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Research Paper

Rice Yield Differentials between IFAD Participating and Non-Participating Farmers in Nigeria's Niger State

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ABSTRACT

The research empirically determined rice yield differentials between the IFAD participating and non-participating farmers in Nigeria's Niger state. A field survey data of 2018 cropping season collected through structured questionnaire complemented with interview schedule from 111 participants and 185 non-participants sampled *via* a multistage sampling technique were used. The collected data were analyzed using descriptive statistics, profit function and inferential statistics. The empirical findings showed that the participating farmers are efficient in managing their enterprise risk owing to low cost of production and high yield. In addition, the programme had impact on the farmers' productivity both in the short-run and long-run, thus the reason for the high yield in comparison to their counterparts. Furthermore, the decomposition analysis justified the impact of the programme as structural difference called programme participation accounts for more than 92% variation in the yield of the participating farmers been higher than that of the non-participating farmers, leaving less than 10% to be contributed by resource endowment difference. Therefore, the study advised the participating farmers to increase their insurance coverage and adjust their structural pattern of production as a risk management strategy so as to enhance their chances of breaking even in rice production. In addition, the programme should be broaden to cover the non-treated groups so as to enhance the livelihood and rice food security of the farming households in particular; and that of the rural, state and national economies in general.

Highlights

- Quantifying yield gap between programme participants and non-participants
- Determining the effect and impact of IFAD programme on farmers yield

Keywords: Yield Differential, Rice, Farmers, IFAD, Nigeria

Around 1.5 billion people worldwide work in smallholder farming (Abdullahi *et al*. 2015). They include 75 % of the world's poorest people, whose prospects for food, income and livelihood depend on agriculture (Andrea 2014; Abdullahi *et al*. 2015). Peasantry is Nigeria's dominant mode of agricultural production and subsistence, with more than 70 percent of the population engaged as a profession in agricultural activities and primarily feeding the nation (Atala and Hassan, 2012). Schubert (1994); Abdullahi *et al*. (2015) reported that agriculture is the main source of income for the poor, and that poverty amongst these smallholder farmers is perhaps more prevalent. Reducing poverty in the country would not be feasible without a fast increase in agriculture. Babatunde (2006) reported that the concern about growing levels of poverty, especially in developing countries such as Nigeria, and the

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need to alleviate it as a means of improving people's living standards, led to the conceptualization and implementation of various poverty alleviation programs worldwide.

Over the past couple of decades the government and international agencies such as the International Fund for Agricultural Development (IFAD) have embarked on multiple intervention programs to tackle the problems of hunger, food insecurity and also improve the quality of life of rural citizens. The government's main worry in embarking on the aided projects of the IFAD is to reduce poverty among rural Nigerians by increasing their income (IFAD, 2013). The project has been extremely focused in targeting the poorest sectors of landless and small-scale farmers. One of its goals is through participatory mechanism to alleviate rural deprivation and food insecurity among the most vulnerable families in the country's environmentally sensitive areas.

Increased agricultural productivity, the shift from subsistence to commercialized farming and increased market access are considered as some of the ways to make the farming sector a viable enterprise, particularly in the study area and Nigeria in general. Very often, the prevalence of market imperfections in the markets of both input and output ration small and marginal farmers and endanger their sustainability. These show that many challenges exist when it comes to making agriculture remunerative, effective, competitive and sustainable. Future stress is expected on the resources for agricultural production. Consequently, the requirement of increased production can be met primarily by increasing agricultural productivity and efficiency. With climate change and globalisation, agricultural risk management and uncertainty are inevitable in the future.

It is view of the foregoing that this study attempts to determine the structural effect of farmers' participation in IFAD rice programme on their productivity gap. The specific objectives were to determine the risk management efficiency of the participating farmers vis-à-vis the non-participating farmers; to determine the effect and impact of the programme on the farmers yield; and, to determine the effect of the programme on the yield gap of the participating farmers.

RESEARCH METHODOLOGY

The study was conducted in Niger state of Nigeria situated on latitudes 8°20'N and 11°30'N of the equator and longitudes 3°30'E and 7°20'E of the Greenwich Meridian time. The vegetation of the state is northern guinea savannah with a sparse of southern guinea savannah. Agriculture is the major occupation in the study area and it's complemented with civil service jobs, artisanal, craftwork, *Ayurveda* medicines and petty trade.

The present study relied on cross sectional data obtained from 296 rice farmers drawn *viz.* multi-stage sampling technique using sampling frame obtained from IFAD-VCDP, NAMDA and reconnaissance survey. In the state, only five (5) Local Government Areas were involved in the IFAD rice programme with Agricultural Zone A (Bida) and C (Kontagora) having two LGAs each, namely Bida and Katcha; and, Wushishi and Kontagora respectively, while Zone B has one participating LGA *viz.* Shiroro. In the first stage, for Agricultural Zone A, one LGA *viz.* Katcha LGA was randomly selected; for Zone B, the only participating LGA *viz.* Shiroro LGA was automatically selected; while for Zone C, Wushishi LGA was purposively selected based on its' comparative advantage given that rice is produce throughout the year owing to the presence of Tungan Kawo irrigation dam. The sample size used for the study was composed of three groups of respondents *viz*. treatment group (IFAD participating farmers), exposed/spill-over group (non-IFAD participating farmers but living within the radius of 50km of IFAD site as adopted by Irshad *et al*. 2016) and the control group (neither IFAD participants nor living within the radius of 50km). In the same vein, the exposed group emanates from the selected IFAD participating LGAs while one LGA from each of the Agricultural zones *viz.* Lapai (Zone A), Gurara (Zone B) and Mariga (Zone C) were selected as control units.

In the second stage, two villages were randomly selected from each of the chosen participating LGAs, exposed sites and the control LGAs. Thereafter, two active co-operative associations from each of the selected participating; exposed and control villages were randomly selected. It is worth to note that Microsoft excel inbuilt random sampling mechanism was used for the random selections of the villages and the co-operative associations. In the last stage, using the sampling frame obtained from IFAD/VCD office in Niger State and developed from reconnaissance survey (Table 1), Cochran's formula was used to determine the representative sample size. Thus, a total of 296 active rice farmers form the sample size for the study. However, only 295 questionnaires were found valid for analysis. Structured questionnaire complemented with interview schedule was used to elicit information from the respondents during the 2018 cropping season. In synchronizing order, the objectives were achieved using profit function and risk enterprise analyzer; WLS in conjunction with Chow F-test statistics and ATE; and WLS in conjunction with Oaxaca-Blinder decomposition model. The Cochran's formula used is shown below:

$$n_a = \frac{n_r}{1 + \frac{(n_r - 1)}{N}} \quad \ldots(1)$$

$$n_r = \frac{(1.96)^2\, pq}{e^2} \quad \ldots(2)$$

Where:

n_a = adjusted sample size for finite population; n_r = sample size for infinite population; N = population size; p = proportion of population having a particular characteristic; q = 1 – p; e^2 = error gap (0.07).

