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Evaluating the Effect of Farmers' Training on Rice Production in Sierra Leone: A Case Study of Rice Cultivation in Lowland Ecology

Alhaji M. H. Conteh, Xiangbin Yan, and M. E. S. Mvodo

Abstract**—**This study endeavors to evaluate the effects of farmers' training program on the adoption of improved farming practices, the output of rice farming, and the income as well as the profit from rice farming by employing an ex-post non-experimental data in Sierra Leone. It was established that participating in farmers' training program increased the possibility of adoption of the improved farming activities that were implemented in the study area. Through the training program also, the proceeds from rice production was also established to have increased considerably. These results were in line with the assumption that one of the main constraints on the growth in agricultural output particularly rice cultivation in most African states is the lack of efficient extension programs.

Keywords**—**Dissemination of information, improved farming practices, rice ecologies, Sierra Leone.

I.Introduction

CONTRARY to the spectacular achievement in increasing agricultural output in China and most Asia countries since the early 1980s, agricultural output has been mostly inactive in sub-Saharan Africa (SSA) particularly rice production. With continued human populationgrowth and increasing [1] annual rice consumption per capita, and large increases in the urbanpopulation of developing countries[2], the demand for ricehasbeenincreasing at a much fasterrate[3] than the domestic rice production, thus causing to a prolonged and persistent surge in importation of rice [4]. Global grain production did decline by 1.3 percent in 2006[5], and between 2008 and 2009, a sharp increase in domestic riceprices [6], has also lead to repeated cycles of foodinsecurity[7], especially among the poor countries in Africa. Rice is currently the most expensive cereal grain [8], which has huge possibility for increases in output in African countries. It is also the majority of one's marketablecrop at harvest [9] which is different from other staple crops usually grown in several African countries. Deliberate and cautious efforts to improve rice productivity are immediately needed for both food security and the generation of revenue from the sales of rice output, and this is the situation Sierra Leone is face with at the moment.

Alhaji M.H Conteh (corresponding author) is with the Management Scienceand Engineering, School of Management, Harbin Institute of Technology,Harbin 150001, China (phone: +86-18745735938, e-mail:hadjmannc90@yahoo.com).

Xiangbin Yan is with the Management Science and Engineering, School of Management, Harbin Institute of Technology,Harbin 150001, China (e-mail: xbyan@hit.edu.cn).

M.E.S. Mvodo is with the Business Administration Department,School of Management, Harbin Institute of Technology, Harbin, 150001, China (e-mail: mvodostephanie@gmail.com).

However, plans are on the way in several African states to improve availability of food by adopting deliberate policies [10].In terms of agro-ecosystems [11], the production of rice in the rainfed lowlands is measured to have the utmost possibility for productivity growth in Africa than those in the upland and irrigated areas. In the rainfedlowlandecosystem, the major factors accounting for yield gaps [12] are low soil fertility and fertilizer use; and poor weed management. Rainfedlowlands are characterized by lack of water control, with floods and drought [13]. Uplandecosystems have several heavy constraints, mainly related to weed and disease aggressiveness and low soil fertility [14] and are regarded as inappropriate for sustainable rice production and the cost of building irrigation facilities is usually high in African countries. Almost all the valley bases in African countries are damp and wet and, therefore, appropriate for plain or lowland rice farming. Furthermore, they have not been completely utilized or exploited, although they can also be used to produce rice sustainably with good organization practices. In actual fact, this is the major reason why the current development of the area under rice farming in some African countries has been intense in the rainfed lowlands areas. In the rainfed lowlandrice ecosystem [15], rice is grown per year because swamps are not developed and water flow is not controlled [16].Although many researchers opined that, the lowproductivity of rice production systems is mainly due to some persistent production constraints [17], others frequently disputed that the low output of lowland rice in many African countries is as a result of low input employ and the little adoption of improved varieties. Nevertheless, the fact that proper farming activities which are extensively used in some Asia countries are not frequently employed in many African countries has been largely overlooked. In many cases for instance, the seedlings are broadcasted, which frequently produces very low growth rate and as well makes it hard to preserve the correct spacing pattern. Even when transplanting of germinated plants is adopted, straight-line planting is not followed, thus failing to guarantee the necessary correct spacing pattern. Building bunds and leveling are not properly employed and hence, the water that is available is not stored squarely in the rice farms. Because unsuitable farming activities are widespread especially in northern Sierra Leone, the Sierra Leone Agricultural Research institute (SLARI) has instigated a project on lowland rice production in the region.

This project offers training facility to rice cultivators on lowland rice farming activities rooted in the Asian understanding.

