. Vegetables
Green leafy vegetables, Other vegetables Orange fruits (Fruits rich in Vitamin A), Other Fruits	4. Fruits
Meat Liver, kidney, heart and / or other organ meats Fish / Shellfish Eggs	5. Meats, fish and seafood, and eggs
Milk and other dairy products	6. Dairy products
Oil / fat / butter	7. Oils and fats
Sugar, or sweet	Not considered
Condiments / Spices	Not considered

**Propensity Score Matching (PSM)**

Propensity Score matching was used to evaluate the impact of participation in contract farming on food security (household dietary diversity score proxy), profitability (Return on investment proxy) and variable production cost, this technique is a non-parametric approach that involves constructing a statistical comparison group by modeling the probability of participating in contract farming on the basis of practical features that are unpretentious by the contract farming. The underlying principle of PSM is that the predicted probabilities (propensity scores) from an estimated Probit model is used to find matches for farmers participating in contract farming (participants). The estimation of average treated effect on the treated (ATT) is specified as follows.

$$ATT = \left( \sum \frac{H1}{D} = 1 \right) - \left( \sum \frac{Ho}{D} = 1 \right) \dots\dots\dots 1$$

The problem with estimation of the equation (1) is that it is not observable. However, it is probable to appraise equation (1) by replacing  $\sum \frac{H1}{D} = 1$  with  $\sum \frac{Ho}{D} = 0$  as follow

$$ATT = \left( \sum \frac{H1}{D} = 1 \right) - \left( \sum \frac{Ho}{D} = 0 \right) \dots\dots\dots 2$$

Valuation of equation (2) is a biased estimate of the causal effect of membership in contract farming. This leads to the modeling of a more reliable estimation by controlling observable characteristics to ensure that participation in maize contract farming is random and not connected with the outcome variables i.e. restricted independence hypothesis is satisfied

$$ATT = \left( \sum \frac{H1}{D} = 1 \right) - \left( \sum \frac{Ho}{D} = 1 \right) \dots\dots\dots 3$$

$$P(z) = \Pr \left( D = \frac{1}{z} \right) = \sum \left( \frac{D}{z} \right) \dots\dots\dots 4$$

$$ATT = \left( \sum \frac{H1-H0}{D} = 1 \right) \dots\dots\dots 5$$

$$ATT = \sum \left( \sum \frac{H1-H0}{D} = 1, P(Z) \right) \dots\dots\dots 6$$

$$ATT = \sum \left\{ \sum \left\{ \sum \frac{H1}{D} = 1, P(Z) \right\} - \sum \left\{ \sum \frac{Ho}{D} = 0, P(Z) \right\} \right\} \dots\dots\dots 7$$

Where, H1= value of the outcome for participants in maize contract farming, Ho = value of the outcome for non-participation in contract farming, D= Participation (1 for participants in maize contract farming and 0 otherwise), Z= socioeconomic characteristics of the farmers. The study employed three matching techniques (Nearest Neighbor Matching, Radius Matching, and Kernel Based Matching) in which one with more robust outcome was selected to determine the impact of farmers' involvement in maize contract farming.

**Results and Discussion**

**Socio-economic characteristics of smallholder maize farmers**

The result in Table 3 and Figure1 indicate socioeconomic characteristics of contract and non-contract maize farmers in the study locations, the socio-economics characteristics were; Age, household size, faming experience, farm size, road accessibility, access to extension service, access to credit and cooperative membership.

The average age of contract farmers was found to be 39years while that of non-contract farmers was 37years. Farming experience was 20 years for maize contract farmers while non-contract maize farmers had average farming experience of 18years in maize production The t-values of their mean difference was 2.47 at (P<0.1). This implies more experience of maize production among contract farmers than their counterpart. The average farming experience of maize farmer is similar to that of Ragasa *et al*, (2018) that found 21years as average farming experience in study of maize out-grower scheme in the upper west Ghana and that of Yakubu (2016) that studied technical efficiencies of maize production Kaduna State Nigeria.