Thus, p = 0.40 and q = 1 – 0.40 = 0.60

Table 1: Sampling frame of participating and non-participating farmers

Groups	LGAs	Villages	Co-operative Associations	SF	SS
TREATMENT	**Katcha**	**Baddegi**	Managi Badeggi Farmers CMPS	24	10
			Aminci EbantiTwaki CMPS Ltd	25	10
		Edostu	Edotsu Co-Operative Credit & Marketing CMPS	25	10
			Edotsu Jinjin Wugakun Yema CMPS	25	10
	Shiroro	**Baha**	Baha Abmajezhin Cooperative Multi-Purpose Society Ltd	15	7
			Abwanubo Najeyi Development Association	18	8
		Paigado	Paigado Achajebwa Development Farmers Soc.	25	10
			Paigado Farmers Cooperative Society Ltd	25	10
	Wushishi	**Bankogi**	Bankogi Alheri Farmers Coop. Multipurpose Soc Ltd	22	9
			Bankogi Gwari Nasara CMPS	16	7
		Kanko	Kanko Arewa Farmers	25	10
			Kanko Unguwar Ndakogi Cooperative Multipurpose Society Ltd	25	10
			SUB-TOTAL	**270**	**111**
SPILL-OVER/EXPOSED	**Katcha**	**Kangi Toga**	Kangi Toga Farmers Cooperative	20	9
			Kangi Toga Youth farmers cooperative society ltd	15	8
		Sheshi Dama	Sheshi-Dama Farmers Cooperative	18	8
			Shinkafamana Multipurpose farmers cooperative Sheshi-Dama	15	8
	Shiroro	**Farin Doki**	Ayenaje multipurpose Development Association Farin-Doki	20	9
			Farindoki Youth Farmers Cooperative Society ltd	15	8
		Zhikuchi	Genuko Farmers Cooperative society Ltd	10	6
			Zhikuchi Rice Farmers Cooperative Society Ltd	12	7
	Wushishi	**Gwarijiko**	Gwarijiko Farmers Cooperative	16	8
			Kyadyafu Cooperative Society Gwariji	10	6
		Fugangi	Fugankpan Farmers Cooperative Society	13	7
			Fugan Youth Farmers Cooperative Society	10	6
			SUB-TOTAL	**174**	**90**
CONTROL	**Lapai**	**Gbage**	Gbage Youth Farmer Cooperative Society	15	8
			Gbage rice farmer Cooperative Society Ltd	20	9
		Puzhi	Puzhi Shinkafamana Farmers C.S. Ltd I	12	7
			Puzhi Shinkafamana Farmers C.S. Ltd II	18	8
	Gurara	**Tufa**	Yanga Multipurpose Cooperative Association	19	9
			Abawa Rice Farmers Association	10	6
		Lambata	Lambata Rice Farmers Cooperative Multipurpose Society Ltd	15	8
			Boku/Sarki Gbadagu Development Association.	14	8
	Mariga	**Kahigo**	Kahigo Fadama User Cooperative Society	17	8
			Young Farmers Cooperative Multi-Purpose Society Limited	20	9
		Bobi	Respect Cooperative Association Cooperative Society	13	7
			Bobi Himma Irrigation Cooperative Society	20	9
			SUB-TOTAL	**193**	**95**
			Grand Total	**637**	**296**

***Source:** IFAD-VCDP farmer database and Niger State Agricultural Mechanization Development Authority (NAMDA), 2018; **Note:** SF and SS means sampling frame and sample size respectively.*

Empirical model

1. Profit Function

A prototype of the profit function is given below:

$$GM = TR - TVC \quad \text{...(3)}$$

$$\pi = TR - TC \quad \text{...(4)}$$

Where,

GM = *Gross margin*; π = *Profit*; *TR* = *Total revenue*; *TVC* = *Total variable cost*; and, *TVC* = *Total cost*

2. Multiple Regression

Shown below is the multiple regression model:

Implicit form

$$Y = f(X_1, X_2, X_3, X_4 \ldots\ldots, X_n) \quad \text{...(5)}$$

Explicit form

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots + \beta_n X_n + \varepsilon_i \quad \text{...(6)}$$

Where, Y = Output of rice (kg); X_1 = Seeds (kg); X_2 = NPK fertilizer (kg); X_3 = Urea fertilizer (kg); X_4 = Herbicides (litre); X_5 = Family labour (man day); X_6 = Hired labour (man day); X_7 = Depreciation on capital items (₦); X_8 = Farm size (ha); β_0 = Intercept; β_{1-8} = Regression coefficient; and, ε_t = Stochastic

The functional forms fitted into the specified equation are as follow:

(a) Linear function

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots + \beta_n X_n + \varepsilon_t \quad \text{...(7)}$$

$$MPP = \beta$$

$$Elasticity = \beta^* \overline{X}/\overline{Y}$$

(b) Semi–log function

$$\log Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 \ldots\ldots + \beta_n \log X_n + \varepsilon_t \quad \text{...(8)}$$

$$MPP = \beta^* \overline{Y}/\overline{X}$$

$$Elasticity = \beta$$

(c) The Cobb Douglas (double log) function

$$\log Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 \ldots\ldots\ldots\ldots\ldots + \beta_n \log X_n + \varepsilon_t \quad \text{...(9)}$$

$$MPP = \beta^* \overline{Y}/\overline{X}$$

$$Elasticity = \beta$$

(d) Exponential function

$$\log Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots\ldots\ldots + \beta_n X_n + \varepsilon_t \quad \text{...(10)}$$

$$MPP = \beta^* \overline{Y}$$

$$\text{Elasticity} = \beta^* \overline{X}$$

3. *Chow F-statistics test*

Following Onyenweaku (1997); Amaefula *et al.* (2012), the F-statistics tests for Test for Effect of the programme, Test for Homogeneity of slopes and Test for Differences in intercepts are given below:

To isolate the effect of the programme, Equation 6 was used to estimate for: (i) for participating farmers (ii) non-participating farmers (iii) pooled data without a dummy variable (iv) pooled data with a dummy variable (participants =1, otherwise = 0)

Test for Effect of the programme:

$$F^* = \frac{[\sum \varepsilon_3^2 - (\sum \varepsilon_1^2 + \sum \varepsilon_2^2)]/[K_3 - K_1 - K_2]}{(\sum \varepsilon_1^2 + \sum \varepsilon_2^2)/K_1 + K_2} \quad \text{...(11)}$$

Where and are the error sum of square and degree of freedom respectively for the pool group (both treated and untreated), and are the error sum of square and degree of freedom respectively for the treated group, and, $\Sigma\varepsilon_2^2$ and K_2 are the error sum of square and degree of freedom respectively for the untreated group.

If the F-cal is greater than the F-tab, it implies that the programme had effect on the participation attitude of the treated group.