However, in an effort to better understand the low rice production in lowland areas; this research endeavors to evaluate the effect of the farmers' training plan on the adoption of modern farming activities, the production of rice, and the earnings and profit of rice output by employing an ex-post non-experimental data. In view of the fact that the report and the number of impact evaluation researches on rural farming training schemes are inadequate, therefore, further research is warranted [18]. Whether these farmers' training project really leads to the spreading of improved production skills is hardly ever observed, since the thought of whether what is learned is in fact thoroughly practice. However, to develop control groups, the researchers employ Propensity Score Methods for Non-Experimental data [19], sincethe type of farming project the authors assess in this study does not costume the situation of a randomized control trial, given that the preeminent farming activities that are carried out in Sierra Leone are dissimilar across regions with diverse agro ecological and socioeconomic situation, which also resulted in dissimilar responds to interventions.

Besides the estimation of the average treatment effect on the treated[20] the study as well look at the way the farming practices change as a result of the rural farming training schemes by estimating the adoption utility of modern farming activities with weighted least squares.

The subsequent sections of this article are prearranged as follows. Section II shows the actual situation of rice production in the lowland ecologies in Sierra Leone and the characteristics of the training programs. Section III gives a detail of the data collection between April and October, 2012 and gives the descriptive statistics. Section IV, involves the techniques to assess the effect of the training project and are clearly elucidated. Section V explains the empirical results and last piece of this article is a clear presentation of the policy implications regarding lowland rice production and the farmers' training scheme in Sierra Leone.

II.The Rice Production in Lowland Ecologies and the Farmers' Training Scheme in Sierra Leone

A.Rice Production in Lowland Ecologies

In SierraLeone, inland swamps that remain inundated until late in the dry season are extremely important to the rice-based [21]. About 10% of the country is covered by swampland in valley bottoms, which are predominantly appropriate for lowland rice production. Rainfedlowlands also have great potential to diversify rice systems [22]. Actually, rice is among the few commercial cash crops which can be grown in all lowlands in Sierra Leone. The Northern part which is a main lowland rice growing region, rice farming technology and modern rice varieties developed by the West Africa Rice Development Association (WARDA), SLARI and Rokupr Agricultural Research Centre (RARC) were introduced in that part of the country. Subsequently, a lot of unutilized swamplands have been transformed to lowland rice plots. The Northern part of Sierra Leone is situated in the rainfall eco-zone and bollards, and farmers who are in the irrigation systems are involved in the twofold farming of rice. Conversely, the twofold farming of rice is not very common in the rainfed lowlands except the water in the swampland is adequate throughout the short rainy period.

B.Lowland Rice Training Scheme

The main purpose of the farmers' training scheme was to increase awareness both in rice production and efficiency through the introduction of sustainable rice farming activities that have been extensively accepted in Asian countries together with the utilization of small-scale easy irrigation services. This farmers' training project was designed to cover all the 14 districts in Sierra Leone and these include 5 districts in North, 4 districts in the South, 3 districts in East and 2 districts in the Western area of Sierra Leone. The training was carried out during the cropping period of 2012 in all the 14 districts in the country.

Each district has a Project location and this was purposively chosen since they were swamplands with recurring streams. In terms of the ecological surroundings for rice farming, these project locations were established to be relatively alike. Over and above, the ecological condition and the formation of farmers' union of rice producers were requirements for executing the project in all the 14 districts in Sierra Leone. Consequently, it is rational to presume that cultivators in the project locations are inclined to be more aggravated in the production of rice and to have comparatively more contact to water than those in other areas within the country.

SLARI at first offered the training for the district agricultural extension personnel (DAEP) and leading cultivators with the intention of disseminating essential information concerning rice farming and basic irrigation management practices by talking to them. Subsequently, SLARI specialists and DAEP offered field training to the cultivators at demonstration plots in each project location or site, in size, the plots ranging from 1 to 5 ha. However, the training was divided into the following stages: (a) the creation of a demonstration plot, the construction of irrigation canals in the neighboring area, and the leveling of major field, this can be done within 72 hours; (b) Nursery beds and seedling preparations, this can be done within 24 hours; (c) transplanting of seedlings, this can be done within 12 hours (d) controlling weed, this also can be done within 24 hours; and (e) harvesting and threshing of rice, can be done within 12 hours. The use of fertilizer was not included in the project. As the training did not need too much time, the training contribution was anticipated to be higher. The stuff taught in all session was basic and the training exercise was provided immediately before the farming practices were executed in the field, which permitted for discretionary learning and successful application.

