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Labour-Use Differential among Mechanized and non Mechanized rice Farmers in Nasarawa State, Nigeria.

H.R.Suleiman[1]; H.Ibrahim[2]; O.M.Isa[3] and O.K.Ishiaku[4]
[1]*Department of Agric and Natural Resources, Obi Local Government Area, Nasarawa State.*
[2]*Department of Agricultural Economics and Extension, Nasarawa state University Keffi.*
[3]*Department Agric Education, College of Education Akwanga, Nasarawa state, Nigeria.*
[4]*National Agricultural Seed Council 6th floor BOA Plaza Central District Abuja.*

Abstract: *This paper examined the savings and utilization of labour among rice farmers using non-mechanized and mechanized system of farm operations. Data were collected from a randomly sample of 132 farmers (66 non-mechanized and 66 mechanized) and analyzed using gross margin and regression analysis. The result revealed that non-mechanized farmers employed a mean total of 60 labourers and utilized 898.49 man-hours per hectare. While the mechanized farmers employed a mean total of 35 labourers and utilized 372.30 man-hours per hectare. A total mean of 25 labourers, 526.19 man-hours labour and a labour cost of ₦12,368. 71 per hectare were saved from the use of mechanization. The relationship between labour use in fertilizer application ($P < 0.01$) and harvesting ($P < 0.05$) with total farm output of non-mechanized farms are positive and statistically significant. The mechanized farms have land preparation ($P < 0.01$), planting ($P < 0.1$), pre-emergency herbicide application ($P < 0.5$), post emergency application ($P < 0.01$) and harvesting ($P < 0.05$) operation as significant with total farm output. Therefore, the used of herbicide and tractor in mechanized farms have been observed as a major labour saving device in rice farms. Farmers should be encouraged to form cooperative organization for the joint use of farm machineries and knowledge of the use of herbicide should be impacted.*

Key words*: labour differential, productivity, labour device, labour utilization, man hours.*

I. Introduction

Rice is indeed one of the world's most important food crops, being the staple food for over 50 percent of the world's population; it is particularly important in china, India and a number of other countries in Africa and Asia. Globally, rice is an important food crop and is increasingly preferred over many traditional foods, such as sorghum, millet and most root and tuber crops such as yam and cassava (Defoer *et al*, 2004). Rice is consumed by over 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, 40 million in Africa, 150.3 million people in America and over 120 million people in Nigeria (Daramola, 2005). It is also one of the major cereals to gain the status of a cash crop status in Nigeria, especially in those rice-producing areas where it provide employment for more than 80 percent of inhabitants as a result of the commercial activity that takes place along the distribution chain from cultivation to consumption (FAO, 2003). Nigeria is currently the highest rice producer in West Africa, producing an average of 3.2 million metric tons of paddy rice or 2 million of milled rice per year (Daramola, 2005). It is also the largest consuming nation in west Africa, with the growing demand amounting to 4.1 million tons of rice in 2002, with only about half of that demand met by domestic production, the growth in rice demand as a preference staple is so strong that production intensification and higher yields per hectare will not be sufficient to fill the gap to meet rice demand (Tollens, 2006).

Agricultural production is strongly influence by the amount of factors of production and the time of applications of necessary operations. The adopters of agricultural technology were found to utilized farm size, labour and seed inputs more efficiently than the non adopters, while the reverse is holds in respect of fertilizer input. Need for more use of fertilizer exist for both adopters and non adopters but more pronounced in non adopters (Idi, 2004). It was also observed that the income and output of farmers could be improved if resources were efficiently used at the existing technology. Thus, in the short run, there lies a potential of about 28 percent to increase the output of rice by adoption of the technology and technique of best practice rice farms, while the potential therein in non mechanized farms is about 38 percent (Ajao *et al,* 2005). The relatively poor performance of irrigated rice schemes in the country can be attributed to a number of biophysical, socio-economic and institutional constraints (Fagade and Nguyen, 2001). The declining self sufficiency ratio in rice production indicates that Nigeria has remained importer of rice with well over US $267 million spent annually (Eke, 2008).

