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Technical Efficiency of USAID Markets II Beneficiary Small-Scale Rice Farmers in Kano State, Nigeria

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Abstract: The challenge of food insecurity made most of the intervention agencies in sub-Saharan Africa to tilt their goal towards increase in productivity. This desire still remains a myth as the farm resource productivity of the major clienteles- smallholder farmers that are the pivot of food security is very poor. In lieu of the foregoing, this research attempted to determine the technical efficiency of USAID MARKETS II in Nigeria's Kano State using a total of 189 beneficiary farmers obtained through a multi-stage sampling technique. A well-structured questionnaire complemented with interview schedule was used for data elicitation and the collected data were analyzed using both descriptive and inferential statistics. The empirical finding showed that none of the farmers was a frontier farmer as their efficiency scores fell below the frontier surface. However, more than half of the farmers are fairly efficient as their efficiency score exceeded the average score of 0.8639, thus very close to the frontier. On the average, it can be inferred that the technical units have the scope to expand their technical efficiency by 13.61%, thus bridging the output lost of 311kg. Besides, the technical efficiency was inhibited by extension gap, thus the need to create an enabling environment viz. adequate market linkage for the farmers thereby enhancing the going concern of the farm business.

Keywords: Rice; Technical efficiency; USAID MARKETS II; Smallholding; Farmers; Nigeria
JELCodes: Q10, Q12, Q19

Usaıd Piyasalarının Teknik Verimliliği II Yararlanıcı Küçük Ölçekli Pirinç Çiftçilerinin Kano Devletinde, Nijerya

Öz: *Gıda güvensizliği sorunu, Sahra altı Afrika'daki müdahale kurumlarının çoğunu, hedeflerini üretkenliği artırmaya yöneltti. Gıda güvenliğinin eksenini oluşturan büyük müşteri-küçük ölçekli çiftçilerin çiftlik kaynak üretkenliği çok zayıf olduğundan, bu arzu hala bir efsane olarak kalmaktadır. Yukarıdakilerin yerine, bu araştırma, Nijerya'nın Kano Eyaletindeki USAID MARKETS II'nin teknik verimliliğini, çok aşamalı bir örnekleme tekniği ile elde edilen toplam 189 yararlanıcı çiftçiyi kullanarak belirlemeye çalıştı. Veri toplama için görüşme programıyla tamamlanan iyi yapılandırılmış bir anket kullanıldı ve toplanan veriler hem tanımlayıcı hem de çıkarımsal istatistikler kullanılarak analiz edildi. Ampirik bulgu, verimlilik puanları sınır yüzeyinin altına düştüğü için hiçbir çiftçinin sınır çiftçisi olmadığını gösterdi. Ancak, verimlilik puanları ortalama 0.8639 puanını aştığı ve dolayısıyla sınıra çok yakın olduğu için çiftçilerin yarısından fazlası oldukça verimlidir. Ortalama olarak, teknik birimlerin teknik verimliliklerini %13,61 oranında artırma kapsamına sahip olduğu ve böylece 311 kg'lık üretim kaybının önüne geçtiği söylenebilir. Ayrıca, teknik verimlilik, uzatma boşluğu tarafından engellendi, dolayısıyla kolaylaştırıcı bir ortam yaratma ihtiyacı, yani. çiftçiler için yeterli piyasa bağlantısı, böylece çiftlik işinin devamı endişesini artırıyor.*

Anahtar Kelimeler: *Pirinç; Teknik verimlilik; USAID PİYASALARI II; Küçük işletme; Çiftçiler; Nijerya*

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1. Introduction

One of the numerous attempts made to increase rice production in Nigeria is the United States Agency for International Development (USAID) rice project (Nwalieje *et al*., 2016). It is one of the latest policy initiatives aimed at prioritizing the rice sector and reducing reliance on foreign imports while also promoting productivity and providing agricultural inputs (Nwalieje *et al*., 2016). According to MacNamara *et al*. (2019), the Nigerian government targeted agriculture after the 2008 oil price crash to reduce rural poverty and improve food security.

The Maximizing Agricultural Revenue and Key Enterprise in Targeted Sites (MARKETS II) project is the flagship project of USAID/Feed Nigeria's the Future (FTF) Agricultural Transformation Program (ATP), and it is the successor to the MARKETS and Bridge to MARKETS 2 (BtM2) projects that run for the previous seven years. MARKETS II intends to spend $60.5 million on activities aimed primarily at the large number of smallholder farmers who cultivate between 1 and 5 hectares of land (Kristen and Jerrod, 2015). From April 2012 to October 2017, the MARKETS II team aims to work with 696,855 smallholder farms (MacNamara *et al*., 2019)producing aquaculture, cassava, cocoa, maize, lowland rice and irrigated rice, sorghum, and soybeans through private sector-driven value chain facilitation and market growth (Iwuchukwu and Beeior, 2018).