SLARI specialists asked all cultivators who contributed in the training exercise to prepare the demonstration plots through their guidance and direction on how to construct the irrigation canals that join the demonstration plots with a supply of water. Farmers 'unions were asked to build their irrigation canals by digging the gullies with their own tools such as hoes with supervision and assistance from SLARI specialists. As a general rule, cultivators supply water to their own plots on every occasion needed with no communal water management. Irrigation channels are rarely sustained collectively, and the cultivators only clean the nearby channels to their own plots. In several systems, the cultivators do not have the skills on how to control water. There are no strategies for monitoring the water intake into the different plots. Also, this training program did not involve the building of up to date irrigation facilities, since they are expensive to build and sustain. SLARI specialists also think that even if an up to date irrigation structures were constructed, the production of rice farming cannot be improved considerably without the appropriate farming practices. Therefore, simple and small-scale irrigation services were encouraged in this SLARI training program

III.Data Collection

A.Sampling

Prior to the expansion of the project size, the pilot survey was carried out in March, 2011. To appraise the result of this pilot survey on rice output and prosperity, the authors tally the data of pilot survey sites with those of family units who live in areas where the farmers training scheme will be executed. A household survey was conducted from May, 2011 and the detail information on rice farming was collected between April and October, 2012 .However, the selection of project sites and locations of the demonstration plots had already been done by SLARI specialists. All project sites were situated in swamplands, since they are appropriate for lowland rice farming. The authors then selected two sites from pilot project such as Rokupr and Tongo, and two other sites where the farmers' training took place in the farming season of 2012 such as Waterloo and Makarie. 53 households were selected at random in each of the sites.

The questionnaire consists of several questions relating to agricultural production such as materials use, yield and plot uniqueness were posed at the plot stage. As information relating to family labor is necessary to compute the imputed expenditure of family labor and proceeds from the production of rice, every household must supply data on a single rice plot with complete information. However, there were 72 sample households that had not harvested their rice during the period of data collection. As a result, the total number of observations used in this research reduced to 140.

In Rokupr and Tongo sites, the training had began immediately before the collection of the data, and the rice production and the adoption of the farming practices documented during the survey were not in any way affected by the SLARI farmers' training. Also, all households sample in these two sites did not participate (non-participants) in the SLARI training program. Conversely, in Waterloo and Makarie, the training project had been introduced since 2012, and as a result, in April 2012, both training participants and non-participants were present.

The size of swampland ranges from 13–22 ha in each of the sites, and the number of rice cultivators using the swampland ranges from 101–129. However, the proportion of households cultivating lowland rice is comparatively high in Waterloo and Makarie (91%) and only 49% for Rokupr and Tongo sites. The majority of the rice producers started rice farming during the early 1990s and mid 1990s.

B.Descriptive Statistics

Table I shows the descriptive statistics by the participation of the training project. The average rice yield was about 1.9 tons per hectare in the four sites, which is better when you compare to the trend in average world riceyield [23]. Among those who participated in the training program, the average yield was more than 2 tons per hectare; this is considerably higher than those among the non-participants by roughly 1.2 tons per hectare. Almost all the participants have a tendency to farm rice at smaller plots, to frequently adopt the improved varieties, to utilize lesser amount of seeds, to frequently apply additional chemical fertilizer, and lastly to adopt better farming practices than those who do not participants. Majority of those who participated in the farmers' training adopted leveling together with bunding, even though the adoption of planting in a straight-row was limited to approximately 59% of all the rice plots. However, among those who do not participate in training, the adoption of improved farming practices was lesser. Furthermore, there is an unremarkable difference between family and hired labour used. Again the reason was that, during the process of applying the improved farming practices that required extra labor for cleaning of land and planting, straight-row planting together with improved water control system can stop weeds from growing and thus reduce the weeding period.

The Income from rice production, point out that the participants that are involved in the training take home higher income from the production of rice than the non-participants. Obviously, the difference is expected since the participants get higher output with no increase in the number of hired labor which is the most expensive aspect of farming as most of the sample households are poor. Also, the profit received from rice production, which subtracts imputed expenditure of family labor along with own seeds from rice income. In each village, the average cost of seeds alone for each variety is computed and used to estimate the imputed expenditure of own seeds. The locations in addition to activities and specific wages are used for imputation of family labor expenditures. All imputed expenditure are changed to the measure per hectare except the labor expenditure which is use to repel birds is not responsive to the size of the plot and therefore, expenditures are not altered in regulating the size of hectare. In a season, the average profit per hectare is USD 117 for the participants and for the non-participants; the average profit is negative, and this is lesser than the average profit of about USD 380 for the participants.

Table II depicts the household traits by the training participation category. Here the training participants prone to be members of different local associations including rice, livestock, land, to exist in areas with lesser rainfall and better contact to the nearest district headquarter town than the non-participants. The plots of Rice of the participants are likely to be rented to have rivers and streams as source of water more frequently than the non-participants.