Test for Homogeneity of Slope:

$$F^* = \frac{[\sum \varepsilon_4^2 - (\sum \varepsilon_1^2 + \sum \varepsilon_2^2)]/[K_4 - K_1 - K_2]}{(\sum \varepsilon_1^2 + \sum \varepsilon_2^2)/K_1 + K_2} \quad \text{...(12)}$$

Where $\Sigma\varepsilon_4^2$ and K_4 are the error sum of square and degree of freedom respectively for the pooled group (both treated and untreated) with a dummy variable.

If the F-cal is greater than the F-tab, it implies that the programme brought about a structural change or shift in the participation behaviour parameter.

Test for differences in intercepts:

$$F* = \frac{[\sum \varepsilon_3^2 - \sum \varepsilon_4^2]/[K_3 - K_4]}{\sum \varepsilon_4^2 / K_4} \quad \ldots(13)$$

If the F-cal is greater than the F-tab, it implies that the participation attitudes of the treated farmers differ from that of the untreated group.

4. *Average Treatment Effect (ATE)*

ATE: It show the average difference in outcome between units assigned to the treatment and units assigned to the placebo (control). Following Lokshin and Sajaia (2011); Wang *et al.* (2017) the equation is given below:

Income of participants is given by:

$$E(y_{1i}|I = 1; X) \quad \ldots(14)$$

Income of non-participants is given by:

$$E(y_{2i}|I = 0; X) \quad \ldots(15)$$

Income of participants if they had not participated is denoted by:

$$E(y_{2i}|I = 1; X) \quad \ldots(16)$$

Income of non-participants if they had participated:

$$E(y_{1i}|I = 0; X) \quad \ldots(17)$$

Where:

$E(.)$ = Expectation operator

y_{1i} = Yield of participants (dependent variable)

y_{2i} = Yield of non-participants (dependent variable)

I = Dummy variable (1 = participant, 0 = non-participant)

X = Explanatory variables that is common to both participants and non-participants.

$$ATT = E(y_{1i}| I = 1; \mathrm{X}) - E(y_{2i}| I = 1; X) \quad \ldots(18)$$

$$ATU = E(y_{1i} | I = 1; \mathrm{X}) - \mathrm{E}\ (y_{2i} | I = 1; X) \quad \ldots(19)$$

Average Treatment effect on Treated = ATT

Average Treatment effect on Untreated = ATU

Equations (12) and (13) were further simplified as:

$$\mathrm{ATT} = \frac{1}{N_1}\sum_{i=1}^{N_1}[p\ (y_{1i} \mid I = 1; X) - p(\ y_{2i} \mid I = 1; X)] \quad \ldots(20)$$

$$\mathrm{ATU} = \frac{1}{N_2}\sum_{i=1}^{N^2}[\ p\ (\ y_{2i} \mid I = 0; X) - p(\ y_{1i} \mid I = 0; X)] \quad \ldots(21)$$

Where, N_1 and N_2 are number of participants and non-participants respectively and p = probability.

5. *Oaxaca-Blinder Decomposition model*

Following Marwa (2014); Revathy *et al.*(2020) the extent to which the yield gap between the treated and untreated farmers can be explained by differences in observed capital resources estimated using the standard Oaxaca-Blinder procedure (Oaxaca 1973; Blinder 1973) is as follows:

$$ln\bar{Y}_T = \beta_{T0} + \beta_{Ti}\sum_{i=1}^{i} X_T + \varepsilon_T \quad \ldots(22)$$

$$ln\bar{Y}_{NT} = \beta_{NT0} + \beta_{NTi}\sum_{i=1}^{i} X_{NT} + \varepsilon_{NT} \quad \ldots(23)$$

Where,

$\overline{Y}_T$ = *average yield of treated group;*

$\overline{Y}_{NT}$ = *average yield of non-treated group;*

X_{i-n} = *explanatory variables;*

β_0 = *intercept;*

β_{i-n} = *parameter estimates; and,* ε_i = *stochastic term.*

The Oaxaca-Blinder decomposition as cited by Revathy *et al.*(2020), equations 22 and 23 can be explained as follow:

$$\begin{aligned}(ln\bar{Y}_T - ln\bar{Y}_{NT}) = (\beta_{T0} - \beta_{NT0}) &+ [\beta_{T1}(\bar{X}_{T1} - \bar{X}_{NT1}) + \beta_{T2}(\bar{X}_{T2} - \bar{X}_{NT2}) \\ &+ \beta_{T3}(\bar{X}_{T3} - \bar{X}_{NT3}) + \beta_{T4}(\bar{X}_{T4} - \bar{X}_{NT4}) \\ &+ \beta_{Tn}(\bar{X}_{Tn} - \bar{X}_{NTn})] + [\bar{X}_{NT1}(\beta_{T1} - \beta_{NT1}) \\ &+ \bar{X}_{NT2}(\beta_{T2} - \beta_{NT2}) + \bar{X}_{NT3}(\beta_{T3} - \beta_{NT3}) \\ &+ \bar{X}_{NT4}(\beta_{T4} - \beta_{NT4}) + \bar{X}_{NTn}(\beta_{Tn} - \beta_{NTn}) \\ &+ (\varepsilon_T - \varepsilon_{NT})\end{aligned} \quad \ldots(24)$$

The yield gap is divided into two segments: one is the proportion attributable to differences in the endowments of income-generating activities ($\overline{X}_T - \overline{X}_{NT}$) evaluated at the treated group returns (β_T). This is taken as a reflection of endowment differential and it's termed endowment or explained effect. The second segment is attributable to the difference in the returns ($\beta_{Tn} - \beta_{NTn}$) that the treated and untreated groups get for the same endowment of income-generating activities ($\overline{X}_{NT}$). This segment is often taken as a reflection of discrimination or income differential and its termed discrimination/structural/unexplained effect.

RESULTS AND DISCUSSION

Enterprise Risk Analysis/Enterprise Risk Managerial Efficiency between the IFAD Group and Non-IFAD Groups

The enterprise net income risk analysis results for both the whole farm and individual enterprises are shown in Table 2. The net income for the whole farm ranges from a negative ₦ 55999.28 to a positive ₦ 2166858.12, with a positive ₦ 715204.32 being the most likely net income across all the enterprises (Table 2c). Besides, the net cash income ranges between a positive value of ₦ 158136.01 and ₦ 2380993.41, with the most likely net cash income at ₦ 929339.61 across all the enterprises. All the enterprises had a positive net income cum net cash income for the most likely outcome with the income of IFAD participants been higher that of the both non-treated groups. The most likely net income cum net cash income for the treated group is ₦ 361821.30 and ₦ 424485.08 respectively; while that of the spill-over group and the control group are ₦ 212608.66 and ₦ 277282.67, and, ₦ 140774.36 and ₦ 227571.86, respectively; thus making the net income cum net cash income of the treated group to be higher than that of the spill-over and control groups by 41.24% and 34.68%; and 61.09% and 46.39%, respectively.