As Nigeria and its partners prepare to invest for another decade in millions of smallholder farmers, it's important to learn from the successes and shortcomings of USAID investments in order to boost economic and nutrition outcomes. Furthermore, Nigeria is critical to the region's economic development as a result of its multinationals, producers, and exporters of raw and refined commodities and services.

Smallholder farmers are the unsung heroes who provide most of the world's food, but they are also the poorest and malnourished. Smallholder farmers, who number 2.5 billion worldwide, make regular decisions to protect their livelihoods and feed their families. Every day, government extension agents, private agribusinesses, and non-governmental organizations (NGOs) provide these farmers with a staggering amount of information. Farmers are given knowledge and resources that they didn't ask for and can't use, forcing them to make hazy decisions due to a lack of communication between these actors. The gap between what is required and what is offered is widening as climate change affects demand and supply chains are disrupted by crises like COVID-19.

Rice is still a staple food in Nigeria, with about 7 million metric tonnes consumed annually (Russon, 2019), resulting in a supply deficit of about 3 million MT (KPMG, 2019). This is a significant demand, and the country has imported a large quantity of grain to meet it. However, according to the African Development Bank (ADB), the import is not exclusive to Nigeria, as the continent of Africa spends around $35 billion on food imports per year. Despite the fact that Africa contains two-thirds of the world's most arable uncultivated soil (Russon, 2019). It is a valuable food security crop as well as a vital cash crop for its primarily small-scale farmers, who usually sell 80% of total production while consuming just 20%. Nigeria's central bank barred the use of the country's foreign exchange to pay for rice imports in 2015, and has since backed loans worth at least 40 billion naira ($130 million) to help small-scale farmers increase production (George, 2020).

In sub-Saharan Africa, agricultural productivity growth has been described as a key driver of poverty reduction and increased food security (Ligon and Sadoulet, 2008; Sepahvand, 2019). The Sustainable Development Goals (SDG) 1 (End Poverty) and SDG 2 (Zero Hunger) are formalized in the United Nations' Agenda 2030. In agricultural production, resource efficiency and productivity are critical in terms of the national economy and producer prosperity (Semerci, 2013).

Subsistence agriculture, with its primitive farming method, low capitalization, and low yield per hectare, accounts for the majority of the country's farmland. As a result, rice productivity has either remained constant or improved at a snail's pace (Sadiq *et al.*, 2020). Rice yield in many countries exceeds 2 t/ha, which is significantly higher than that of Nigeria. However, since there is a large yield gap between research stations and farmers' fields, it is possible to increase its productivity.Reduced production costs and increased efficiency will result in a positive shift in the producer's income when the optimum usage level is determined (Akcay and Uzunoz, 1999; Semerci, 2013).

In order to alleviate poverty and achieve food security in the studied region, it is critical to identify the factors that impede farmers' rice production efficiency and to quantify the degree to which they restrict rice farm efficiency. A better understanding of technological efficiency and its relationship with rice farmers will significantly assist policymakers in developing efficiency-enhancing policies and assessing the efficacy of current and previous reforms. Consequently, this research attempted to determine the technical efficiency of the USAID MARKETS II small-scale rice farmers in Kano State, Nigeria.

2. Research Methodology

The co-ordinates of Nigeria's Kano state in the northern region are latitudes 10° 33' to 12° 37'N and longitude 07° 34' to 09° 25'E of the Greenwich meridian time. The vegetations of the northern and southern parts of the state are characterized by Northern-Guinea savannah and Sudan savannah respectively. The annual rainfall in the Northern-Guinea savannah varies from 600-1200 mm to 300-600 mm in the Sudan savannah. Furthermore, in the Sudan savannah region, arable crop growing periods vary from 90 to 150 days; while in the Northern-Guinea savannah region, they range from 150 to 200 days. The state has an approximate estimated population of 9.4 million habitants (NPC, 2006) with a population growth rate of approximately 3.5% per annum. The cultivable land in the state is over 1,754,200 hectares. The state is famous for its commercial activities as majority of the inhabitants engaged in trading of agricultural commodities.