TABLE I
DESCRIPTIVE VARIABLES OF RICE PLOT BY TRAINING PARTICIPATION CATEGORY BETWEEN APRIL AND OCTOBER, 2012

				Non-participants		
	All	Participants in the Training	Non-participants	Participated just after the collection of data	Treatment village	Control village
	(1)	(2)	(3)	(4)	(5)	(6)
Number of plots together with labor information	140	38	102	11	52	39
Size of Rice plot (ha)	0.311	0.242	0.271	0.296	0.309	0.298
	(0.201)	(0.163)*	(0.200)	(0.304)	(0.171)	(0.191)***
Yield (ton/ha)	1.97	2.83	1.61	0.64	1.21	1.44
	(2.93)	(4.01)*	(1.66)	(0.91)**	(2.13)	(1.68)***
Number of plot with fertilizer application	4	4	0	0	0	0
Application of fertilizer (kg/ha)	10.06	10.06	nill	nill	nill	nill
	(1.61)	(1.61)				
Application of seed(kg/ha)	59.4	43.3	81.7	44.5	92.1	50.1
	(74.9)	(61.1)*	(77.3)	(19.7)	(98.5)	(53.2)
variety of rice plots (R-series), %	48.4	63.9	50.3	4.9	82.1	10.7
	(50.5)	(30.8)*	(54.2)	(28.1)**	(29.3)	(40.2)***
Hired labor (man-days/ha)	168.2	190.0	154.0	118.0	178.7	321.1
	(181.3)	(206.6)	(184.0)	(177.6)	(300.9)	(254.0)
Family labor (man-days/ha)	643.9	621.4	708.8	523.6	844.9	635.4
	(598.1)	(484.7)	(611.9)	(301.6)	(797.8)	(498.0)
Adoption of modern farming methods (% of rice plots)						
Bunding	79.5	87.1	70.3	69.1	93.5	43.1
	(29.9)	(10.4)*	(40.7)	(39.3)**	(11.2)	(53.3)***
Leveling	59.8	76.7	50.8	34.3	75.4	31.9
	(42.3)	(31.2)*	(43.1)	(49.4)**	(30.3)	(42.2)***
Row planting	29.0	59.4	10.1	23.8	12.8	3.8
	(43.8)	(43.6)*	(30.7)	(42.8)**	(32.9)	(19.8)***
Transplanting of seedlings	69.8	83.2	60.6	46.4	79.4	50.9
	(41.9)	(26.3)*	(40.5)	(49.0)*	(32.2)	(48.2)***
Income from rice plot (USD/ha)	654.21	854.70	565.14	67.43	784.04	387.06
	(876.4)	(876.8)*	(723.1)	(298.2)**	(711.8)	(687.0)***
Profit from rice plot (USD/ha)	117.12	379.54	−96.57	−(485.8)**	−144.10	−301.00
	(656.06)	(841.6)*	(675.6)	(490.09)	(790.1)	(786.9)

* In column 2, mean difference between training participants and non-participants (columns 2 and 3), it is significant at the 5% level

**In column 4, mean difference between training participants and non-participants who participated in training after data collection in control villages (columns 2 and 4) it is significant at the 5% level

***In column 6, mean difference between non-participants in treatment villages and non-participants in control villages (columns 5 and 6) it is significant at the 5% level

TABLE II
TRAITS OF THE SAMPLE HOUSEHOLDS BY TREATMENT CATEGORY

			Non-participants		
	Training participants	Non-participants	Participated after data collection	Treatment village	Control village
	(1)	(2)	(3)	(4)	(5)
Number of male 21–60	1.742	1.711	1.698	1.801	1.921
	(1.090)	(1.089)	(1.095)	(1.201)	(1.076)
Number of female adults 21–60	1.784	1.812	1.489	1.601	2.090
	(1.032)	(1.301)	(0.704)	(0.951)	(1.800)
Age of household head	41.56	42.33	45.80	39.39	42.56
	(11.59)	(13.49)	(14.21)	(10.46)	(11.56)
Years spent in school by household head	9.09	9.42	9.09	9.29	4.17
	(2.82)	(3.76)	(3.43)	(3.19)	(9.10)
Female headed household	0.025	0.035	0.059	0.027	0.071
	(0.131)	(0.211)	(0.240)	(0.149)	(0.261)
Member of indigenous associations	0.934	0.601	0.875	0.405	0.778
	(0.270)*	(0.481)	(0.349)	(0.495)	(0.499)***
Duration of lowland rice farming	9.09	8.77	12.08	5.74	9.14
	(7.72)	(9.00)	(9.06)	(7.01)	(9.90)***
Area of owned land (ha)	0.801	1.600	2.611	0.877	1.994
	(1.300)*	(1.589)	(1.311)*	(1.182)	(1.756)***
Worth of household assets (USD)	90.5	82.3	81.1	84.1	84.6
	(90.46)	(87.11)	(85.00)	(92.43)	(84.44)
Worth of livestock (USD)	96.1	120.4	200.9	98.5	220.9
	(155.1)*	(204.6)	(176.4)**	(169.0)	(190.8)***
Annual rainfall (mm)	900.9	1110.0	1120.4	898.6	1606.9
	(98.8)*	(259.4)	(347.3)**	(95.2)	(350.8)***
Period of travelling to nearest district headquarter town (hours)	2.031	2.090	2.112	2.100	2.210
	(0.110)*	(0.290)	(0.262)**	(0.139)	(0.441)***
Land Rented (%)	0.610	0.481	0.170	0.582	0.391
	(0.509)*	(0.504)	(0.343)**	(0.497)	(0.453)
Rivers and Streams as	0.454	0.331	0.375	0.381	0.241

source of water (%)					
	(0.561)*	(0.401)	(0.424)	(0.456)	(0.413)***

*In column 1 indicates that mean difference between training participants and non-participants (columns 1 and 2) is significant at the 5% level

