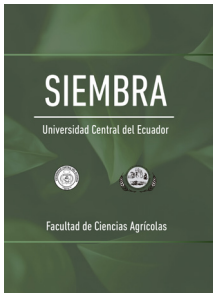
Original Article

Labour-use efficiency of rice farmers in Nigeria's north-central region

Eficiencia en el uso de la mano de obra de los arroceros de la región Centro-Norte de Nigeria



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Abstract

A cross sectional data collected through a structured questionnaire coupled with an interview schedule from 360 rice farmers selected *via* multi-stage sampling technique was used to determine the labour efficiency of rice farmers in Nigeria's North-Central region. Both descriptive and inferential statistics were used to analyze the 2020 cropping season data. The empirical evidences showed a farming population that is gender bias due to stereotypes, that affected women access to and control over productive resources. Besides, economic-productive people that explored pecuniary advantages in order to achieve economies of scale engaged in cultivation of thinly uneconomic holdings. The poor economic status of the farm families made most of the farmers to rely on family labour for farm operations, thus keeping most of their children and young ones out of school. Furthermore, most of the farmers were fairly efficient in the use of labour with little technical support required to enable them achieve optimum labour efficiency level (frontier point). However, the empirical evidences showed competition for labour demand between farm and off-farm activities and conservative and complacency attitudes due to longevity in the enterprise to be the factors that affected labour efficiency. Therefore, the study calls for gender mainstreaming in agricultural budget to overcome women's challenge on productive resources; incentivized the enterprise *viz*., credit provision; adoption of bottom-to-top approach in research and practical demonstration approach in transfer of innovative rice technologies.

Keywords: labour-use, efficiency, rice, farmers, Nigeria.

Resumen

Para determinar la eficiencia de la mano de obra de los arroceros de la región Centro-Norte de Nigeria se utilizaron datos transversales recogidos mediante un cuestionario estructurado y un programa de entrevistas a 360 arroceros, quienes fueron seleccionados mediante un muestreo por conglomerados multietápico. Los datos obtenidos de la época de cultivo 2020 fueron analizados mediante estadísticas descriptivas e inferenciales. Las evidencias empíricas mostraron una población agrícola sesgada por el estereotipo de género, que afectó al acceso y control de los recursos productivos por parte de las mujeres. También, se encontró que los agen-

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tes económicamente productivos que exploraban las ventajas financieras para alcanzar economías de escala se dedicaban a cultivar explotaciones poco rentables. La mala situación económica de las familias agricultoras hizo que la mayoría de los agricultores dependieran de la mano de obra familiar para las operaciones agrícolas, manteniendo así a la mayoría de sus niños y jóvenes fuera del sistema educativo. Además, la mayoría de los agricultores eran bastante eficientes en el uso de la mano de obra, y apenas necesitaban apoyo técnico para poder alcanzar un nivel óptimo de eficiencia laboral (punto límite o frontera). Sin embargo, las pruebas empíricas mostraron que los factores que afectaban a la eficiencia de la mano de obra eran la competencia por la demanda de mano de obra entre las actividades agrícolas y las no agrícolas y las actitudes conservadoras y de complacencia a causa de la longevidad en la empresa. Por tanto, el estudio aboga por la integración de la perspectiva de género en el presupuesto agrícola para superar el desafío existente para las mujeres en cuanto a los recursos productivos; por el estímulo a las empresas mediante la concesión de créditos; y, por la adopción de un enfoque de abajo hacia arriba en la investigación y de un enfoque de demostración práctica en la transferencia de tecnologías innovadoras del arroz.

Palabras clave: uso de la mano de obra, eficiencia, arroz, agricultores, Nigeria.

1. Introduction

The socio-economic developments in Africa are primarily agrarian and about 70 % of its workforce directly or indirectly involved in agriculture live in rural areas and rely on agriculture for their livelihoods (Okpara, 2013). In the staple food crop sub-sector of Nigeria, rice production occupies an important position, especially among cereal crops (Sadiq *et al*., 2020a). Rice is one of the world's most important grains and staple food for millions of individuals in South Asia, America and Africa (FAO, 2017). Presently, the average Nigerians consumes 21 kg of rice per year, comprising 9 % of the total caloric intake and 23 % of the total consumption of cereals, with the population consuming approximately 2.1 million tons of rice annually.