One approach to solving Nigeria's rice production problem is to investigate the pattern of resource use among rice farms, especially small holder rice farmers, to determine what adjustment might be made to increase

rice output (Olagoke, 1991).It has been demonstrated that all nations (developed or developing) that have successful agricultural mechanization began with a viable local manufacture of agricultural machinery and equipment (Odigboh, 1994). In Nigeria, it is observed that medium and large-scale machinery manufacturing industry, the nucleus of Agricultural mechanization has the capacity increase quantity of yield per unit area, increased cropping pattern, reduce drudgery and time of operation (Dakogol, 2004). Osabo (2004) Labour availability during peak season is frequently a greater constraint to increasingly agricultural production than availability of land. Odigboh (1994) Rice production is labour intensive and rank second to yam in labour demand, Nigeria have to rely on a variety of imported farm machines, which are seldom appropriate for small farms. The issue of mechanization in small farms has the center of controversy since the 1960's, aside from whether the adoption of mechanical power has increased farm output significantly, and subsequently farm incomes.

Increase demand for rice is of great concern to rice produce in the country as a whole, and that effort to increase rice production in Nigeria have been thwarted by factors such as low productivity and inefficient use of labour. It is against this backdrop that the study was designed to;

- Determined the socio-economic characteristic and their influence on labour used among the mechanized and non-mechanized rice farmers in the study area.
- Make comparism of the number of labour employed by mechanized and non mechanized rice farmers.
- Compare the amount of labour utilized by mechanized and non-mechanized rice farmers.
- Compare the cost of labour incurred in rice production between the two groups.
- Compare the cost and returns of rice production between the two groups.

II. Methodology

Study Area: The study was conducted in Nasarawa state; the state is located in the middle belt zone of the country. It lies between latitude 7^o and 9^o North and longitude 7^o and 10^o East, and shares common boundaries with Benue state to the South, Kogi state to the West, the federal capital territory (FCT), Abuja, to the North West, Kaduna and plateau states to the North East, and Taraba state to the south East. The state has a climate typical of the tropical zone, because of its location. It climate is quite pleasant: A mean temperature of 60^o F and 80^o F maximum have been recorded while rainfall varies from 313.73cm in some places to 145cm in other areas. The month of December, January and February are cold (sometimes quite cold) due to the very dry harmattan winds blowing across the state from the North-East. It is characterized by two distinct seasons: dry and wet. The dry season start from November to February, while the rainy season is from March to October. Average daily sunshine in the state is 6.2 hours and average daily vapour pressure is 26hpg.

The physical features of the study area are largely mountainous. It covers very large area of the state, much of which are rocky and of undulating highlands to average height of about 1,400m above sea level. The coastline of river Benue and its trough created alluvial fertile soil, which is very good for crop production. Other smaller rivers cover most parts of the state and empty into the river Benue. The sediments are generally comprised of sandstones, siltstones and subordinate inter-bedded clays all of cretaceous age. Alluvial soils are found along the Benue trough and their flood plains. These are always swampy in nature due to availability of water all the year round. The forest soil, which are rich in humus, and laterite soils are found in most parts of the state.

The 1991 census put the state's population at 1.2million. The state's population by 2003, estimated at the national average growth rate of 2.83% per annum, is projected to 2.0million. However, with the influx of people particularly into Karu and Keffi LGAs, due to their proximity to the federal capital territory, Abuja, as well as into Lafia, being the state capital, places the current estimated population of the state at 2,040,097 (NPC, 2006). Males constitute 51% and females 49% of the population. Over 80% of the people of the state are subsistence farmers and live in rural areas. Major crops suitable to the state ecological conditions are rice, sesame, soya beans, groundnut, cassava, yam, maize, cashew, sorghum, melon, mangoes, citrus and vegetables. There is an estimated water surface area of over 5,645 square kilometer and favourable climatic conditions for the fish industry.