**In column 3 indicates that mean difference between training participants and non-participants who participated in training after data collection in control villages (columns 1 and 3) is significant at the 5% level

***In column 5 indicates that mean difference between non-participants in treatment villages and non-participants in control villages (columns 4 and 5) is significant at the 5% level

IV. Research Methodology

A.Mean Treatment Effect on the Treated

This research examines an ex-post assessment of the training offered in March, 2011 by building a suitable counterfactual. The mean treatment effect on the treated (MTT) of the outcome variable ρ, conditional on θ and T, is stated as:

$$\text{M TT} = \text{E}\left\{\rho_t^{\;1} - \rho_t^{\;0} / \theta, \text{T} = 1\right\} = \\ \text{E}\left\{\rho^1{}_t / \theta, \text{T} = 1\right\} - \text{E}\left\{\rho_t^{\;0} / \theta, \text{T} = 0\right\} \quad (1)$$

Where ρ^0 and ρ^1 are respectively the outcomes of agricultural activities before and after receiving treatment, θ is a vector of covariates and T is the dummy variable assuming the value 1 if the cultivator received the treatment and the value 0 if the same cultivator does not receive no treatment.

To compute MTT, it is essential to locate a group of cultivators who were non- participants, but have similar traits to that of the participating households before the farmers' training schedule in order that, the unobserved;

$$\text{E}\left\{\rho_t^{\;0} / \theta, \text{T} = 1\right\} \quad (2)$$

It can thus be represented by:

$$\text{E}\left\{\rho_t^{\;0} / \theta, \text{T} = 0\right\} \quad (3)$$

Again, this study utilizes the non-experimental and cross-sectional data. To satisfy the assumption;

$$E\left\{\rho_t^1 / \theta, T = 1\right\} = E\left\{\rho_t^0 / \theta, T = 0\right\} \quad (4)$$

We need to use the propensity scores to construct a suitable and valid control group which has similar visible traits to those of the treated households. The propensity score is the probability of assignment to one treatment conditional on a subject's measured baseline covariates [24]. It is also the expected probability that a household has contact to the treatment (the training program).The methods of matching are nearest neighbormatching with and without replacement, radiusmatching, and Kernelmatching [25], and these are utilized to determine the point estimates of the likely outcome variables to check the robustness. Propensity scores can be estimated by employing a Probit model of training participation program in which the control variables at the plot-level are the size of rice plot, ownership of rice plot and source of water , and those at the village level are the amount of annual rainfall and the time of traveling to the nearest district headquarter town ,and finally those at household-level are lowland rice farming experience, years of schooling of the household head, number of household members, the worth of household assets, age of household head and membership in a local association,

B.The Model

The outcome of the training program on the production technology is assessed by employing weighted regressions in which the weights are the inverse expected probability of training participation. The weights for plot i can be estimated by:

$$\varphi_i = \frac{\text{T}_i}{\Pi(\text{T}_i)} + \frac{1 - \text{T}_i}{1 - \Pi(\text{T}_i)} \quad (5)$$

Where Π (T_i) is actually the estimated propensity scores with T_i the indicator for participating in the training program. Thus this can be represented by:

$$\text{T}_i = 0 \quad (6)$$

For non participants and

$$T_i = 1 \quad (7)$$

For training participants.

The weights are employed to regulate the distributions of both participants and non-participants and this can be achieved by allocating better weights to those areas with greater participation. Also, the subsequent linear probability model:

$$\prod_{rij} = \left\{\alpha_1\lambda_j + \alpha_2\mu_{ij} + \alpha_3\Phi_{rij} + \alpha_4\psi_i + \varepsilon_{rij} \succ 0\right\} \quad (8)$$

It can be used to ascertain the factors of the adoption of improved farming activities in the study area. Where 1{} indicate if household i in village j adopt modern farming activities on the rice plot, while Ø, ψ and μ are respectively the plots of rice, community-level traits during the period of the adoption decision and the household, and λ is a dummy variable and this specify whether a household participated in the SLARI farmers' training program. The coefficients to be determined are α_1, α_2 and α_3, and e is an error term. In the regression model stated, a dependent variable assumes the value 1 if the farmers farming activities which include (Bunds construction, leveling and planting in straight-rows) were adopted between April and September, 2012. At the household level however, all explanatory variables assume values at the start of April 2012, moreover, those at plot level are better measured in each relevant farming period.