Nigerian farmers complain of unavailability and high labor costs, long propagation periods, and high use of crude rice processing technologies. There is a need to make effective use of basic production factors, including labor, land and resources, in order to have sustainable agricultural growth. Human labor stimulates other factors of production and converts other farm inputs into the outputs needed. The lack of farm labor has had a negative effect on planting accuracy, improved weed control, timely harvesting and crop processing (Kadurumba *et al*., 2020; Oluyole *et al*., 2011). Sarma *et al*. (2011), Akanni & Dada (2012), Anyiro *et al*. (2013), and Kadurumba *et al*. (2020) have noted the inadequacy of farm labor to promote the expansion of rice farms and to intensify the already chosen area for rice production in Nigeria.

In Nigeria, smallholder farmers contribute more than 85 % of domestic agricultural production (Akanni & Dada, 2012). Empirical evidence has shown that the labor force available consisted primarily of elderly farmers, excluding men and women in the active working age, thus had a negative effect on the production of rice. Drudgery in farm activities, rural-urban migration and lack of social infrastructure in rural areas, as well as low farm income and low life expectancy in rural areas could be due to the growing absence of people under the productive/active age. The only main source of labor available to small-scale rice farmers in Nigeria is human labor (Kadurumba *et al*., 2020). Thus, there is a need to continue to supply the ever-growing Nigerian population with food, which is rooted on the productivity of human labor.

Some studies confirm that the supply of farm labour by humans on the farm is not homogeneous and that the content of work varies. In general, these studies showed that men carried out heavy farm operations such as land preparation, staking and harvesting with women and children carrying out lighter operations such as planting, application of fertilizers and weeding (Akanni & Dada, 2012; Kadurumba *et al*., 2020). Researchers have observed that total labour supply depends on factors such as population size, age composition and certain institutional factors (Anyiro *et al*., 2013; Bervidová, 2001).

The seasonal relationship between the periodic shifts in the patterns of labour usage and the various labour operations expected to be carried out in a timely manner exercises a limit on the proportion of household labour on which to rely upon. Almost all farm activities are concentrated in the wet season, thus, slight delays, particularly in the very short wet season, can be costly. At such times, labor demand is becoming the most worrying issue. The conspicuously scarce factor of production is labour supply. In the farming communities, the responsiveness of the labor supply of both family and hired to prospective profitable alternative job opportunities among smallholder farmers poses barriers to the extended use of labor in agricultural production.

Increasing the production of rice requires increased productivity in the use of labor, increased land use and the expansion of indigenous technology. It is in view of the foregoing that the research themed "labour-use efficiency

among rice farmers of North-Central Nigeria" was conceptualized so as to provide a roadmap that will guide policymakers and farmers on productive labour-use enhancement in rice production. To the best of our knowledge literature showed no information of related study in the Northern region of the country. Thus, the outcome of this research will add to the existing literature of related studies that covered the southern part of the country. Therefore, the research ought to determine the labour-use efficiency of rice farmers in Nigeria's North-Central region.

2. Research Methodology

The North-Central region is geographically located in the middle belt of Nigeria and consists of six states *viz*., Benue, Nasarawa, Niger, Plateau, Kogi and Kwara; and a Federal Capital Territory called Abuja. The region spanned from the west to around the serenity of the confluence of two major rivers- River Niger and River Benue. The geographical coordinates of the region are latitude 10˚ 20' and longitude 7˚ 45'; and its vegetation cover is largely guinea savannah alongside mountainous and tropical vegetation. The mean cumulative annual and monthly rainfall of the region are 1247.52 ± 166.68 mm and 103.96 mm, respectively; while the annual mean temperatures hovered around minimum and maximum values of 22.55 ± 0.42 ˚C and 33.54 ± 0.23 C, respectively. The mean is slightly above 50 % for the relative humidity and varied between the small range of 50.08 and 52.75 %. The distribution of monthly rainfall ranges from May to October, with a unimodal peak in August (274.23 mm) (Olayemi *et al.,* 2014). The months of january and february are completely dry season (no rainfall) while the months of April and november witnessed little spring, thus referenced as pre and post-rainy season transition periods respectively. The inhabitants of the region majorly engage in arable crop production alongside tree cropping, fishing, hunting, artisanal, civil service and Ayurvedic medicines. In achieving a representative sampling size for this study, a multi-stage sampling technique was adopted. With the exception of Benue state, all the state units and the Federal Capital Territory are suitable for cultivation of rice. Thus, three out of the seven units *viz*., Niger and Kogi States; and FCT Abuja were conveniently selected. Given the preponderance of rice cultivation across the chosen units, two Local Government Areas (LGAs)/Municipal Area Councils (MAC) were randomly selected from each of the selected units using Microsoft inbuilt sampling analytical tool. Furthermore, using the same Microsoft sampling analytical tool, two villages were randomly selected from each of the chosen LGAs/MAC. Based on the sampling frame sourced from the States' Agricultural agencies and reconnaissance survey, a scale ratio of 18 % was used to determine the representative sample size (Table 1). Thus, a total of 376 active rice farmers that made the sample size were drawn through simple random sampling technique. However, 16 out of the 376 questionnaires retrieved contained outliers, thus were eliminated. Therefore, a total of 360 valid questionnaires were subjected to the analysis. Using an easy cost-route approach, a structured questionnaire complemented with an interview schedule is the instrument used to elicit cross-sectional data of 2020 rice cropping seasons from the farmers. Both descriptive and inferential statistics were the tools used for data analysis.