Majority(85%) of contract farmers had road accessibility to their farms that is more than that of non-contract participation farmers as only (36%) of them had accessible road to their farms as shown in figure 1. The difference in terms of accessibility have implication with regard to participation contract farming, this is due to the fact that maize contracting firms in the study area prepared and select the farmers farm that is close to main road. may be because road accessibility ease transportation of harvested maize to firm location and also facilitate supervision by the firms extension officers.

Farmer's access to extension services result shows that majority (83%) of the contract maize farmers had access to extension service while non-contract farmers had only 48% of them that have access to extension services, this implies more access to extension services among contract participating farmers, this is due to the fact that one of the important services of contracting firms is the extension service delivery.

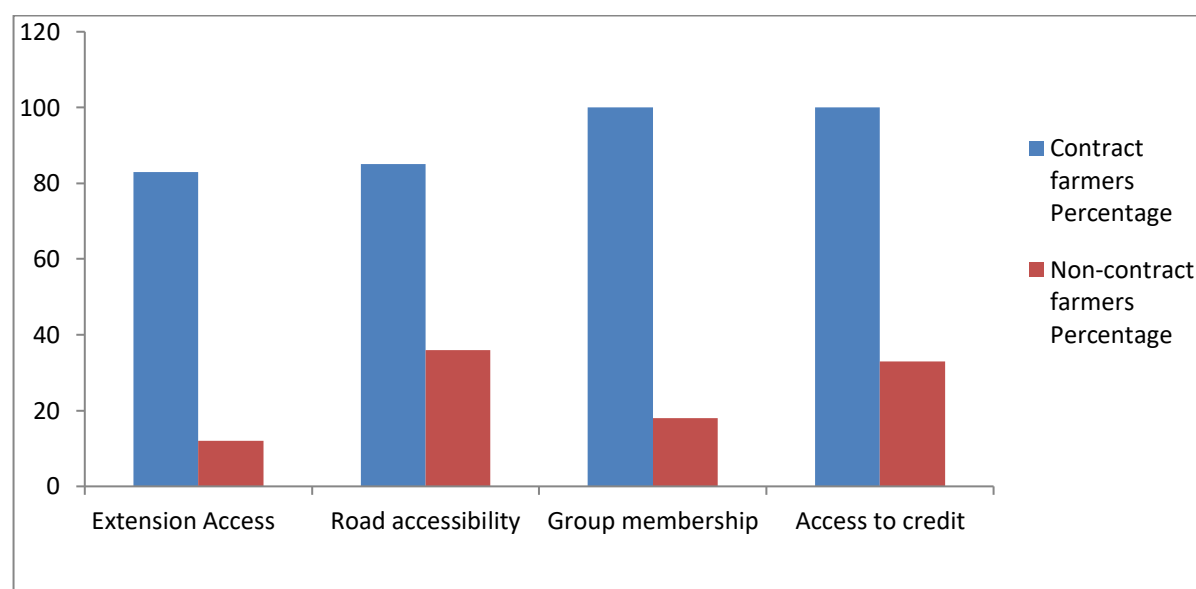
All (100%) of the contract participating farmers have access to credit while; non-contract participating farmers have 33% of them with access to credit. This implies that participating in contract farming ensures farmers access to Agricultural credit. Therefore maize production contracting firm delivered their services of improving farmers' access to credit facilities for increased production.

Contract participating farmers, all (100%) of them belong to a particular cooperative group while non-contract farmers have only 36% of them belonging to cooperative group. This implies that for a farmer to participate in contract he has to belong to particular cooperative group may be because formal signing of contract is between the farmer group and contracting firm, also cooperative groups helps to facilitate farmers control, management and supervision by the contracting firm, the finding is similar to that found by Geoffrey (2016) on "performance of cotton smallholder farmers under contract farming in Bariadi district.