Table 2a: Rice cost of cultivation

Variable	Qty in kg/litre			Unit price (₦)	Cost (₦)			
	Treated	Control	Spill-over		Treated	Control	Spill-over	Total
Qty (min.)	1500	1000	1500	100				
Qty(max.)	5250	4500	4821.43	180				
Qty (mean)	3622.864	2223.16	2519.718	140	507201	311242.5	352760.6	1171204
GFR					**507201**	**311242.5**	**352760.6**	**1171204**
Seed	39.04648	58.38359	70.92488	250	9761.62	14595.9	17731.22	42088.74
NPK fertilizer	173.6159	115.6514	126.7289	130	22570.06	15034.68	16474.76	54079.5
Urea	95.69378	82.93124	93.60658	140	13397.13	11610.37	13104.92	38112.42
Herbicides	3.732057	4.73663	3.589176	1600	5971.292	7578.609	5742.681	19292.58
Family labour	51.4566	78.91777	55.18432	750	38592.45	59188.33	41388.24	139169
Hired labour	34.68776	39.80144	23.23247	750	26015.82	29851.08	17424.35	73291.25
Lease				5000	5000	5000	5000	15000
Depreciation				1	3135.817	2794.552	3149.859	**9080**
Mgt. cost					11630.84	13785.9	11186.62	36603.35
Interest rate					9304.67	11028.72	8949.294	29282.68
TFE-cash					**82716**	**83671**	**75478**	**241865**
TFE-NC					62664	86798	64674	214135
GFE					**145380**	**170468**	**140152**	**465000**
NFI					361821	140774	212609	715204

Source: *Field survey, 2018; Note: NFI = Net farm income; GFR = Gross farm revenue; GFE = Gross farm expenses; TFE = Total farm expenses; NC = Non-cash; Management (Mgt.) cost = 10% of TVC; Interest rate = 8% of TVC; Qty = Quantity; ₦ = Naira currency*

Table 2a: Continued………… Unit price (₦)

Variable	Min	Max
Seed	100	400
NPK fertilizer	80	180
Urea	110	170
Herbicides	1000	2200
Family labour	500	1000
Hired labour	500	1000

Table 2b: Farm revenue

Farm revenue	Whole farm	Treated group	Control group	Spill-over group
Total farm income- cash	171204.00	507201.00	311242.50	352760.00
Total non-cash income adjustments				
Gross farm revenue	171204.00	507201.00	311242.50	352760.00
Farm expenses				
Farm expenses-cash	241865.00	82715.92	83670.64	75477.93
Farm expenses-non-cash expense adjustments	214135.00	62663.78	86797.50	64674.01
Gross farm expenses	456000.00	145379.70	170468.14	21608.66
Net Farm Income	**715204**	**361821.30**	**212608.66**	**140774.36**

Source: *computer print-out, 2018.*

Table 2c: Net income risk analysis

Net Income Risk Analysis	Whole farm	Treated group	Control group	Spill-over group
Net enterprise-cash income				
Minimum	158136.01	67284.68	16329.46	74521.87
Most likely	929339.61	424485.08	227571.86	277282.67
Maximum	2380993.41	862284.68	726329.46	792379.27
Net enterprise revenue				
Minimum	(55999.28)	4620.90	(70468.04)	9847.86
Most likely	715204.32	361821.30	140774.36	212608.66
Maximum	2166858.12	799620.90	639531.96	727705.26

Source: *computer print-out, 2018.*

For the minimum estimate, the enterprises of treated and the spill-over groups recorded a positive net income cum net cash income while the enterprise of the control group recorded a negative net income and a positive net cash income. For the maximum estimates, all the enterprises recorded a positive net income cum net cash income.

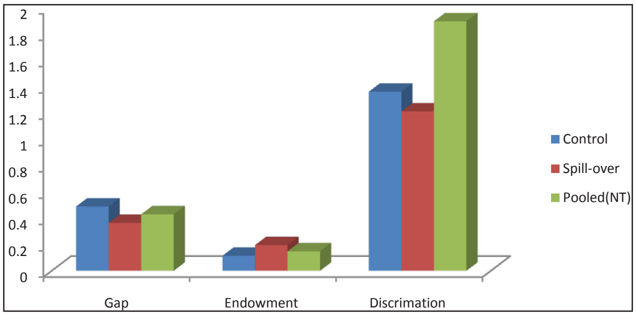

Fig. 1: Yield Decomposition Gap

On a whole farm basis, the rice enterprise is most likely to earn a net return between a positive ₦ 684950 (p = 0.073) and a positive ₦ 759050 (p= 0.073) on a net income basis, and between a positive ₦ 899090 (p = 0.073) and a positive ₦ 973180 (p = 0.073) on a net cash income basis. For the IFAD enterprise, the technical unit is most likely to generate a net income cum net cash income between a positive ₦ 349120 (p = 0.073) and a positive ₦ 375620; and a positive ₦ 411780 (p = 0.073) and a positive ₦ 438280 (p = 0.072), respectively. In addition, for the spill-over group, a technical unit is most likely to generate a net income cum net cash income between positive values of ₦ 201280 (p = 0.074) and ₦ 225210 (p = 0.074); and, ₦ 265950 (p = 0.074) and ₦ 289880 (p = 0.074), respectively. Lastly, for the control group, a technical unit is most likely to earn a net income cum net cash income between a positive values of ₦ 142530 (p = 0.074) and ₦ 166200 (p = 0.073); and, ₦ 229330 (p=0.074) and ₦ 253000 (p = 0.073), respectively.

Evaluating Break-Even Analysis between the IFAD Group and Non-IFAD Groups

A cursory review of the results showed that for the treated group, the most likely break-even price of rice per kg is ₦ 40.13 to cover gross expenses and ₦ 22.83 to cover only cash expenses. For the control group, the most likely break-even prices of rice per kg are ₦ 55.62 and ₦ 29.95 respectively, to cover gross expenses and only cash expenses for the former and latter. Also, for the control group, the most likely break-even prices to liquidate both the gross expenses and only cash expenses are

₦ 76.68 and ₦ 37.64 respectively. Since the break-even price represents the cost of production, thus it can be inferred that the treated group had the lowest cost of production, thus the most efficient technical unit (Table 3).

Table 3: Break-even price (BEP) analysis

Yield per enterprise unit	Treated group	Control group	Spill-over group
Minimum	1500	1000	1500
Most likely	3622.86	2223.16	2519.72
Maximum	5250	4500	4821.43
BEP- Cash expenses			
Minimum	15.76	18.59	15.65
Most likely	22.83	37.64	29.95
Maximum	55.14	83.67	50.32
BEP- Gross expenses			
Minimum	27.69	37.88	29.07
Most likely	40.13	76.68	55.62
Maximum	96.92	170.47	93.43

Source: *Computer print-out, 2018.*

Furthermore, the results showed the break-even yield for the treated both for the net income and net cash income bases to be 1038.43kg and 590.83kg respectively. For the spill-over group and the control group, their break-even yields at net income cum net cash income are 1001.09kg and 539.13kg; and, 1217.63kg and 597.65kg, respectively. On the basis of break-even yield, it can be inferred that the impact of the programme made the treated group to have a higher break-even yield that the non-treated groups (Table 4).