Table 1. Sampling frame of rice farmers (States' Agricultural Agencies, 2020).
Tabla 1. Marco muestral de los arroceros (States' Agricultural Agencies, 2020).

States	LGAs/MACs*	Villages	Sample frame	Sample size
FCT Abuja	Kwali	Dabi	85	15
		Gada-biu	109	20
	Abaji	Yaba	100	18
		Pandagi	90	16
Kogi State	Yagba West	Omi	198	36
		Ejiba	220	40
	Kogi	Giryan	250	45
		Panda	180	32
Niger State	Borgu	Swashi	208	37
		Saminaka	170	31
	Katcha	Katcha	238	43
		Badeggi	242	43
Total	**6**	**12**	**2090**	**376**

* District unit is called Municipal Area Council (MAC) and Local Government area (LGA) in FCT Abuja and State respectively.

2.1. Empirical model

Following Masso & Heshmati (2003), Akanni & Dada (2012), Anyiro *et al*. (2014) and Kadurumba *et al*. (2020), the imposed Cobb-Douglas Stochastic Labour-use frontier function approach is given in equation [1].

$$L_i = f(X_{ij,} Y_{ij,}; \beta) + (V_i - U_i)\ (i = 1,2 \ldots n) \quad [1]$$

Where L_i = Labour of the i^{th} farmer; X_i = Vector of the actual j^{th} inputs used by the i^{th} farmer; Y_i = Vector of the actual j^{th} output of the i^{th} farmer; β_i = parameter to be estimated; V_i = Uncertainty which is beyond the control of the i^{th} farmer; and, U = Risk which is attributed to the error of the i^{th} farmer;

Given the level of technology at the disposal of a technical unit, the labour-use efficiency is expressed as the ratio of the observed labour-use (L^b) to the corresponding optimum labour requirement (, and it is given in equation [2].

$$L_e = \frac{L^b}{L^{opt}} = \frac{f(X_{ij,} Y_{ij,}; \beta) + (V_i + U_i)}{f(X_{ij}\ Y_{ij}; \beta) + V_i} = \exp(U_i) \quad [2]$$

Where L_e is the labour efficiency, and it takes the value of with 1 defining labour-use efficient technical unit. The observed labour-use (L^b) represents the actual labour-use while the potential labour requirement L^{opt} represents the frontier labour requirement level.

The explicit form of the Cob-Douglas functional form of the LCF function is as given in equation [3].

$$lnL_i = ln\beta_0 + \sum \beta_k lnX_{ij} + \beta_l lnY_{ij} + (V_i - U_i) \quad [3]$$

Where L_i = Total human labour-use of i^{th} farmer (man-day); X_i = Vector of farm inputs used: X_1 = inorganic fertilizer (kg), X_2 = seeds (kg), X_3 = herbicides (litre), X_4 = pesticides (kg), X_5 = depreciation on capital items (₦), and X_6 = farm size (hectare); Y_i = Farm output (kg) from i^{th} farmer; V_i = random variability in the production that cannot be influenced by the i^{th} farmer also known as uncertainty; U_i = deviation from potential labour requirement attributable to labour-use inefficiency and also known as risk. B_0 = intercept; B_k = vector of input parameters to be estimated; B_1 = vector of output parameter to be estimated; *i = 1,2,3…n farmers*; *j = 1,2,3…n inputs*.

The inefficiency model is given in equation [4].