**Table 3.** Socio-economic characteristics of maize farmers

Variables	Contract Maize farmers					Non-Contract Maize farmers					t-value
	Freq(%)	Min	Max	X	SD	Freq(%)	Min	Max	X	SD	
Age(Years)		18	65	39	9		18	70	37	11	1.79***
18-29	29(12)					58(25)					
30-41	127(55)					98(42)					
42-53	55(24)					55(24)					
54-65	22(9)					13(11)					
66-77						5(2)					
Household Size		1	30	8	5		1	33	8	6	0.85
1-7	118(51)					127(55)					
8-15	101(43)					85(36)					
16-23	11 (5)					16(7)					
24-31	3(1)					4(2)					
32-38						1(1)					
Experience		4	45	20	8.45		1	50	18	9	2.47*
1-10	37(16)					63(27)					
11-21	116(50)					116(50)					
22-32	62(27)					46(20)					
33-43	17(6.6)					14(6)					
44-54	1(0.4)					5(2)					
Farm Size (ha)		0.5	10	2.4	1.63		0.5	8	2.3	1.6	1.72
0.5-2.5	175(75)					172(74)					
2.6-4.6	40(17)					35(15)					
4.7-6.7	9(2)					25(11)					
6.8-8.8	4(2)					1(0.5)					
9.9-10.9	5(2)										
Total	233(100)					233(100)					

Source: Field survey 2019; X= Mean; \*, \*\*, \*\*\* donates significant at 10%, 5% and 1% respectively



**Figure 1.** Socio-economic characteristics of the farmers (Source: Field Survey, 2019).

#### Food security status of contract and non-contract farmers household

The result of food dietary diversity score (DD) of smallholder farmers households was presented in Table 4. The result show that contract participating households in the study area had average DD score of 5.36 and 85% of their households had medium to

high dietary diversity score. On the other hand, non-contract farmers in the study area also had DD average of 3.15 and 72% of their households had good to medium dietary diversity. The result implies that contract participating farmer's households have mildly better food security than the non-contract farmer's households in the study locations given

their higher dietary score average. The findings is consistence with that of Bellamere and Novak (2017) that studied the food security status of contract participating farmers in Madagascar, and

also in line with that of Adebisi *et al* (2019) who study the impact of contract farming on the households' food security of poultry farmers.

**Table 4.** Estimated Food Dietary Diversity Score (HDDS) of farmers Household

Variables	Contract farmers Household		Non-Contract farmers Household	
	Frequency	Percentage	Frequency	Percentage
Dietary Score				
Good DDS (6+)	78	33.48	22	10
Medium DDS (4 – 6)	120	51.50	145	62
Low DDS (<4)	35	15.02	66	28
Total	233	100	233	100
Mean	5.36		3.15	
Standard deviation	1.42		1.39	

Note: DDS stand for dietary diversity score.

Source: Field Survey, 2019.