However, the outcome of the recommended farming activities (adopted or not) should be affected by both the farmers' training participation and the characteristics of the household sample for instance the educational status, experience in rice farming, and household assets, in addition to the plot characteristics like farm land tenancy and accessibility of water. Some farmers that might have failed to witness the training meetings, but they might have learned and acquired effectual methods of planting rice from their friends, relatives and even neighbors and their personal knowledge. This is so, because the farmer might exchange crucial information that leads to adoption with a more distant network partner [26].These farming practices as well have significant effects on rice production especially when water is accessible, and consequently the adoption rate will as well be certainly affected by the accessibility of water supply. However, farmers may be less motivated to find out about modern methods of farming if the farm land is leased or rented from neighborhood family as the case in most agricultural sittings in Sierra Leone.

V.Results

A.Training Participation

Using the probit model from which the propensity scores are predicted, the first column in Table III depicts the estimated results for the training participation at rice plot level. Also, the figures show the marginal effects estimated at the sample means. However, households that have younger household as head, better experience in lowland rice farming, membership of indigenous organization besides that of rice, fewer livestock, better entrance to the nearest headquarter town and lesser rainfall have higher possibility to participate in the training program. Hence, the results also point out that, the training participation is positively connected to information contact and knowledge; own rice farming experience, membership of local association and educational status of the household head.

TABLE III
Farmers' Training Participation and Adoption of Modern Farming Practices

	Participation in training Probit (dy/dχ) (1)	Leveling IV Probit (dy/dχ) (2)	Straight row planting IV Probit (dy/dχ) (3)	Bunding IV Probit (dy/dχ) (4)
Training participation[r]		0.301	0.491	0.073
		(1.24)	$(5.28)^{**}$	(0.07)
Number of male (20-55) years old	−0.030	0.111	0.029	−0.132
	(−0.67)	(0.91)	(1.09)	(0.73)
Number of female (20-55)years old	0.023	−0.069	−0.058	0.081
	(0.41)	(0.57)	(3.03)	(0.61)
Age of household head	−0.009	−0.038	0.091	−0.034
	$(-1.61)^{+}$	$(2.13)^{*}$	(0.14)	$(1.77)^{*}$
Time spent(yrs) in school by household head	0.006	0.055	0.002	0.110
	(0.64)	$(1.52)^{+}$	(0.33)	$(2.02)^{*}$
Household with female as head.	−0.203	−0.061	−0.111	−1.161
	(−1.21)	(0.25)	(0.48)	(1.71)
Experience in lowland rice farming	0.016	0.003	−0.005	0.020
	$(2.13)^{*}$	(0.61)	(0.18)	(0.81)
Size of owned farm(ha)	0.010	0.147	0.008	−0.202
	(0.18)	(1.32)	(0.13)	(1.93)
Worth of household assets (USD)	−0.061	0.501	0.044	0.320
	(−0.78)	(1.17)	(0.50)	(0.84)
Worth of livestock (1,000 USD)	−0.176	−0.244	0.162	0.531
	$(-2.09)^{*}$	(1.43)	$(1.66)^{+}$	$(1.74)^{*}$
Annual rainfall(100 mm)	−0.033	0.108	0.021	0.062
	$(-2.30)^{*}$	$(3.91)^{**}$	$(1.65)^{+}$	$(1.71)^{+}$
Period of travelling to nearest headquarter town (hr)	−0.661	1.311	−0.124	1.622
	$(-3.82)^{**}$	$(2.13)^{*}$	(0.59)	$(1.74)^{+}$
Land rented (%)	0.065	0.423	0.010	0.478
	(1.49)	(1.70)	(0.20)	$(2.11)^{*}$
River as source of water source (%)	0.050	0.704	0.123	0.677
	(0.61)	$(2.74)^{**}$	(1.70)	$(2.43)^{**}$
Member of indigenous organization	0.512 $(6.09)^{**}$			
Sample size	140	140	140	140
Log likelihood	−54.91	−161.04	−170.32	-103.11
Chi-squared	116.23	29.52	121.01	24.00

[r]Endogenous variable (IV) is a dummy variable and it means a farmer belongs to an association besides that of rice. Where $^{+}$,* ** respectively significant at 10%, 5% and 1%

B.Adoption of Modern Farming Methods

Columns 2–4 in Table III depicts the results of the regression analyses for the adoption of modern rice farming methods and this respectively specify the results for the adoption function of leveling, row planting and construction of bunds. As the farmers' participation training is an endogenous variable (changeable character), the authors employ the influential variable estimation regression model in a situation where the influential variable for the farmers training participation is a dummy variable of belonging to an indigenous organization besides that of rice. With the exception of column 3, the training participation lacks a significant and positive impact on the adoption of the modern farming methods. Constructive accessibility to water which is measured by a dummy signifying that the source of water is a river and the amount of annual rainfall; this has a positive impact on the adoption of modern farming methods. However, inadequate access to land and water are obstacles to efficient and effective agricultural practices [27].

In terms of adoption of modern farming methods, younger and better educated household heads are more likely to practice such methods. As suggested by [28], that the factors that influenced adoption were age of the household head and educational level, and that Male-headed households most times have a higher likelihood of adopting agricultural technologies. Again the worth of livestock increases the possibility of adopting row planting and bunding.