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 \ldots + \delta_n Z_n \quad [4]$$

Where Z_1 = Age (year); Z_2 = Gender (male = 1, female = 0); Z_3 = Marital status (married = 1, otherwise = 0); Z_4 = Educational level (year); Z_5 = Dependent household member (number); = Independent household member (number); = Farming experience (year); Z_8 = Mode of land acquisition (inheritance = 1, otherwise = 0); Z_9 = Distance from home to farm (kilometer); Z_{10} = Distance from home to market (kilometer); Z_{11} = Cooperative membership (yes = 1, no = 0); δ_1 = intercept; and, $\delta_{1\text{-}n}$ = parameters to be estimated.

Using the generalized likelihood function, the test for the presence of labour-use inefficiency is defined by equation [5]:

$$\lambda = -2ln(\frac{H_0}{H_a}) \quad [5]$$

Where, H_0 is the value of the likelihood function for the unrestricted frontier (OLS) while H_a is the value of the likelihood function for the restricted Cobb-Douglas frontier model. Thus, if the calculated Chi^2 is greater than the tabulated Chi^2 at 5 % degree of freedom, then the null hypothesis is rejected in favour of alternative hypothesis. The alternative hypothesis has approximately a mixed Chi^2 distribution with a degree of freedom equal to the number of parameters omitted in the unrestricted model, if the null hypothesis is true (Sadiq & Singh, 2016).

3. Results and Discussion

3.1. Socio-economic profile of the farmers

A perusal of Table 2 revealed an economic active (41 years) farming population with capacity to achieve high labour productivity that will ensure rice food security in the studied area. Besides, the value of standard deviation being ±10.8 depicts that most of the farmers fall within the age bracket of 30 to 50 years; an age bracket recommended by FAO to be viable and productive. Most of the farmers are married (84.44 %) with family obligations to meet-up, thus suggesting sustainable rice production for the purpose of achieving sustainable earnings-income inflow.

Table 2. Socio-economic profile of the farmers.
Tabla 2. *Perfil sociodemográfico de los agricultores.*

Variables*	Mean	Standard deviation	CV
Age	41.49	10.83	0.261
Gender	0.8111	0.391	0.483
Marital status	0.8444	0.362	0.429
Education	8.083	4.97	0.614
Child composition	1	1.22	1.103
Adult composition	3	1.88	0.588
Total household size	4	2.62	0.606
Experience	9.68	7.112	0.734
Land acquisition	0.7361	0.441	0.599
DHF	4.34	3.390	0.780
DHM	5.68	4.166	0.733
Co-operative memb.	0.7278	0.464	0.637
Farm size	2.79	1.448	0.519
Seasonal cultivation	0.8500	0.357	0.4206
Kharif season cultiv.	0.8105	0.392	0.4843

* DHF and DHM are Distance from House to Farm and Distance from House to Market respectively.

However, the enterprise is gender biased (81.11 % of male farmers) and this may be attributed to gender stereotype which hinders women from access to and control over productive resources. Women face many constraints despite playing a pivotal role in food production, the chief being landless with no assets in their name. Even if they have land, they are constrained by money and other resources needed for cultivation (inputs and technical know-how). This depicts that the studied area did not recognize farm women as 'farmers' rather 'wives' of the farmers. Thus, it can be suggested that women are very vulnerable or susceptible to the vicious cycle of poverty as they have little or no title of economic ownership.

This scenario depicts a threat to development as gender equity is more than a goal itself because it is a pre-condition for reducing poverty, promoting sustainable development and building good governance (Sadiq *et al*., 2020b). When male farmers earn cash from crop sales, they either re-invest it for more agricultural productivity or use it on personal things. Their income does not increase the quality of food accessible to their families, but it is likely to be spent on family food when female farmers earn cash, albeit comparatively less (Sadiq *et al*., 2020b). Thus, the studied area needs to revise their narrative about farm women so as to achieve growth and development.

Most of the farmers had post-primary school education (8.1 years), thus depicting a farming population that will be receptive to farm skills capacity building acquisition programs on rice production. In addition, the studied area been populated by literate farmers, the reception of rice innovations/technologies and managerial efficiency is likely to be high. Most of the farmers maintained a sustainable household size (4 persons) that is recommended by FAO for a sustainable livelihood, thus with little or no consequence on the enterprise going concern. Most of the farmers have been in rice production for many years with an average experience of 9.7 years. Thus, adequate experience plays a key role in enhancing the quality of farm decision-making in the allocation of resources, products supply and adoption of rice technologies.

The mode of farm acquisition is majorly through inheritance (73.61 %), thus indicating the susceptibility of the thinly uneconomic holdings to fragmentation as any adult family member will want to have his own portion of the parcel. This form of land ownership mostly does not permit the use of land for mechanized agricultural practices as land is viewed from the perspective of cultural, political and economic and not solely an economic good.