Table 4: Break-even yield (BEY) analysis

Price per enterprise unit	Treated group	Control group	Spill-over group
Minimum	100	100	100
Most likely	140	140	140
Maximum	180	180	180
BEY- Cash expenses			
Minimum	459.53	464.84	419.32
Most likely	590.83	597.65	539.13
Maximum	827.16	836.71	754.78
BEY- Gross expenses			
Minimum	807.67	947.05	778.62
Most likely	1038.43	1217.63	1001.09
Maximum	1453.80	1704.68	1401.52

Source: *Computer print-out, 2018.*

Probability analysis is another important ERA feature for evaluating enterprise performance; allowing the farmers to examine the likelihood of various price and yield levels to cover either only cash or gross (cash and non-cash) expenses or both. The probability curve shows the probability of breaking even at a given price or yield for a technical unit. Examining the rice technical unit of the treated group, the result shows that there is a 51% probability of breaking even at approximately ₦ 46.15 per kg for gross expenses and ₦ 26.26 per kg for cash expenses. For the spill-over group and the control group, the probability of breaking even at ₦ 59.11 per kg for gross expenses and ₦31.83 per kg for cash expenses is 57%; and, the tendency of breaking even at ₦ 86.50 per kg for gross expenses and ₦ 42.46 per kg for cash expenses is 54%, respectively.

Furthermore, on the yield basis, for the treated group, the result reveals that there is 51% probability of breaking even at 1066.10kg for gross expenses and 606.6kg for cash expenses. While for the spill-over and the control group, the results indicate that there is 51% probability of breaking even at 1027.8 kg for gross expenses and 553.5kg for cash expenses; and, 1250.10 kg for gross expenses and 613.60kg for cash expenses, respectively. Therefore, from the above findings, for risk management strategy, in order to improve the chances of enhancing the breaking even, the treated group should increase their insurance coverage and adjust their production structural pattern, while the non-treated groups should adjust their level of production.

Summary of the Productive Resources

On per hectare basis, given that the treatment group used improved rice seed variety, the quantity of seed utilization was lower (39.1kg) than that of the non-treatment group by (64.17kg) (Table 2a). In addition, access to adequate supply of inorganic fertilizer for increased productivity makes the quantity utilized by the treatment group to be higher than that of the non-treatment group. The reason for the adequate access is due to the facilitating functions of the IFAD programme: linking the treatment group with the input supplier i.e. backward market linkage, thus gives them pecuniary advantage of bulk discount; and, credit provisions. Furthermore, on the average, the quantity of the rice productivity of the treatment group was higher than that of the non-treatment group by 34.86%. Therefore, it can be suggested that the programme support *viz*. technical and financial services made the treatment group to have head advantage in respect of access to adequate tradable inputs and yield than the non-treatment group.

Determinants of Production vis-à-vis Treated Group and Non-Treated Groups

The results of the OLS estimation was inefficient to make the best fit functional forms to be a classical normal regression given that they failed the test of homoscedasticity, thus the weighted least square (WLS) estimation was applied and the best fit functional forms became a classical normal regression (Table 5). Therefore, it suffice that the chosen functional forms *viz.* linear for the treated group, control group and pooled (non-treatment); and, double logarithm for the spill-over group were reliable for predictions with certainty and accuracy.

The coefficients of multiple determination for the treated group, control group, spill-over group and pooled (non-treated) were 0.7908, 0.6796, 0.7623 and 0.6223 respectively. Thus, it implies that 79.08%, 67.96%, 62.23% and 62.23% of the variation in the output of the treated, control, spill-over and pooled (non-treated) groups were influenced by the inputs captured in their respective models while the disturbed economic reality accounts for the remaining percentages.

The results showed that the output of the treated group was significantly influenced by NPK fertilizer, human labour and farm size as evident by their respective parameter estimates which were different from zero at 10% degree of freedom. In addition, all these significant variables had positive effect on the rice output of the participants, thus an indication of rational application of these productive resources.

Table 5a: Weighted least square (WLS) production estimates

Variable	Coefficient	t-stat	VIF(10.0)	Coefficient	t-stat	VIF(10.0)
	Treated Group (linear+)			Control Group (linear+)		
Intercept	66.271(389.73)	0.170^{NS}		949.57(273.14)	3.476***	
Seed	6.8045(4.992)	1.363^{NS}	2.817	-5.4721(2.608)	2.098**	2.461
NPK fertilizer	7.70259(2.111)	3.650***	3.039	-0.1825(1.573)	0.116^{NS}	1.716
Urea	0.544047(4.225)	0.128^{NS}	3.413	-1.7619(1.309)	1.345^{NS}	1.629
Herbicides	-102.869(75.59)	1.361^{NS}	2.526	28.447(38.21)	0.744^{NS}	3.077
Family labour	8.1351(2.506)	3.245***	2.483	-2.7482(0.9747)	2.819***	2.175
Hired labour	7.66875(3.237)	2.369**	1.266	5.3272(2.651)	2.010**	1.549
Depreciation	-0.00474(0.068)	0.069^{NS}	2.288	0.1504(0.0426)	3.524***	1.793
Farm size	1650.59(463.12)	3.564***	3.988	1498.31(262.73)	5.703***	4.577
R^2	0.7908			0.6796		
F-stat	47.73[5.8e-31]***			23.06[1.6e-18]***		
Normality test	16.41[2.7e-4]***			1.77[0.41]^{NS}		
	Spill-over Group(double-log+)			Pooled (Non-Treated) (linear +)		
Intercept	7.118(0.572)	12.43***		710.12(218.15)	3.255***	
Seed	-0.03725(0.0599)	0.621^{NS}	1.428	-4.20837(1.975)	2.131**	1.757
NPK fertilizer	0.047852(0.0563)	0.849^{NS}	2.084	1.36689(1.137)	1.202^{NS}	1.822
Urea	0.019643(0.0545)	0.359^{NS}	1.755	0.519244(1.117)	0.464^{NS}	1.599
Herbicides	0.127301(0.0640)	1.989*	1.917	31.9118(34.05)	0.937^{NS}	2.672
Family labour	0.157141(0.0701)	2.243**	1.578	-3.40184(0.967)	3.515***	1.964
Hired labour	0.033183(0.0299)	1.108^{NS}	1.285	0.834399(2.205)	0.378^{NS}	1.255
Depreciation	-0.04316(0.0627)	0.687^{NS}	1.408	0.062735(0.0312)	2.007**	1.437
Farm size	0.722966(0.0955)	7.564***	2.376	1787.62(214.83)	8.321***	3.576
R^2	0.7623			0.6201		
F-stat	32.0[6.2e-22]***			35.9[3.0e-33]***		
Normality test	1.87[0.39]^{NS}			45.1[1.5e-10]***		