C. Mean Treatment Effect onthe Treated (MTT)

Table IV illustrates the results of the MTT estimates on the rice output, the rice profit, the rice income as well as the adoption of modern farming methods at rice plot level. From all the matching estimators, the MTT estimates produce different results: For instance, in column (1) the nearest neighbor matching, the training participation overall did not have positive effect on rice production, except the adoption of row planning. Conversely, in the radius matching the rice yield in addition to profits and the adoption of row plunging and bunding were improved by the training. However, results from kernel matching are related to those in the radius matching, even though the effect of the training participation on rice outputs is not statistically significant. Though the evidence is not completely decisive, these results point out that lowland rice profits can be improved considerably by the farmers' training program that teach about the fundamental farming methods.

TABLE IV
MEAN TREATMENT EFFECTS ON THE TREATED

	Nearest neighbor	Kernel	Radius
	(1)	(2)	(3)
	Level of plot		
Yield (ton/ha)	0.256	0.241	0.573
	(0.501)	(0.521)	(1.231)$^{+}$
Income from ice (USD/ha)	101.01	114.21	214.04
	(0.621)	(0.702)	(0.592)
Profit from rice (USD/ha)	150.90	301.87	324.17
	(0.712)	(0.857)*	(0.575)**
	Adoption of modern farming methods.		
Bunding	0.081	0.110	0.108
	(0.970)	(1.125)$^{+}$	(2.651)**
Leveling	0.021	0.051	0.109
	(0.432)	(0.651)	(1.060)
Row planting	0.154	0.264	0.342
	(2.005)*	(1.901)*	(2.980)**
Modern variety	−0.050	−0.014	0.097
	(0.543)	(0.156)	(1.123)

Where^{+},*, ** respectively significant at 10%, 5% and 1%

VI. CONCLUSION

This article examined the impact of a participatory training project on the adoption of improved farming practices, rice outputs, in addition to the income and profit of rice production by estimating the mean treatment effect on the treated and the adoption function of the farming practices with distribution weights. It was establish that the training program improved the adoption of row planting and the construction of bunds. MTT estimates recommended that the participation training project generally had significant positive impacts on rice profits. Even though the evidence is not completely decisive; these results however, show that lowland rice profits can be considerably improved if basic farming practices are adopted. Therefore, rice cultivators that were present in the training program were at an advantage. The policy implication is that a similar training project ought to be expanded and implemented on regular bases.

Nevertheless, the feeble effect of the training program on rice output can substantiate the limitations of the training program that did not give irrigation services. As a result, for some rice producers who have been encountering dangers like floods and drought, the yield effects of the improved farming practices can be restricted. Hence, additional investment in irrigation to have constant supply of water may be required for the production of lowland rice to be improved significantly. However, this is imperative, since increasing yield is the foremost means of improving food security particularly in Sierra Leone and generally in most African states.

A. Observations

- In China and most Asia countries, improve seedlings are in greater circulation since the application of chemical fertilizer such as herbicides are more usually.
- The act of leveling actually leads to the smooth supply of water in the farm plots which make possible in controlling weeds, and also assist rice plant to germinate smoothly and grow better.
- Earlier in the 90s, WARDA introduced the development of rice schemes with some rice technology development scheme in Sierra Leone for the multiplication of seedlings. These schemes were widely known to farmers.
- The types of farming practices taught in the SLARI training program are generally adopted in China and in most develop countries. The Lowland rice seeds are most times over used by farmers and locally traded and exchange in the form of barter system among farmers in Sierra Leone. The two most popular lowland rice varieties are ROK 24 and ROK 27, upland varieties are ROK 16 and ROK 17, irrigation varieties are ROK 11 and ROK 14, and mangrove varieties are CP4 and ROK 10. These varieties are also widely adopted in neighboring Guinea and Liberia.
- Though we do not clearly assess the adoption of chemical fertilizer in this research, there are merely 2 rice plots where fertilizer was practically applied.

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REFERENCES

[1] D. Hongmin, L. Yue, D. Kemp, D. Michalk, N. Renhua, T. Takahashi, and Y. Yubo, Reducing methane production from livestock: can more efficient livestock systems help? Development of sustainable livestock systems on grasslands in north-western china, 2011, pp. 115.

[2] M.L. Burgoyne, Factors affecting housing delivery in South Africa: a case study of the Fisantekraal housing development project, Western Cape (Doctoral dissertation, Stellenbosch: University of Stellenbosch), 2008.

[3] O. O. Ogundele, and V. Okoruwa, Technical efficiency differentials in rice production technologies in Nigeria (No. RP_154). African Economic Research Consortium, 2006.

[4] E. L. Molua, Rice production response to trade liberalization in Cameroon. Research Journal of Agriculture and Biological Sciences, vol. 6, no.2, pp.118-129, 2010.