The average distances from the farmers' house to farm and house to market are 4.34 and 5.68 km respectively, thus indicating a quite distance of the economic activity units from farmer's abode. The farther the farmers' houses from their technical units the better, as the famers will spend much of their valuable time on farm operations with little or no social disturbances that may emanate from their families. Likewise, the farther the farmers' homes from the market units the better as the farmers will less frequent the market for non-farm and off-farm activities, thus make them to concentrate and spend adequate time on farm operations during the production season.

Most of the farmers belong to co-operative association, indicating that the farmers explore their social capital so as to benefit from pecuniary advantages *viz*., bulk input discount, timely access to credit-kind and cash, bargaining output market power, technical advices; that are inherent in cooperative organization. Most of the farmers are small-scale farmers cultivating rice on an average farmer size of 2.8 hectares. Therefore, it can be suggested that the farmers produced rice on subsistence level, a thinly uneconomic holding which majorly improvise for household consumption with little or no output to serve the non-farming population. Most of the farmers cultivated rice under rainfed condition i.e. during the kharif season (85 %) while 15 % cultivated rice during the rabi (hay) season. Under the rainfed condition, 81.05 % cultivated rice on lowland while 18.95 % did so on upland.

3.2. Labour-use Pattern for Different Farm Activities

A perusal of the results showed that for a hectare of rice farm a total of 216.73 labour man-hours were utilized in the production of rice output (Table 3). Gender-wise, it was observed that adult male farmers provided 142.24 labour man-hours used in the farm operation while the adult female and children accounted for 55.22 and 19.27 labour man-hours respectively.

Furthermore, it was observed that labour requirements were high during land preparation, planting and harvest in the following average proportion of 19.25, 16.76 and 16.75 % respectively. Thus, this outcome conforms to a prior expectation as these operations are intensive farm operations that required high labour engagement. The farm operations that utilized low labour man-hours were winnowing (2.49 %), transportation of farm produce (2.21 %), third weeding (1.95 %) and second weeding (1.77 %). However, the use of labour was found to be moderate in fertilizer application (14.21 %), threshing (13.54 %) and first weeding (11.07 %).

Most of the labour used for the farm operations was sourced from family labour (93.64 %) which is cheap and almost free while hired labour contribution was marginal (6.36 %). Thus, high reliance on family labour revealed the poor economic position of the farmers as most of them are resource-poor cultivating rice on thinly uneconomic holdings. In addition, farm families spend most of their time during the cropping season on farm activities. This suffices that children spend valuable school hours on farm activities all in an effort to supplement family labour due to the poor capital position of the farmers to improvise for paid labour.

Table 3. Labour-use distribution pattern per hectare (man-hour per hectare).
Tabla 3*. Patrón de distribución de la mano de obra por hectárea (hora hombre por hectárea).*

Operations	Family labour (FLAB)			Hired labour (HLAB)			FLAB**	HLAB**	AM**	AF**	Children**	Total labour**
	AM*	AF*	Children	AM	AF	Children						
Land preparation	18.57058	18.53538	0.067689	4.53912	0	0	37.17364	4.53912	23.1097	18.53538	0.067689	41.71276 (19.25)
Planting	31.65439	3.628111	0.103524	0.939677	0	0	35.38602	0.939677	32.59407	3.628111	0.103524	36.3257 (16.76)
1st weeding	6.872387	13.44535	0.238901	3.440175	0	0	20.55664	3.440175	10.31256	13.44535	0.238901	23.99681 (11.07)
2nd weeding	0	3.073223	0.123432	0.621143	0.021342	0	3.196655	0.642485	0.621143	3.094565	0.123432	3.83914 (1.77)
3rd weeding	4.093171	0.133386	0	0	0	0	4.226558	0	4.093171	0.133386	0	4.226558 (1.95)
Fertilizer appl.	29.44854	0.698945	0.314553	0.310571	0	0.027872	30.46203	0.338443	29.75911	0.698945	0.342425	30.80048 (14.21)
Harvesting	24.03345	9.870595	0.298626	2.078439	0.005335	0.003982	34.20267	2.087756	26.11189	9.875931	0.302608	36.29042 (16.74)
Threshing	10.09755	2.662393	15.61617	0.73263	0.085367	0.167231	28.37611	0.985228	10.83018	2.74776	15.7834	29.36134 (13.55)
Winnowing	0.055744	2.529007	2.102329	0.605216	0	0.099542	4.687079	0.704758	0.66096	2.529007	2.201871	5.391838 (2.49)
Transportation	4.093171	0.533546	0.051762	0.055744	0	0.051762	4.678479	0.107505	4.148915	0.533546	0.103524	4.785984 (2.21)
Total	**128.919**	**55.10993**	**18.91698**	**13.32272**	**0.112045**	**0.350388**	**202.9459 (93.64)**	**13.78515 (6.36)**	**142.2417 (65.63)**	**55.22198 (25.48)**	**19.26737 (8.89)**	**216.731**

* AM = Adult male; AF= Adult female
** Values in ( ) are percentage.