A multi-stage sampling technique was used to draw a representative sample size of 195 participating farmers from the project sites. In the first stage, high concentration of smallholder rice producers was used as a yardstick/ justification for the purposive selection of six (6) participating Local government areas (LGAs) out of the nine (9) LGAs designated for USAID MARKETS II program in the state. The chosen LGAs are Bunkure, Garun-Mallam, Kura, Dambatta, Bagwai and Makoda. Secondly, from each of the selected LGAs, five (5) participating communities were randomly selected. In the third stage, from Bunkure, Garun-Mallam and Kura LGAs each, nine (9) farmers were randomly selected while four (4) farmers were randomly selected from each of these LGAs- Dambatta, Bagwai and Makoda. Thus, a total of 195 farmers formed the representative sample size. However, only 189 questionnaires were found to be valid, thus subjected to analysis. A well-structured questionnaire complemented with interview schedule was used to elicit data of 2018 rice cropping season. The stochastic production frontier function and descriptive statistics were used for data analysis.

Model Specification

Stochastic Production Frontier Function: Following Umoh (2006); Wakili (2012); Etim and Okon (2013), a typical stochastic production frontier (SPF) function is given below:

$$Y_i = f(X_{ij}\, ; \beta) - (V_i + U_i) \quad (i = 1,2 \ldots\ldots n) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

$Y_i = Total\ output\ of\ the\ i^{th} farmer$;

$X_i = Vector\ of\ the\ actual\ j^{th}\ inputs\ used\ by\ the\ i^{th} farmer$;

$\beta_i = parameter\ to\ be\ estimated$;

$V_i = Uncertainty\ which\ is\ beyound\ the\ control\ of\ the\ i^{th} farmer$; and,

$U_i = Risk\ which\ is\ attributed\ to\ the\ error\ of\ the\ i^{th} farmer$;

Given the level of technology at the disposal of a technical unit, the technical efficiency is expressed as the ratio of the actual output (Y) to the corresponding potential output (Y^*), and it is given below:

$$T_e = \frac{Y}{Y^*} = \frac{f(X_{ij,};\beta) - (V_i + U_i)}{f(X_{ij,};\beta) + V_i} = \exp\,(U_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

WhereT_e is the technical efficiency and takes the value of≤ 1, with 1 defining technical efficient decision making unit (DMU). The observed output

(Y)represents the actual total output while the potential output(Y^*) represents the frontier output level.

The explicit form of the Cobb-Douglas functional form of the SPF function is as follow:

$lnY_i = ln\beta_0 + \sum \beta_k lnX_{ij} - (V_i + U_i)$ ……………………….. (3)

Where Y_i = Total output of i^{th}farmer (kg); X_i= Vector of farm inputs used: X_1= NPK fertilizer (kg), X_2= urea fertilizer (kg), X_3= humanlabour (man-day), X_4= insecticides (kg), X_5= herbicides (litre), X_6= seed (kg), X_7= depreciation on capital items (₦), X_8= farm size (hectare); V_i = random variability in the production that cannot be influencedby the i^{th} farmer also known as uncertainty; and,U_i= deviation from maximum potential output attributable to technical inefficiency and also known as risk. β_0=intercept; β_k=vector ofinput parameters to be estimated;$i = 1,2,3 \dots \dots n\ farmers$; $j = 1,2,3 \dots \dots \dots m\ inputs.$

The inefficiency model is:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 \dots \dots \dots . + \delta_n Z_n$ ……………………… (4)

Where Z_1 = gender (male=1, otherwise=0); Z_2 = marital status (married=1, otherwise=0); Z_3 = age (year); Z_4 = educational level (year); Z_5 = primary occupation (farming =1, otherwise=0); Z_6 = secondary occupation (farming =1, otherwise=0); Z_7 = Household size (number); Z_8= rice farming experience (year); Z_9= mixed cropping (yes =1, no = 0); Z_{11} = extension visit (yes=1, otherwise=0); Z_{12} = length of participation in MARKETS II (year); Z_{13} = Duration of adoption of urea displacement project (UDP)(year); Z_{14} = proportion of farm size cultivated under UDP (%); Z_{15} = co-operative membership (yes=1, otherwise=0); Z_{16} = total livestock unit (TLU) (Camel=1.0; Horse=0.8; Cattle=0.7; Donkey=0.5; Sheep & Goat =0.1; and, Chicken=0.01); Z_{17} = commercialization index (CI)(ratio of marketed surplus to marketable surplus); and, Z_{18} = dead stocks (capital assets); δ_0 = intercept;δ_{1-18} = regression coefficient; and, ε_t = chance

3. Results And Discussion

Maximum Likelihood Estimate of Stochastic Production Frontier Function

The plausibility of the variance parameters *viz*. sigma-squared and gamma coefficients within the acceptable margin of 10% probability level indicates the correctness and fit of the specified distribution of the composite error term; and, the presence of inefficiency that owes to differences in farmers' covariates, respectively. The estimated gamma coefficient being 0.8408 implies that 84.08% of the variation in the inefficiency is due to differences in the farmers' technical efficiencies (Table 1). Besides, critical Chi^2 of the generalized likelihood ratio being higher than the tabulated Chi^2 indicates that the traditional response function *viz*. ordinary least square (OLS) estimation is not fit for the data but rather the maximum likelihood estimation (MLE) (Table 2).