Source: *Field survey, 2018*

Note: **** ** * ^{NS} means significant at 1%, 5%, 10% & Non-significant, respectively.*

Figures in ( ) and [ ] are standard error and probability level, respectively

Table 5b: Marginal physical product (MPP) and Elasticity (EP) estimates

Variable	Treated Group		Control Group		Spill-over Group		Pooled (NT) Group	
	MPP	EP	MPP	EP	MPP	EP	MPP	EP
Seed	6.80454	0.073338	-5.47209	-0.1437	-1.32342	-0.03725	-4.20837	-0.11443
NPK fertilizer	7.70259	0.369128	-0.18253	-0.0095	0.951413	0.047852	1.36689	0.069944
Urea	0.544047	0.01437	-1.76189	-0.06572	0.528781	0.019643	0.519244	0.019399
Herbicides	-102.869	-0.10597	28.4469	0.060608	89.37064	0.127301	31.9118	0.056891
Family labour	8.1351	0.115545	-2.74815	-0.09755	7.175158	0.157141	-3.40184	-0.09797
Hired labour	7.66875	0.073426	5.32719	0.095372	3.598891	0.033183	0.834399	0.011369
Depreciation	-0.00474	-0.0041	0.150429	0.18909	-0.03452	-0.04316	0.062735	0.078645
Farm size	1650.59	0.455604	1498.31	0.673946	1821.734	0.722966	1787.62	0.757442

Source: *Field survey, 2018.*

Despite cultivating rice on a small-scale basis, the farmers had pecuniary advantage *viz*. economies of scale. However, the non-significant of the improved seed, urea and herbicides indicate insufficient dosage application owing to poor productivity of capital despite the programme credit support; while that for the depreciation on capital items revealed rudimentary of the farm implements used in the cultivation process. The marginal and elasticity implications of a unit increase in NPK fertilizer, family labour, hired labour and farm size would lead to an increase in output by 7.70kg and 0.37%; 8.14kg and 0.12%; 7.67kg and 0.07%; and, 1650.59kg and 0.46%, respectively.

The rice output of the controlled group was significantly influenced by seeds, human labour, depreciation on capital items and farm size as indicated by their respective parameter estimates which were within the plausible margin of 10% degree of freedom. In addition, seeds and family labour decreased the output level of rice; while hired labour and a host of the remaining significant variables increased the output level of rice. The marginal and elasticity implications of a unit increase in seeds and family labour would decrease output by 5.47kg and 0.14%; and, 2.75kg and 0.10% respectively, while a unit increase in hired labour, depreciation on capital items, and farm size would increase output by 5.37kg and 0.10%; 0.15kg and 0.19%; and, 1498.31kg and 0.67% respectively. Therefore, it can be inferred that the farmers used local seed varieties and excess of family labour was deployed on the rice farms, thus affecting rice output. The meticulous use of hired labour due to its cost implication i.e. it is not free and cheap; pecuniary advantage *viz.* economies of scale despite been smallholder; and, replacement and judicious use of rudimentary tools of cultivation increased the farmers' output.

In the case of the spill-over group, the farmers' output level was significantly influenced by herbicides, family labour and farm size as evidenced by their respective parameter estimates which were within the acceptable margin of 10% degree of freedom. In addition, it was observed that these significant inputs increased the output level of rice, thus indicating adequate utilization of these productive resources. Thus, the marginal and elasticity implications of a unit increase in herbicides, family labour and farm size would increase output by 89.37kg and 0.13%; 7.18kg and 0.16%; and, 1821.73kg and 0.72% respectively. Therefore, it can be inferred that herbicides was adequate and it was applied based on the recommended dosage to substitute the manual drudgery of weeding; and the excess labour which is common to a typical traditional farming setting in the studied area was channeled into alternative use, thus increasing rice output. In addition, despite that the farmers cultivated rice on a small-scale basis, they benefitted from the economies of scale.

For the pooled (non-treated) group, it was observed that the rice output level was significantly influenced by seed, family labour, depreciation on capital items and farm size as indicated by their respective coefficients which were within the acceptable margin of 10% degree of freedom. In addition, the use of local seed varieties and excess of family labour because it is free, they tends to have a negative effect on the output level. Despite the fact that the farmers produce rice on a small-scale basis, they tend to benefit from economies of scale. In addition, despite that the farmers used primitive implements to cultivate rice, their output level increased. Therefore, the marginal and elasticity implications of a unit increase in seed and family labour will lead to a decrease in output by 4.21kg and 0.11%; and, 3.40kg and 0.10% respectively, while a unit increase in depreciation on capital items and farm size will lead to an increase in output by 0.06kg and 0.08%; and, 1787.62kg and 0.76% respectively.

Despite the non-programme intervention, the non-treated groups were efficient managers while the treatment groups inspite of the technical and financial supports, they were not efficient managers as indicated by the significant and non-significant of the managerial efficiency parameters of the former and latter, respectively. The non-significant of the treated group may be largely due to inadequate economic capital as well as social capital.

Effect of IFAD on Participating Farmers' Production

A perusal of the Table 6 showed that the programme had effect on the output of the participating farmer when compared to that of their counterparts in control, spill-over and the pooled (non-treated) groups as indicated by the significance of their respective Chow F-statistics which were different from zero at 1% degree of freedom. In addition, the empirical evidence confirmed the presence of heterogeneity in the slopes of the production between the treated group vis-à-vis the non-treated groups as evidenced by the significance of their respective Chow F-statistics at 1% probability level. This implies that the slopes of the production functions are heterogeneous i.e. different and not homogenous. The heterogeneity of the slopes indicates that the production functions are factor-biased. Therefore, it can be inferred that the programme brought about a structural change in the production process of the treated group. In addition, there is a shift in the production attitude of the participating farmers. It was observed that there is heterogeneity i.e. differences between the intercepts of the treated and untreated as indicated by the significance of the Chow F-statistics at 10% degree of freedom. Therefore, it can be inferred that the programme made the attitude of the participants *viz*. the technological practices of the treated group to be different from that of the non-treated group. This confirmed the earlier submission which revealed that the participating farmers were not managerially efficient as compared to their counterparts (non-treated) group, thus indicating complexity in the comprehension of the programme technological practices. Thus, the programme should harp more on their technical services so as to ease the use of these technological practices.