3.3. Maximum Likelihood Estimates of Stochastic Labour-Use Frontier Function

A cursory review of the MLE of the stochastic frontier function showed the variance parameters *viz*. sigma square and gamma to be within the plausible margin of 10 % probability level. Thus, the former implies that the distribution assumed for the composite error term is correct and fit while the latter indicates that the dominant sources of random error are systematic influences that are unexplained by the labour-use function (Table 4). Besides, there is presence of inefficiency effect in labour that owes to differences in farmers idiosyncratic characteristics. The gamma coefficient of 0.4184 depicts that 41.84 % of the variation in the total labour-use among the farmers is due to the disparities in their labour efficiencies. The calculated LR Chi^2 being greater than the tabulated as evidenced by the generalized likelihood ratio test, implies that inefficiency effect is present, thus the traditional response (OLS) model is not an adequate representation for the data (Table 5).

Table 4. MLE of the stochastic labour-use frontier.
Tabla 4. *Estimación de verosimilitud máxima de frontera estocástica del uso de la mano de obra.*

Variable	Coefficient	Standard error	t-statistic$^+$
Deterministic model			
Constant	2.9618	0.5603	5.285***
Inorganic fertilizer (kg)	-0.0183	0.0522	0.350^{NS}
Seed (kg)	0.0792	0.0460	1.722*
Herbicides (litre)	-0.0538	0.0462	1.164^{NS}
Pesticides (kg)	0.0423	0.0487	0.868^{NS}
Capital item Deprec. (₦)	0.1307	0.0470	2.777***
Farm size (hectare)	0.1821	0.0607	2.995***
Output (kg)	0.0279	0.0566	0.493^{NS}
Inefficiency model			
Constant	1.0326	0.4804	2.149**
Age	-0.0395	0.0240	1.648*
Gender	-0.9876	0.4871	2.027**
Marital status	-0.4496	0.2057	2.185**
Education	0.0270	0.0201	1.350^{NS}
Children composition	-0.0283	0.0648	0.436^{NS}
Adult composition	0.1530	0.0902	1.695*
Experience	0.0413	0.0214	1.925*
Mode of land acquisition	-0.4356	0.3601	1.209^{NS}
DHF	0.0089	0.0117	0.751^{NS}
DHM	0.0209	0.0166	1.254^{NS}
Co-operative membership	-0.1703	0.1524	1.117^{NS}
Variance parameters			
Sigma-squared	0.4039	0.0700	5.766***
Gamma	0.4184	0.1217	3.437***

+ *, **, *** and NS means significance at 10 %, 5 %, 1 % and non-significant respectively

Table 5. Generalized Likelihood ratio test of hypothesis for parameters of SLFF.
Tabla 5. Prueba de razón de verosimilitud generalizada de la hipótesis de los parámetros de la función de frontera estocástica de uso del trabajo.

H_0	Log likelihood function	λ*	Critical	Decision
$\gamma = 0$	-265.89	168	77.92	$\gamma \neq 0$
* λ = -2(47-131) = 168				

Furthermore, the significant variables that influenced labour requirements are seed, depreciation on capital item and farm size while labour inefficiency is affected by age, gender, marital status, independent household ratio and experience as evidenced by the plausibility of their respective parameter estimates at 10 % significant level. The positive significant of seed coefficient implies that high labour requirement was used during seed sowing and the possible reason is that local and fourth filial generation seed varieties were used.

Therefore, the marginal and elasticity implications of a unit increase in seed quantity will lead to an increase in labour-use by 0.08 man-days and 0.08 % respectively. The positive significant of depreciation on capital items coefficient indicated that obsolesce of the farm implements due to wear and tear resulted in high labour quantity utilization in rice production. Thus, the marginal and elasticity implications of a unit increase in wear and tear of the capital will lead to an increase in labour-use by 0.003 man-days and 0.13 % respectively. The positive significant of the farm size coefficient indicated that the unit of cultivation was large, thus utilization of high labour quantity as most of these farmers lack economic capital. Because of farmers' inability to procure or lease labour saving implements, high quantity of manual labour is deployed in rice production. Therefore, the marginal and elasticity implications of an increase in farm size by 1 hectare will lead to an increase in labour-use by 6.46 man-days and 0.18 % respectively.