[5] D. Mitchell, A note on rising food prices. World Bank Policy Research Working Paper Series, Vol, 2008.

[6] S. V. Self-reporting, Derek Headey was the global food crisis really a crisis? Simulations versus self-reporting, 2012.

[7] T. Atinmo, P. Mirmiran, O. E. Oyewole, R. Belahsen, and L. Serra-Majem, Breaking the poverty/malnutrition cycle in Africa and the Middle East. Nutrition reviews, vol, 67(s1), S40-S46, 2009.

[8] B. M. Mati, R. Wanjogu, B. Odongo, and P. G. Home, Introduction of the system of rice intensification in Kenya: experiences from Mwea Irrigation Scheme. J.Paddy and Water Environment, vol. 9, no. 1, pp.145-154, 2011.

[9] M., Mallory, and K. Baylis, The Food Corporation of India and the Public Distribution System: Impacts on Market Integration in Wheat, Rice, and Pearl Millet, 2012.

[10] United Nations. Economic Commission for Africa. Sub regional Office for Southern Africa; United Nations. Economic Commission for Africa. (2007). Impact of food aid and developed countries' agricultural subsidies on long-term sustainability of food security in Southern Africa.

[11] S. Pandey, and D. Van Minh, A socio-economic analysis of rice production systems in the uplands of northern Vietnam. J. Agriculture, ecosystems & environment, vol.70, no., pp.249-258, 1998.

[12] D. Van Tran, Closing the rice yield gap for food security. International Rice Commission. Food and Agricultural Organization, 2001.

[13] A. Doberman, and T.Fairhurst, Rice: Nutrient disorders & nutrient management. Int. Rice Res. Inst, 2000.

[14] A. Ferrero & A. Tinarelli, Rice cultivation in the EU ecological conditions and agronomical practices. Pesticide Risk Assessment in Rice Paddies: Theory and Practice: Theory and Practice, vol.1, 2011.

[15] K. S. Fischer, S. Fukai, A. Kumar, H., Leung, and, B. Jongdee, Field phenotyping strategies and breeding for adaptation of rice to drought. Frontiers in Physiology, vol.3, 2012.

[16] S. O. Adigbo, T. Wakatsuki, J. N. Odedina, T. O. Fabunmi, and V. B. Adigbo, Exploiting the Potentials of Inland Valleys of Nigeria for Poverty Alleviation. COLERM Proceedings, vol.2, pp.464-477, 2012.

[17] M., Demont, J., Rodenburg, M., Diagne, and S.Diallo, The impact assessment of herbicide resistant rice in the Sahel. J. Crop Protection, vol.28, no.9, pp.728-736, 2009.

[18] M. L. McNeely, S. A., Olivo, and D. J. Magee, A systematic review of the effectiveness of physical therapy interventions for temporomandibular disorders. J. Physical Therapy, vol.86, no.5, pp.710-725, 2006.

[19] E. Duguet, Are R&D subsidies a substitute or a complement to privately funded R&D? Evidence from France using propensity score methods for non-experimental data. Evidence from France using Propensity Score Methods for Non-Experimental Data (July 2003). University of Paris I Cahier de la MSE EUREQua Working Paper, (2003.75), 2003.

[20] B. Melly, Estimation of counterfactual distributions using quantile regression. Review of Labor Economics, vol.68, pp.543-572, 2006.

[21] M. P. McCartney, and M. C. ACREMAN, 17 Wetlands and Water Resources. The Wetlands Handbook, 2 Volume Set, pp.357, 2009.

[22] P. A. Seck, E. Tollens, M., Wopereis, A., Diagne, and I. Bamba, Rising trends and variability of rice prices: Threats and opportunities for sub-Saharan Africa. J.Food Policy, vol.35, no. 5, pp.403-411, 2010.

[23] R. S. Zeigler, and A. Barclay, The relevance of rice. Rice, vol.1, no1, pp.3-10, 2008.

[24] P. C. Austin, Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. Pharmaceutical statistics, vol.10, no.2, pp.150-161, 2011.

[25] J. Mensah, J. R., Oppong, and C. M. Schmidt, Ghana's National Health Insurance Scheme in the context of the health MDGs: An empirical evaluation using propensity score matching. Health economics, vol 19. (S1), pp.95-106.

[26] I. Matuschke, and Qaim, M. The impact of social networks on hybrid seed adoption in India. J. Agricultural Economics, pp.40, no.5, pp.493-505, 2009.

[27] V. Anosike, and M. Fasona, Gender dimensions of urban commercial farming in Lagos, Nigeria. J.Urban Agriculture Magazine, vol.12, pp.27-28, 2004

[28] M. Buyinza, and N. Wambede, Extension for agroforestry technology adoption: mixed intercropping of crotolaria (Crotolaria grahamiana) and maize (Zea mays L.) in Kabale district, Uganda. Environmental Research Journal, vol.2.no.3, pp.131-137, 2008.