Impact of IFAD Programme on Participating Farmers' Yield

A perusal of Table 7 on the impact of the programme on the yield between the treated group and the control group showed that the ATE and the ATET coefficients for all the estimation methods were within the acceptable margin of 10%, thus indicating that the programme had impact on the yield of the participating farmers both between and within,

Table 6: Effect of IFAD rice programme on farmers' yield

Items	ESS	DF	Test	F-stat	ESS	DF	Test	F-stat
	Treated group vs. Control group				**Treated vs. Spill-over**			
Treated	6.83E+08	109			6.83E+08	109		
Non-treated	4.07E+09	95	I	-204.0***	13.49943	88	I	-197.0***
Pooled	17.28586	204	II	-1340.0***	10.94338	198	II	-132.0***
Pooled with dummy	2.69E+08	204	III	-204.0***	2.26E+08	198	III	-198.0***
	Treated vs. Pooled (Non-treated)							
Treated	6.83E+08	109						
Non-treated	1.05E+10	184	I	-293.0***				
Pooled	22.7452	294	II	-4660.0***				
Pooled with dummy	3.28E+08	294	III	-294.0***				

Source: *Field survey, 2018*

Note: *ESS, DF, I, II & III means Error sum of square, Degree of freedom, Test for Effect of the programme, Test for Homogeneity of slope and Test for differences in intercepts, respectively.*

Note: **** ** * & NS means significant at 1%, 5%, 10% & Non-significant, respectively.*

Table 7: Impact of IFAD rice programme on farmers' yield

Items	Regression Adjustment		Nearest –neighbor matching		Propensity score matching	
	Treated group vs. Control group					
ATE	1136.18(138.91)	8.18***	1219.99(93.07)	13.11***	1332.77(128.62)	10.36***
ATET	1088.84(103.38)	10.53***	1130.39(107.08)	10.56***	1028.37(182.21)	5.64***
Treated (Mean)	3595.86(126.10)	28.52***				
Untreated (Mean)	2459.67(63.78)	38.57***				
	Treated vs. Spill-over					
ATE	838.86(191.13)	4.39***	1104.79(104.24)	10.60***	929.82(236.82)	3.93***
ATET	987.79(179.20)	5.51***	1097.89(108.08)	10.16***	738.10(376.27)	1.96***
Treated (Mean)	3456.38(157.39)	21.96**				
Untreated (Mean)	2617.52(109.89)	23.82***				
	Treated vs. Pooled (Non-treated)					
ATE	988.17(181.78)	5.44***	1142.93(95.98)	11.91***	1367.32(170.45)	8.02***
ATET	1081.41(99.63)	10.85***	1066.82(114.34)	9.33***	1097.33(108.06)	10.15***
Treated (Mean)	3475.11(175.75)	19.77***				
Untreated (Mean)	2486.94(49.38)	50.35***				

***Source:** Field survey, 2018.*

***Note:** ATE and ATET means Average treatment effect and Average treatment effect on treated, respectively.*

***Note:** *** ** * & NS means significant at 1%, 5%, 10% & Non-significant, respectively.*

Figure in ( ) is standard error.

respectively. Thus, programme participation made the yield of the treated group to be higher than that of the control group by 1136.18kg as revealed by the ATE regression adjustment coefficient.

Between the treated group and the spill-over group, the programme had impact on the yield of the participating farmers both between and within as revealed by the ATE and the ATET coefficients for all the estimation methods respectively, which were different from zero at 10% degree of freedom. The impact of the programme made the yield of the participating farmers to be higher than that of the spill-over group by 838.86kg as evident by the ATE regression adjustment coefficient.

Furthermore, between the treated group and the pool (non-treated) group, it was observed that the programme impacted on the yield of the treated group as evident by the significant of the ATE and ATET coefficients for all the estimation methods at 10% probability for between and within, respectively. Thus, the impact of the programme made the productivity of the treated group to be higher by 988.17kg than that of the pool (non-treated) group.

Generally, it can be inferred that participation in the programme made the yield of the participating farmers to be higher and different from that of the non-treated groups; while participation intensity results in higher and differed yield level within the treated group. Thus, the programmee has improved the rice food security of the participating farmers.

Yield Differential between the Treated Group and Non-Treated Groups

Shown in Table 8 are the individual variables absolute contributions to the total yield differentials between the treated group and non-treated groups *viz.* control, spill-over and the pooled (non-treated).

For the treated group versus the control group, it was observed that resource endowment factors *viz.* NPK fertilizer, urea fertilizer, herbicides and farm size contribute favourably to the yield level of the treated group; while seed, family labour, hired labour and depreciation on capital items favoured the yield level of the control group. Furthermore, the contribution of the productive resources toward the yield differential between the two groups arose due to the differences in the parameter estimates of the predictor variables. The structural factors *viz.* seed, NPK fertilizer, urea and family labour favoured the production level of the treatment group; while herbicides, hired labour, depreciation on capital items and farm size favoured the yield level of the control group.

Table 8: Yield Differentials between IFAD participants and Non-participants

Items	Treated	Control	Spill-over	Pool (NT)	$\overline{X}_T$	$\overline{X}_C$	$\overline{X}_S$	$\overline{X}_P$
Constant	6.01221	6.81949	7.11822	6.57742				
Seed	0.073338	-0.14371	-0.07488	-0.11443	3.949932	4.325787	4.44113	4.382938
NPK fertilizer	0.369126	-0.0095	0.016614	0.069945	5.442024	5.009332	5.021559	5.015233
Urea	0.01437	-0.06572	-0.01421	0.019398	4.846332	4.676764	4.718609	4.700638
Herbicides	-0.10597	0.060609	0.136481	0.056891	1.602139	1.814078	1.457431	1.658225
Family labour	0.115545	-0.09755	0.124339	-0.09797	4.225918	4.627158	4.190187	4.440458
Hired labour	0.073426	0.095373	0.046819	0.01137	3.831566	3.942655	3.325059	3.692059
Depreciation	-0.0041	0.189092	-0.01736	0.078645	8.335824	8.194179	8.234622	8.213839
Farm size	0.455604	0.673955	0.758314	0.757474	0.285179	0.258752	0.179509	0.221412
Yield					**3622.864**	**2223.16**	**2519.718**	**2359.974**
lnYield					**8.19502**	**7.706685**	**7.831902**	**7.766406**
Yield Gap						**1399.704**	**1103.146**	**1262.89**
lnYield Gap						0.488335	0.363118	0.428614

Source: *Field survey, 2018.*

Table 8: Continued ………..