However, the agrochemicals such as, inorganic fertilizer, herbicides and pesticides were not used in sufficient quantity, thus the reason for the non-significant of their estimated coefficients. The negative coefficient of inorganic fertilizer showed that the farmers used synthetic liquid form which required less man-day as compared to the granulated form due to the use of sprayer implements. In the same vein, weed suppressant-repellant effect of herbicides made the farmers to utilize little labour during land preparation and weeding as evidenced by the negative sign of herbicides coefficient. On the other hand, use of pesticides, a powdery substance required much labour in order to ensure adequate spray in the field against the use of few hands, thus the positive sign associated with the pesticides coefficient. The non-significant of the output coefficient depicts diseconomies of size which did not come as a surprise because most of the farmers cultivate rice on small-scale basis. Thus, an increase in output implies increase in labour utilization for post-harvest operations.

The negative significance of the age coefficient implied that old farmers are more labour efficient.Since they are not energetic enough they are conscious in labour utilization and are less likely to embark on futile labour exercise that has consequence on judicious use of their labour workforce. Besides, coupled with experience on rational allocation of resources, they are likely to be more efficient that the young farmers who are mostly novice in the rice farming enterprise. Therefore, for a unit increase in a farmer's age, his/her labour inefficiency will decrease by 0.04 %.

The negative significance of the gender coefficient depicted that gender stereotype due to cultural barrier hinders women's folk access to and control of production resources, thus affected their labour efficiency. In addition, most of the farm implements used is designed to suit men and not women, thus increasing the drudgery and ergonomic challenges faced by women farmers. Consequently, access to and control of productive resources and less ergonomic hazard encountered by the male farmers play a crucial role in decreasing their labour inefficiency by 0.99 %.

The negative significance of the marital status coefficient implied that married farmers are more labour efficient that their counterparts that are single. Apart from the twin capital benefits *viz*. social and economic capitals associated with marriage; the need to carter for household forced married farmers to take to sustainable rice farming. Therefore, the need to achieve sustainable income inflow makes married farmers to be rational in resource allocation, thus achieving efficiency in farm labour utilization. Therefore, being married will lead to a decrease in labour inefficiency by 0.45 %.

The positive significant of the household coefficient implied that less of the able-bodied household members are involved in the rice farm operation, thus affected farmers' labour efficiency. This is true as able-bodied household members take to white collar jobs with little or no money remittances to the household to substitute for hired labour. Also, on the other hand, it depicts a household composed of vulnerable people *viz.* old people and women; thus affected the labour-use efficiency. Therefore, an increase in a farmer's household by one adult person will lead to an increase in his/her labour inefficiency by 0.15 %. However, though not significant, there is exploitation of dependent household members such as children below 18 years as evidenced by the negative sign associated with the dependent household member coefficient which implied increase in labour efficiency.

The positive significance of the experience coefficient implied that longevity in the rice farming makes experienced farmers to develop complacency to innovative labour saving technologies, thus affected their labour efficiency. Therefore, an increase in the farmers' experience by one year will lead to an increase in their labour inefficiency by 0.04 %.

Though, non-significance associated with inheritance, distance of farm from home, distance of home from market and cooperative membership coefficients convey useful information. The negative sign of inheritance coefficient implies that the ability to enhance land productivity *viz*. reclamation among farmers that in-

herited their farm lands enhanced their labour efficiency. Farmers with farmland far away from their homes are more labour efficient as there is little or no distraction that are likely to emanate from their abodes, thus more valuable time is spent on the farm. However, farmers that have their homes close to the markets spent most of their valuable time in non-farm and off-farm market activities than on-farm activities; thus affected their farm labour efficiency. The pecuniary advantages benefited by farmers that belongs to cooperative associations made them to be more labour efficient than their counterparts who had no cooperative membership.