**Covariate balancing and matching quality test**

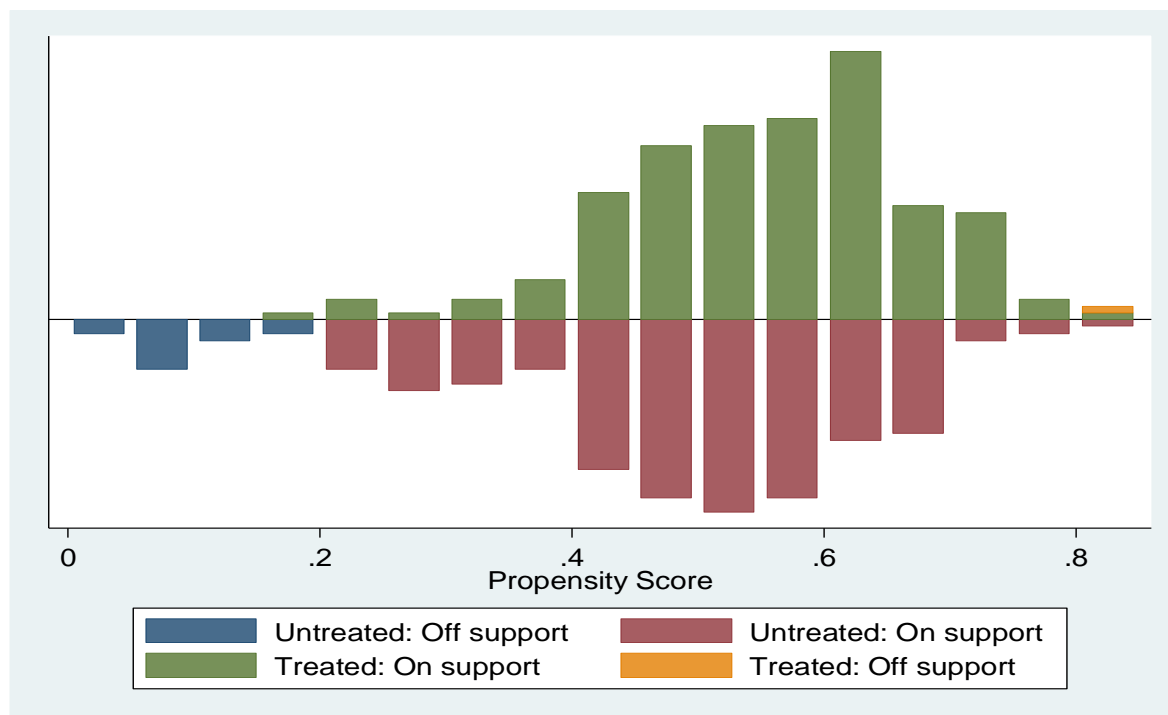
The overall balancing test was presented in table 5. The high total bias reduction, the significant p-values of likelihood ratio test after matching, low pseudo-R<sup>2</sup>, and significant reduction in the mean standardized bias are indicative of successful balancing of the distribution of covariates between participants and non-participants groups. The result

revealed that standardized mean difference for all covariates used in the PSM is reduced from 23.9% to 3.7% post-matching; result also show the matching reduction bias by 97.2%. In addition, the joint significant of covariates post-matching was also rejected (p-value=0.972). In addition to that, propensity score histogram in Figure 2 also revealed the quality distribution of the matching.

**Table 5.** Covariate Balancing and Matching Quality Test

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias
Unmatched	0.067	35.35	0.000	23.9	22.8
Matched	0.005	2.79	0.972	3.7	3.7

Source: Field Survey, 2019



**Figure 2.** Matching histogram, for the contract and non-contract maize farmers (Source: Field Survey, 2019).

### Impact of Contract Farming on Maize Yield per hectare

Impact of contract farming on maize yield per hectare was presented in table 6, result revealed that contract farming had a positive and significant effect on maize yield of smallholder maize farmers considered in the study area, the average treatment effect on treated (ATT) was NGN1742.98Kg/ha of maize produced by farmers. Average treatment

effect on the entire farmers population (ATE), that is picking any farmer at random was also 1742.98Kg/ha. This implies that participation in contract farming will result to yield increase by about 1.7tonne/ha. For the effect on untreated category ATU value was 1732.98Kg/Ha, implying that, categories of respondents if assume they were treated their maize yield will also increase by 1732.98Kg/ha

**Table 6.** Impact of Contract Farming Participation on Maize Yield per Hectare

Outcome	Sample	Treated	Control	Difference	t-test
Yield per hectare	Unmatched	3628.65241	1895.67298	1732.97943	7.06***
	ATT	3628.22826	1885.24375	1742.9845	7.66***
	ATU	1885.24375	3628.22826	1742.9845	
	ATE			1742.9845	