A cursory review of the production component shows explanatory variables *viz*. NPK fertilizer, urea fertilizer, human labour, herbicides, seeds and farm size to be the significant factors that influenced rice output as evidenced by their respective estimated coefficients that are within the acceptable margin of 10% probability level (Table 1). Also, all the estimated coefficients have positive elasticity, thus no case of input congestion- monotonicity of the marginal output with respect to input. It is worth to note that all the contributions of the inputs were inelastic- a unit increase in an input leads to a less than proportionate increase in the output. The positive and significant of the inorganic fertilizer- NPK and urea indicates the imperative of high rice productivity due to poor fertility of the soil encouraged the use of fertilizer for soil reclamation, thus increase in output. In addition, there is evidence of adoption of recommended dosage of the inorganic fertilizers. Therefore, the elasticity implication of a unit increase in both NPK and urea fertilizers by 1% will lead to an increase in output by 0.17 and 0.09% respectively. The positive sign of human labour indicates the importance of labour in the traditional farming setting due to cultivation of tiny uneconomic holdings which hinders mechanization, thus high utilization of human labour. Besides, there is adequate utilization off human labour unlike in most researches were it is found to be over-employed owing to free access. Thus, a 1% increase in the use of human labour will lead to an increase in output by 0.59%. The positive sign of herbicides, likewise the seeds may be attributed to the substitute of labour for herbicides for weed control especially during land clearing and the use of improved rice variety for enhanced productivity, respectively, thus the increase in the output. Also, adequate utilization of herbicides and improved seed varieties according to recommended dosage plays a crucial role in enhancing the farmers' rice output. The positivity of the farm size indicates that the farmers are experiencing economies of size as the average cost in the long-run is decreasing, thus increase in the output. Therefore, the elasticity implication of a unit increase in farm size by a 1% will lead to an increase in the output by 0.13%. However, the non-significant of insecticides and depreciation coefficients may be attributed to less usage due to low insect infestation on the rice crop and the use of primitive implements in the cultivation of rice respectively.

The empirical evidence shows that all the farmers were operating at stage I surface of production as indicated by the sum of the return to scale that is 1.30. Therefore, it can be inferred that the farmers have the scope to increase their scale of production as they are yet to attain the rational production point which is the economic feasible point of production-necessary and sufficient conditions required for economic efficiency.

In the inefficiency component, technical efficiency was observed to be driven by gender, marital status, educational level and mixed cropping as indicated by their respective estimated coefficients that were within the plausible margin of 10% significance level (Table 1). Except gender, all the significant variables increased technical inefficiency as evidenced by the positive sign associated with their respective coefficients. The negative sign of the gender coefficient showed how access and control to productive resources due to gender stereotype among male farmers enhanced their technical efficiency against their female counterparts. Gender inequality due to religious and cultural barriers is the *de facto*that inhibited women active engagement and performance in agricultural supply chain. Thus, being a male farmer will decrease a farmer's technical inefficiency by 0.27%. The positive sign of the marital status implies that poor access to twin capital benefit *viz*. social and economic capitals which is inherent in marital status affected the farm resource productivity of farmers that are unmarried, thus increased their technical inefficiency. Therefore, the probability of a farmer being unmarried would lead to an increase in his/her technical inefficiency by 0.37%. Besides, the positive sign associated with the education level coefficient implied that complacency due to the low educational level of the extension agent coupled with engagement in white collar job affected literates farmers keen concentration on farm activities, thus plummeted their technical efficiency. Therefore, a unit increase in a farmer's educational level by a year has the tendency of increasing his/her technical inefficiency by 0.03%. The positive sign associated with mixed cropping implies that farmers that didn't engaged in crop diversification faced challenge ofpoor farm resource productivity due to slim farm income stream, thus plummeted their technical efficiency. Thus, the farmers that engaged in mono-cropping have their technical inefficiency increased by 0.45%.