3.4. Labour-use Efficiency Scores

On the average, the mean labour efficiency is 0.866, implying that an average farmer achieved a labour efficiency of 86.6 % that is below the defined frontier level (Table 6). Besides, an average farmer's labour efficiency fell short of the maximum defined frontier level by 13.4 %. Thus, it can be inferred that an average farmer lost a potential labour-use of 13.4 % in the production of rice. In other words, 13.4 % of labour man-days utilized in rice production of average farmers were wasted relative to the best practiced farms facing the same technology and producing the same output. Furthermore, the frequencies of occurrences of the predicted labour efficiency above the average score represents 84.5 % of the sampled farmers, thus indicating that most of the farmers are fairly efficient in labour utilization at a given level of output using available technology at their disposal in the studied area. However, approximately 15.6 % of the sampled population had their labour efficiency in the range of 30-70 %, indicating that at least 30 % of their potential labour input is lost to inefficiency.

Table 6. Frequency distribution of labour-use efficiency scores.
Tabla 6. Distribución de frecuencias de las puntuaciones de eficiencia en el uso de la mano de obra.

Efficiency level	Frequency	Relative efficiency (%)
0.30-0.39	1	0.277778
0.40-0.49	4	1.111111
0.50-0.59	0	0
0.60-0.69	11	3.055556
0.70-0.79	40	11.11111
0.80-0.89	158	43.88889
0.90-0.99	146	40.55556
1.00	0	0
Total	360	100
Mean	0.865712	
Maximum	0.954285	
Minimum	0.398376	
Standard deviation	0.080365	

The worst and best labour efficient farmers achieved efficiency scores of 0.398 and 0.954 respectively; while the most frequent efficiency score is 0.89. Therefore, it can be inferred that the worst and best practiced farmers lost potential labour inputs of 60.16 and 4.57 % in rice output due to factors that are within their control. For the worst, average and best practiced farmers to be on the frontier level they need to increase their labour efficiency by 39.8, 13.4 and 4.57 % respectively. However, for the worst and average farmers to be on the same level with the best practiced farmers they need to increase their labour efficiencies by 9.22 % {[1-(0.866/0.954)]*100} and 58.24 % {[1-(0.398/0.954)]*100} respectively. Generally, most of the farmers were relatively efficient but there still exists an opportunity for them to increase their labour efficiency so as to optimize allocation of labour resource in rice production.

4. Conclusion and Recommendations

Based on the findings, it was suggested that the enterprise is not gender sensitive as gender stereotype hindered women access to and control over productive resources. Besides, the enterprise is dominated by a low-level

literate people that engaged in sustainable production so as to earn a sustainable income that will guarantee sustainable households' livelihood. Most of the farmers had adequate experience in the production of rice and benefited from pecuniary advantages that wade-off diseconomies of scale due to cultivation of thinly uneconomic holdings. The poor economic capital status of the farmers made them to deploy labour majorly from families, thus keeping their wards out of schools. Furthermore, the empirical evidence showed that most of the farmers were fairly efficient in utilization of labour input with little effort needed by them to achieve optimum labour efficiency. It was observed that labour inefficiency owes majorly to search for white collar jobs that affect farm labour supply by the able-bodied household members; and, conservative attitudes and complacency against adoption of innovative rice technologies due to many years of experience in the enterprise. Therefore, based on the foregoing the following recommendations were proffered:

- Policymakers should introduce gender budget mainstream into agricultural sector so that women farmers can have access to and control over productive resources. This will help in reducing poverty-escape from vicious cycle of poverty, enhance growth, promote sustainable development and build good governance.
- Given that most of the farmers need little push to achieve optimum labour efficiency, more technical support from policymakers-governmental and non-governmental organizations should be given to the farmers.
- The enterprise should be made more attractive through provision of credit-kind and cash so as to attract and encourage the teeming population that rush for white collar jobs, thus enhancing rice food security in the studied area.
- Besides, advisories services should adopt more of practical demonstrations so as to change farmers' attitudes, especially the experience ones, towards improved rice technologies.
- Also, farmers should be sensitized on the importance of child education to the immediate environment and the society at large by providing them with light labour substitute technologies at subsidized rates with fair amortization time frame for repayment.

Contributor Roles

- Mohammed Sanusi Sadiq: conceptualization (lead), methodology (lead), validation, formal analysis (lead), investigation (lead), resources, data curation, visualization, supervision, writing - original draft (lead), writing- review & editing (lead).
- Invider Paul Singh: conceptualization, methodology (lead), validation, formal analysis, investigation, resources, data curation, visualization (lead), supervision (supporting), writing - original draft, writing-review & editing.
- Muhammad Ahmad Makarfi: conceptualization (supporting), methodology (supporting), validation, formal analysis, investigation, resources (lead), data curation (supporting), visualization, supervision, writing - original draft, writing- review & editing.

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