**Note:**\*, \*\*, \*\*\* donates significant at 10%, 5% and 1% respectively

Source: field survey, 2019

### Impact of Contract Farming on Food Security Status

Impact on food security result was presented in table 7; result revealed that participation in maize contract farming had positive and significant influence at 1% level of confidence on the food Security status of smallholder farmers, the average treatment effect on treated (ATT) was 0.8933. This implies 0.9 increase in food security of participating households. Result further show ATU of 1.136 for non-participants, this also implies 1.136 DDS increase in food security of non-contract household had it been they participated in the contract farming. Increase in nutritional food security status may be because contract participating farmers obtained higher yield and premium price of maize, which

enables them to have more income to cater for household food expenditure than the non-contract maize farmers. The result is consistence with findings of Bellamere and Novak (2016) that studied the impact contact participation on food insecurity in Madagascar, in which they used the length of time household members go without eating three meals per day as proxy to food insecurity that revealed significant impact of contract participation in reducing the period of hunger. It's also in line with that of Adebisi L.O et al (2019) that analyzed impact of contract farming on the households' food security of the poultry farmers, in which their findings revealed a calorie intake increased on the average by 1047 kCal/AE/day as a result of participating in contract farming.

**Table 7.** Impact of Contract Farming Participation on Food Security Status

Outcome	Sample	Treated	Control	difference	t-test
Food security status	Unmatched	5.337755	4.28804348	1.04971162	6.46***
	ATT	5.32923077	4.43589744	0.8933	4.81***
	ATU	4.33529412	5.47152941	1.13623529	
	ATE			1.00646575	

**Note:**\*, \*\*, \*\*\* donates significant at 10%, 5% and 1% respectively

Source: field survey, 2019

### Challenges Faced by Maize Contract Farmers

Result for challenges faced by farmers participating in maize contract production was presented in table 8. result shows that excessive control on pricing by contracting firm and inadequate insurance provision were. the 1<sup>st</sup> and 2<sup>nd</sup> major challenges faced by the farmers; the excessive control on pricing by contracting firm was due to the larger quantity of harvested maize that is collected by the firm and their dominance on price decision and inadequate insurance provision was as a result of contracting firms forcing the farmers to provide or pay for the required quantity even in the case of crop failure as a result of pest and disease or drought incidence and the farmers have no insurance to protect them. lower pricing of harvested maize by

contracting firm was ranked as 3<sup>rd</sup> and delay in payment of farmers benefits as 4<sup>th</sup> challenge, the lower pricing was stated by the farmers as because the firm always possess highest power in deciding the price to be paid per bag of harvested maize and is mostly below market price, while the delay in payment of farmers benefits was due to the fact that after harvesting the farmers are not given their profit after company deducted their services fees and credit in time. Low quality fertilizer and herbicide was ranks 5<sup>th</sup> and high transaction cost as 6<sup>th</sup>, the low inputs quality was related to the quality of production inputs supplied to the farmers and the likely production inputs diversion by the farmers and yield they produced less than expected. While the high transaction cost were realized by the farmer

as a result of small amount of money they received as final payment from company and the number of bags given per hectare to contract firm as signed initially in the contract. limited farm monitoring by

contracting firm agent was ranked 7<sup>th</sup> this was stated by the farmers as because the firms staffs number of visit to their farm is limited to only time of input supply and the harvesting periods.

**Table 8.** Challenges Faced by Maize Contract Participating Farmers

Challenges	Frequency	Percentages	Rank
Excessive pricing control by contracting firm	186	79.83	1 <sup>st</sup>
Inadequate insurance provision	182	78.11	2 <sup>nd</sup>
Lower pricing by contacting firm	176	75.54	3 <sup>rd</sup>
Delay in payment of farmers benefits	172	73.82	4 <sup>th</sup>
Low quality fertilizer and herbicide	168	72.10	5 <sup>th</sup>
High transaction cost	162	69.53	6 <sup>th</sup>
Poor farm monitoring by contracting firm agent	86	36.91	7 <sup>th</sup>
Total	233	100	

Source: Field Survey 2019.

### Conclusion

Participation in maize contract farming increases per hectare productivity of smallholder maize farmers and also reduces food insecurity status of their households. This suggested that contract farming can be used as an instrument to reduce food insecurity and poverty among rural farming household.

### Compliance with Ethical Standards

#### Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

#### Author contribution

The contribution of the authors to the present study is equal.

All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

#### Ethical approval

Ethics committee approval is not required.

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#### Data availability

Not applicable.

#### Consent for publication

Not applicable.

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