Items	$\beta_T(\overline{X}_T – \overline{X}_C)$	$\beta_T(\overline{X}_T – \overline{X}_S)$	$\beta_T(\overline{X}_T – \overline{X}_P)$	$\overline{X}_C(\beta_T – \beta_C)$	$\overline{X}_S(\beta_T – \beta_S)$	$\overline{X}_P(\beta_T – \beta_P)$
Constant				-0.80728	-1.10601	-0.56521
Seed	-0.02756	-0.03602	-0.03175581	0.938883	0.658244	0.822969
NPK fertilizer	0.159718	0.155204	0.15753952	1.896639	1.77016	1.500461
Urea	0.002437	0.001835	0.002093676	0.374584	0.13488	-0.02364
Herbicides	0.022459	-0.01533	0.005943465	-0.30219	-0.35335	-0.27006
Family labour	-0.04636	0.004128	-0.02478915	0.986043	-0.03685	0.948127
Hired labour	-0.00816	0.037191	0.010243405	-0.08653	0.08847	0.229115
Depreciation	-0.00058	-0.00042	-0.00050034	-1.58306	0.109168	-0.67967
Farm size	0.01204	0.048144	0.029052303	-0.0565	-0.05434	-0.06684
Endowment Difference	**0.11399**	**0.19473**	**0.147827065**			
Discrimination Difference				1.360592	1.210371	1.89526
Overall yield diff.				**1.474582**	**1.405101**	**2.04308687**
%	**7.730324**	**13.85877**	**7.235476217**	**92.26968**	**86.14123**	**92.76452**
Contr. Gap (Yield)	**108.2016**	**152.8824**	**91.37610335**	**1291.502**	**950.2633**	**1171.514**
Without Discrimination				**3514.662**	**3469.982**	**3531.488**
% of Discrimination in AY				**58.09306**	**37.71308**	**49.64096**
Firm Discrimination				0.150221		

Source: *Field survey, 2018.*

Note: *AY = Actual yield.*

A cursory review of the results showed that 92.27% of the yield differential between the treated group and the control group was largely due to structural effect called programme participation; while the endowment effect *viz*. resources accounted for 7.73%. With an average yield of 3622.86kg and 2223.16kg for the treated and control groups respectively, the yield gap is 1399.70kg. Of the yield gap *viz*. 1399.70kg, the difference due to the superior resource endowment of the treated group accounted for 108.20kg; while the difference due to the participation in the programme accounted for 1291.50kg. This implies that due to the structural difference, the control group lost 1291.50kg per hectare. The value of the discrimination represents 58.09% of the average actual yield of the control group. Given the inputs at the disposable of the control group, the result showed that without the structural difference their average actual yield should be 3514.66kg. The results showed the estimated yield gap to be 48.83% (i.e. $ln\overline{Y}_T – ln\overline{Y}_C$ = 0.4883), the resource endowment effect was 11.39% [i.e. $(\overline{X}_T – \overline{Y}_C)\ \hat{\beta}_T$ = 0.1139] and the discrimination effect was 136.06% [i.e. $\left(\hat{\beta}_T - \hat{\beta}_C\right)\overline{X}_C = 1.3606$](Fig. 1).

For the treated group versus the spill-over group, the resource endowment factors *viz*. NPK fertilizer, urea fertilizer, family labour, hired labour and farm size favoured the output level of the treated group; while seed, herbicides and farm size favoured the output level of the spill-over group. However, the contribution of the inputs toward the yield gap between the two groups is largely due to the differences in the coefficients of the controlled variables. The empirical evidences showed structural factors *viz*. seed, NPK fertilizer, urea fertilizer, hired labour and depreciation on capital items favoured the yield level of the treated group; while herbicides, family labour and farm size favoured the yield level of the spill-over group.

Furthermore, it was observed that structural difference *viz*. participation in the programme was responsible for 86.14% yield differential between the two groups while 13.86% is attributed to endowment difference *viz*. inputs. For average productivities of 3622.86kg and 2519.72kg for the treated group and spill-over group respectively, their productivity gap is 1103.15kg. Of the total yield gap of 1103.15kg, the superior resource endowment of the treated group accounted for 152.88kg while participation in the programme accounted for 950.26kg. Thus, this implies that due to non-participation in the programme by the spill-over group, they lost 950.26kg of rice output. The discrimination effect represents 37.71% of the average actual yield of the spill-over group. Thus, in the absence of structural difference, the yield of the spill-over group should be 3469.98kg. The yield gap was observed to be 36.31% (i.e. $ln\overline{Y}_T – ln\overline{Y}_S = 0.3631$), the resource endowment effect was 19.47% [i.e. $(\overline{X}_T – \overline{X}_S)\ \hat{\beta}_T = 0.1947$] and the structural effect was 121.04% [i.e. $\left(\hat{\beta}_T - \hat{\beta}_S\right)\overline{X}_S = 1.2104$](Fig. 1).

Between the treated group and the pool (non-treated) group, NPK fertilizer, urea fertilizer, herbicides, hired labour and farm size were the endowed resources that contributed favourably to the yield of the treated group; while seed, family labour and depreciation on capital items were the resource endowments that contributed favourably to the yield of the pooled group. Furthermore, the contribution of the inputs used towards the yield differential was majorly due to the differences in the coefficients of the independent variables. Thus, structural difference due to seed, NPK fertilizer, family labour and hired labour favoured the yield of the treated group; while urea fertilizer, herbicides, depreciation on capital items and farm size favoured the yield of the pool non-treated group.

It was observed that 92.77% of the yield differential was due to structural difference while the resource endowment accounted for 7.24%. Given an average yield of 3622.86kg and 2359.97kg for the treated and pooled (non-treated) groups respectively, the resultant yield gap is 1262.89kg. Out of the 1262.89kg, 1171.51kg and 91.38kg owed to programme participation and superior resource endowment respectively, of the treated group. Therefore, it means that the pooled (non-treated) group lost 1171.51kg of rice output due to non-participation in the programme. The structural effect accounts for 49.64% of the average actual productivity of the pooled (non-treated) group. However, without structural difference, the yield of the pooled (non-treated) group should be 3531.48kg. The results showed the yield gap to be 42.86% (i.e. $ln\overline{Y}_T – ln\overline{Y}_P = 0.4286$), the resource endowment effect was 14.78% [i.e. $(\overline{X}_T – \overline{X}_P)\ \hat{\beta}_T = 0.1478$] and the structural effect was 189.53% [i.e. $\left(\hat{\beta}_T - \hat{\beta}_P\right)\overline{X}_P = 1.8953$ (Fig. 1).

Generally, it can be inferred that the overall gap in the yield level between the treated group and untreated groups is attributed to participation in the programme i.e. structural difference. In addition, the yield gap that can be explained by differences in the covariates vis-à-vis the treated versus untreated groups were positive, meaning the non-treated groups have less characteristics associated with higher productivity. Furthermore, with the difference of the unexplained gaps between control and spill-over groups being 0.15, it can be inferred that the control group suffered from only non-participation discrimination, while the spill-over group suffered from both firm and non-participation discriminations. The positive difference-in-difference estimate conforms to the *a priori* expectation.

CONCLUSION AND RECOMMENDATIONS

Based on the empirical evidence, it can be inferred that the technical unit of the treated group is more efficient owing to low break-even price i.e. cost of production and high break-even yield. Thus, the participating farmers are efficient in managing their enterprise risk. Furthermore, both in the short-run and long-run, the programme had effect on the yield of the participating farmers. In addition, disparity in the yield of the treated group been higher than that of the non-treated groups, majorly owed to the structural difference called participation in the programme. Therefore, the following recommendations were made:

For risk management strategy; the participating farmers should increase their insurance coverage and adjust their production plan so as to increase their chances of breaking even in rice production.

This programme should be extended to the non-participating areas in order to maximize their potentials, thus enhancing the livelihood and rice food and nutrition securities of the farming households in particular, and that of the rural, state and national economies in general.

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