Table 1: *MLE of the stochastic production frontier*

Variable	Coefficient	Standard error	t-statistic
Deterministic model			
Constant (β_0)	3.2159858	0.44946434	7.1551522***
NPK fertilizer (β_1)	0.17752436	0.052953074	3.3524845***
Urea fertilizer (β_2)	0.099208919	0.047382645	2.0937818**
Humanlabour(β_3)	0.59175576	0.083663568	7.0730400***
Insecticides(β_4)	0.042913972	0.060783304	0.70601579^{NS}
Herbicides (β_5)	0.11200685	0.059638952	1.8780822*
Seed (β_6)	0.14265612	0.073317714	1.9457251*
Depreciation on cap. (β_7)	0.0032756159	0.027310941	0.11993786^{NS}
Farm size(β_8)	0.13225746	0.063029608	2.0983386**

Table 1 Cont. : *MLE of the stochastic production frontier*

Inefficiency model			
Constant (δ_0)	0.30290813	0.57924215	0.52293870^{NS}
Gender (δ_1)	-0.26940138	0.12582623	2.1410590**
Marital status (δ_2)	-0.0052000398	0.007763625	0.66979531^{NS}
Educational level (δ_3)	0.37208350	0.21775441	1.7087301*
Primary occupation (δ_4)	0.022601137	0.009459713	2.3891990**
Secondary occupation (δ_5)	0.25487561	0.27729691	0.91914333^{NS}
Household size(δ_6)	0.016777659	0.095547411	0.17559511^{NS}
Experience (δ_7)	0.011363675	0.0088967219	1.2772878^{NS}
Mixed cropping (δ_8)	-0.014619467	0.010010957	1.4603465^{NS}
Extension contact (δ_9)	0.44850521	0.23607190	1.8998670*
Length of part. in MKT11(δ_{10})	-0.42038878	0.33874607	1.2410145^{NS}
Length of adoption of UDP(δ_{11})	-0.043308952	0.044132940	0.98132940^{NS}
% of farm under UDP(δ_{12})	0.010284347	0.0019240177	0.53452456^{NS}
Co-operative membership(δ_{13})	-0.0006691384	0.0014217653	0.47063916^{NS}
Total livestock unit (TLU)(δ_{14})	-0.14396133	0.18893283	0.76197095^{NS}
Commercialization index (CI)(δ_{15})	0.012211508	0.033746010	0.36186525^{NS}
Ln Dead-stock (δ_{16})	-0.26725206	0.26101895	1.0238799^{NS}
Variance parameters			
Sigma-squared(σ^2)	0.11151890	0.023037051	4.8408494***
Gamma (γ)	0.84080611	0.21130196	3.9791685***

Source: Field survey, 2018

*, **, *** and ^{NS} means significance at 10%, 5%, 1% and non-significant respectively

Table 2: *Generalized Likelihood ratio test of hypothesis for parameters of SPFF*

H_o	LLF (OLS)	LLF-MLE(Cobb-Douglas)	λ	Critical (5%)	Decision
$\gamma = 0$	58.348766	93.557039	70.42	67.32	$\gamma \neq 0$

Source: Field survey, 2018

Individual farm technical efficiency

A perusal of Table 3 showed the mean efficiency score to be 0.8639, implying that on the average; farmers achieved a technical efficiency of 86.39%, a potential output lost of 311kg (Table 4), relative to the best farmers facing the same technology. This indicates that the average farmers fell short of the frontier surface, the optimum technical efficient point by 13.61% due to extension gap. Besides, an average farm lost 13.61% of their potential output relative to the best practiced farms producing the same output and facing the same technology. The lower the value of the efficiency score, the more inefficient is a technical unit. From the empirical evidence, the frequencies of occurrence of the predicted efficiency score between 0.80-0.98 represents 76.2% of the sampled farmers. Even at the mean efficiency score of 0.8639, half of the farmers (54%) are very close to the frontier. This implies that most of the farmers were fairly efficient in producing at a given level using necessary and satisfactory conditions- economic efficiency which reflects farmers' tendency to achieve output maximization associated with production process from output perspective. The worst farmer had an efficiency score of 0.5397, thus lost a potential output of 596kg; while the best practiced farmer had an efficiency score of 0.9889, thus a potential output lost of 21.2kg (Table 4). Therefore, for the worst inefficient farmers to be on the same level with the best practiced farmer and on the frontier surface, he/her need to bridge his/her inefficiency gaps by45.40 [1-(0.5397/0.9889)*100] and 46% respectively. Therefore, it can be inferred that the average farmers still have the scope to expand their technical efficiency by adopting the appropriate technologies so as to attain the optimum efficiency level.

Table 3: *Frequency distribution of technical efficiency scores*

Efficiency level	**Frequency**	**Relative efficiency %**
0.30-0.39	1	0.5
0.40-0.49	9	4.8
0.50-0.59	16	8.5
0.60-0.69	19	10.1
0.70-0.79	42	22.2
0.80-0.89	42	54.0
0.90-0.99	102	
Total	**189**	**100**
Mean	**0.863929**	
Maximum	**0.988985**	
Minimum	**0.539677**	
Standard deviation	**0.115772**	

Source: Field survey, 2018

Table 4: *Individual-wise actual, potential and yield gap*

DMU	TE	ACTUAL	POTENTIAL	GAP	DMU	TE	ACTUAL	POTENTIAL	GAP
DMU 1	0.853793	3150	3689.418	-539.418	**DMU 16**	0.929172	2940	3164.108	-224.108
DMU 2	0.540276	700	1295.634	-595.634	**DMU 17**	0.986597	3500	3547.548	-47.5482
DMU 3	0.675811	700	1035.793	-335.793	**DMU 18**	0.694425	3360	4838.533	-1478.53
DMU 4	0.587118	840	1430.717	-590.717	**DMU 19**	0.785094	2450	3120.644	-670.644
DMU 5	0.692766	1890	2728.192	-838.192	**DMU 20**	0.851456	1120	1315.394	-195.394
DMU 6	0.969715	6650	6857.683	-207.683	**DMU 21**	0.611786	980	1601.866	-621.866
DMU 7	0.91487	6510	7115.767	-605.767	**DMU 22**	0.906764	5320	5867.019	-547.019
DMU 8	0.904214	3500	3870.764	-370.764	**DMU 23**	0.802342	3920	4885.696	-965.696
DMU 9	0.691544	560	809.7821	-249.782	**DMU 24**	0.983885	560	569.172	-9.17201
DMU 10	0.652665	420	643.5158	-223.516	**DMU 25**	0.984032	840	853.6308	-13.6308
DMU 11	0.571777	420	734.5525	-314.552	**DMU 26**	0.952854	2590	2718.148	-128.148
DMU 12	0.599187	525	876.1875	-351.187	**DMU 27**	0.957632	2800	2923.879	-123.879
DMU 13	0.553289	420	759.0974	-339.097	**DMU 28**	0.844571	7000	8288.23	-1288.23
DMU 14	0.965312	1960	2030.432	-70.4325	**DMU 29**	0.834277	910	1090.765	-180.765
DMU 15	0.949132	5250	5531.368	-281.368	**DMU 30**	0.839195	2100	2502.399	-402.399

Table 4: Continued: *Individual-wise actual, potential and yield gap*

DMU 31	0.924711	6300	6812.939	-512.939	**DMU 46**	0.948788	1400	1475.567	-75.5668
DMU 32	0.600124	1120	1866.28	-746.28	**DMU 47**	0.874137	1470	1681.659	-211.659
DMU 33	0.640862	1120	1747.646	-627.646	**DMU 48**	0.976371	700	716.9409	-16.9409
DMU 34	0.69493	1750	2518.24	-768.24	**DMU 49**	0.836649	700	836.6709	-136.671
DMU 35	0.972845	4550	4677.006	-127.006	**DMU 50**	0.921702	3430	3721.375	-291.375
DMU 36	0.588816	1190	2021.004	-831.004	**DMU 51**	0.963178	2100	2180.283	-80.2831
DMU 37	0.560253	1750	3123.587	-1373.59	**DMU 52**	0.969389	1400	1444.208	-44.2084
DMU 38	0.895912	1260	1406.388	-146.388	**DMU 53**	0.895033	1400	1564.188	-164.188
DMU 39	0.971877	1680	1728.613	-48.6133	**DMU 54**	0.896046	840	937.4521	-97.4521
DMU 40	0.962244	2590	2691.626	-101.626	**DMU 55**	0.90624	3220	3553.141	-333.141
DMU 41	0.846226	1750	2068.006	-318.006	**DMU 56**	0.91826	1400	1524.622	-124.622
DMU 42	0.917981	4200	4575.26	-375.26	**DMU 57**	0.960807	840	874.2647	-34.2647
DMU 43	0.927079	4620	4983.392	-363.392	**DMU 58**	0.86594	2520	2910.133	-390.133
DMU 44	0.919643	1750	1902.913	-152.913	**DMU 59**	0.722874	560	774.6855	-214.685
DMU 45	0.988985	3500	3538.98	-38.9804	**DMU 60**	0.763112	1960	2568.431	-608.431

Table 4: Continued: *Individual-wise actual, potential and yield gap*

DMU 61	0.903565	1400	1549.418	-149.418	**DMU 76**	0.957737	1400	1461.78	-61.7796
DMU 62	0.929168	560	602.6894	-42.6894	**DMU 77**	0.951276	4200	4415.122	-215.122
DMU 63	0.924709	1050	1135.493	-85.4927	**DMU 78**	0.877314	2800	3191.559	-391.559
DMU 64	0.927863	2240	2414.15	-174.15	**DMU 79**	0.650286	1400	2152.898	-752.898
DMU 65	0.915088	560	611.9632	-51.9632	**DMU 80**	0.697105	840	1204.984	-364.984
DMU 66	0.950205	1540	1620.703	-80.7033	**DMU 81**	0.902894	2800	3101.14	-301.14
DMU 67	0.891731	910	1020.488	-110.488	**DMU 82**	0.967175	8400	8685.087	-285.087
DMU 68	0.963285	1470	1526.029	-56.0286	**DMU 83**	0.870097	1750	2011.269	-261.269
DMU 69	0.856459	420	490.3912	-70.3912	**DMU 84**	0.586477	1400	2387.136	-987.136
DMU 70	0.920104	1400	1521.568	-121.568	**DMU 85**	0.632905	1750	2765.03	-1015.03
DMU 71	0.954543	980	1026.669	-46.6693	**DMU 86**	0.935347	630	673.5469	-43.5469
DMU 72	0.879447	980	1114.336	-134.336	**DMU 87**	0.949641	1960	2063.937	-103.937
DMU 73	0.960144	980	1020.68	-40.6802	**DMU 88**	0.968007	1750	1807.839	-57.839
DMU 74	0.682262	350	512.9994	-162.999	**DMU 89**	0.941904	1750	1857.939	-107.939
DMU 75	0.863426	840	972.8683	-132.868	**DMU 90**	0.941632	1050	1115.086	-65.0857

Table 4: Continued: *Individual-wise actual, potential and yield gap*

DMU 91	0.966762	1400	1448.134	-48.1338	**DMU 106**	0.857948	1750	2039.752	-289.752
DMU 92	0.976749	3220	3296.652	-76.6518	**DMU 107**	0.893852	1750	1957.818	-207.818
DMU 93	0.949421	1890	1990.687	-100.687	**DMU 108**	0.953264	1400	1468.638	-68.6377
DMU 94	0.858164	1750	2039.238	-289.238	**DMU 109**	0.91645	840	916.5804	-76.5804
DMU 95	0.977434	2800	2864.645	-64.645	**DMU 110**	0.961675	1120	1164.634	-44.6344
DMU 96	0.948721	3500	3689.178	-189.178	**DMU 111**	0.93434	980	1048.868	-68.8684
DMU 97	0.982501	1750	1781.169	-31.1686	**DMU 112**	0.811387	1400	1725.44	-325.44
DMU 98	0.948406	1400	1476.161	-76.1606	**DMU 113**	0.937821	840	895.6935	-55.6935
DMU 99	0.988026	1750	1771.209	-21.2086	**DMU 114**	0.851082	910	1069.227	-159.227
DMU 100	0.921619	1400	1519.065	-119.065	**DMU 115**	0.827105	350	423.1629	-73.1629
DMU 101	0.979285	4900	5003.651	-103.651	**DMU 116**	0.933051	910	975.2952	-65.2952
DMU 102	0.962082	1050	1091.383	-41.3827	**DMU 117**	0.937436	700	746.718	-46.718
DMU 103	0.978965	1050	1072.562	-22.5616	**DMU 118**	0.946718	1400	1478.794	-78.7935
DMU 104	0.928983	1260	1356.322	-96.3221	**DMU 119**	0.958745	840	876.1452	-36.1452
DMU 105	0.9259	1400	1512.043	-112.043	**DMU 120**	0.801526	2800	3493.336	-693.336

Table 4: Continued: *Individual-wise actual, potential and yield gap*

DMU	TE	ACTUAL	POTENTIAL	GAP	DMU	TE	ACTUAL	POTENTIAL	GAP
DMU 121	0.885467	350	395.2715	-45.2715	**DMU 136**	0.957676	3920	4093.242	-173.242
DMU 122	0.591803	350	591.4131	-241.413	**DMU 137**	0.907299	1050	1157.281	-107.281
DMU 123	0.85776	12600	14689.42	-2089.42	**DMU 138**	0.914319	1400	1531.194	-131.194
DMU 124	0.954381	3150	3300.57	-150.57	**DMU 139**	0.935398	490	523.8412	-33.8412
DMU 125	0.940072	1050	1116.936	-66.9358	**DMU 140**	0.956775	1050	1097.436	-47.4364
DMU 126	0.684531	770	1124.859	-354.859	**DMU 141**	0.953795	2450	2568.685	-118.685
DMU 127	0.769826	1050	1363.945	-313.945	**DMU 142**	0.971749	4900	5042.455	-142.455
DMU 128	0.824078	1050	1274.152	-224.152	**DMU 143**	0.817776	910	1112.775	-202.775
DMU 129	0.916	1190	1299.127	-109.127	**DMU 144**	0.94391	700	741.5959	-41.5959
DMU 130	0.865993	3500	4041.604	-541.604	**DMU 145**	0.926746	1260	1359.596	-99.5963
DMU 131	0.839391	490	583.7563	-93.7563	**DMU 146**	0.74612	770	1032.006	-262.006
DMU 132	0.942732	4200	4455.137	-255.137	**DMU 147**	0.868127	700	806.3337	-106.334
DMU 133	0.978848	1750	1787.816	-37.8158	**DMU 148**	0.921112	700	759.9514	-59.9514
DMU 134	0.752297	420	558.2898	-138.29	**DMU 149**	0.935355	490	523.8653	-33.8653
DMU 135	0.812418	560	689.3006	-129.301	**DMU 150**	0.665672	700	1051.569	-351.569

Table 4: Continued: *Individual-wise actual, potential and yield gap*

DMU 151	0.767069	700	912.5645	-212.565	**DMU 171**	0.778074	840	1079.589	-239.589
DMU 152	0.687328	350	509.218	-159.218	**DMU 172**	0.850211	3500	4116.624	-616.624
DMU 153	0.70292	840	1195.015	-355.015	**DMU 173**	0.723844	1400	1934.119	-534.119
DMU 154	0.967113	2450	2533.312	-83.3124	**DMU 174**	0.913627	490	536.3237	-46.3237
DMU 155	0.539677	700	1297.073	-597.073	**DMU 175**	0.845617	490	579.4589	-89.4589
DMU 156	0.758632	700	922.7136	-222.714	**DMU 176**	0.962866	2450	2544.488	-94.4877
DMU 157	0.763923	5250	6872.424	-1622.42	**DMU 177**	0.7943	1260	1586.302	-326.302
DMU 158	0.720802	770	1068.255	-298.255	**DMU 178**	0.960255	3500	3644.864	-144.864
DMU 159	0.942311	630	668.5694	-38.5694	**DMU 179**	0.778401	350	449.6395	-99.6395
DMU 160	0.954634	3500	3666.325	-166.325	**DMU 180**	0.853919	2170	2541.226	-371.226
DMU 161	0.902617	1750	1938.807	-188.807	**DMU 181**	0.932141	630	675.8631	-45.8631
DMU 162	0.870694	5950	6833.631	-883.631	**DMU 182**	0.922407	1260	1365.992	-105.992
DMU 163	0.83335	10500	12599.75	-2099.75	**DMU 183**	0.772082	1400	1813.279	-413.279
DMU 164	0.949517	770	810.939	-40.939	**DMU 184**	0.892	3780	4237.667	-457.667
DMU 165	0.783209	840	1072.511	-232.511	**DMU 185**	0.981763	7000	7130.03	-130.03
DMU 166	0.76782	420	547.0036	-127.004	**DMU 186**	0.949267	7000	7374.114	-374.114
DMU 167	0.966361	2170	2245.537	-75.5365	**DMU 187**	0.979233	560	571.876	-11.876
DMU 168	0.953634	630	660.6309	-30.6309	**DMU 188**	0.877609	1400	1595.244	-195.244
DMU 169	0.862327	910	1055.285	-145.285	**DMU 189**	0.972072	3850	3960.613	-110.613
DMU 170	0.727686	700	961.9529	-261.953	**MEAN**	**0.863929**	**1972.778**	**2283.496**	**-310.718**

Source: Field survey, 2018

Conclusion and Recommendations

Sequel to these findings, it can be inferred that none of the technical unit is technical efficient-on the frontier surface; though, only half of the sampled farmers were fairly efficiency. The empirical evidence showed that technical efficiency was constrained by lack of crop diversification- mono-cropping, poor access to social and economic capital and less desire for farming due to salaried jobs. In a nutshell, all these constraints owe to extension gap, thus affected farmers' technical efficiency which has direct effect on potential output. Therefore, the study advice the farmers to engage in mixed cropping, a diversification strategy to overcome poor farm resource productivity. In addition, there is need to establish effective marketing linkages so that educated farmers will see farming as a lucrative business against a last resort for livelihood sustenance.

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