Sample size and Sampling Technique: The target population for the study was mechanized and none mechanized rice farmers in Nasarawa state, the state was stratified according to the three agricultural zones (south, north and west). The sampling comprised of a two stage sampling procedure. The first stage involved random selection of two local government areas from each agricultural zones noted for intensive production of rice from the thirteen local government areas, giving a total number of six (6) local government areas. The six local government areas noted for intensive production of rice sampled during preliminary survey were southern zone (Lafia and Awe), Northern zone (Nasarawa Eggon and Kokona) and Western zone (Karu and Toto). Stage two; the sample size used for the study was one hundred and thirty two (132) respondents, selected from both mechanized and non mechanized rice farmers, making up sixty six (66) from each group and six (6) from each of the selected local government area in the study area. Information collected from both group, bothered their

inputs and outputs as well as their current market prices. Sizes of farmers' field were determined by stepping method to estimates the dimension where there is no record. Quantities of seed and fertilizer were measured in kilogram, herbicide in litre and labour in manhours.

Analytical Procedure: The gross margin analysis method was employed to determine the overall gross margin per hectare and regression model.

Cross Margin Analysis: The gross margin, the return over variable cost is an appropriate measure of profitability used for comparing enterprises for short run annual planning decision (castle, 1987). It is a very useful planning tool in farming enterprises in the case of subsistence agriculture (Olukosi and Erhabor, 1989). It forms the basis of most analysis and planning procedure and enable a practicing farmer to understand his business better.

According to Kay (1981), a gross margin is the difference between total income and total variable cost. Olukosi and Erhabor (1989), have illustrated the procedure for calculating gross margin in a farm organization.

Gross Margin=Total Revenue - Total Variable Cost …….. (1)

This research used gross margin to determine the return over variable cost per hectare and per man-hour for rice farm in the study area. The gross margin model used was expressed as:

Gross Margin/Ha=Total Revenue - Total Variable Cost/Total area of production (Ha)…… (2)

The gross margin calculated in equation (2) was used to calculate the gross margin man-hour by dividing the gross margin by the total labour used per hectare. The gross margin per man-hour was therefore expressed as;

Gross Margin/Man-hour = Total Revenue - total variable cost/total labour used/man-hour …… (3)

Regression Model Specification One: Multiple regression analysis was used to determine the contribution of farmer's Farming experience (years), household size, farm size (hectares), distance of farm to farmers residence (kilometers) and membership of cooperative societies to the category of labour employed (man-hours) by rice farmers using mechanized and non-mechanized farm operations.
The regression model was thus expressed as:

$TME\ Lb = a + b_1f_1 + b_2f_2 + b_3f_3 + b_4f_4 + b_5f_5 + b_6f_6 + u$ ……. (4)
$TNM\ Lb = a + b_1f_1 + b_2f_2 + b_3f_3 + b_4f_4 + b_5f_5 + b_6f_{6+} u$ ……. (5)

Where

TME Lb= Total labour employed for Mechanized (man-hours)
TNM Lb= Total Labour Employed for non-mechanized (man-hour)
F_1 =Farming experience, (year)
F_2 =Household size
F_3 =Number of household members engaged in the rice farm.
F_4 =Farm size (hectares)
F_5 =Distance of farm to Farmers residence (kilometers)
F_6 = Membership of cooperative societies.
U = Random error term.

Model Specification Two: The extent to which labour used for various farm operation in rice production to determine farm output were estimated using multiple regression analysis. The model was in linear, semi-logarithm and double logarithmic functional forms. The functional forms were expressed as:

The linear functional form

$METFO = a+b_1LP+b_2PL + b_3fa + b_4HA_1 + b_5HA_2 + b_6HV + b_7TH$
$+U...$ (6)
$NMTFO\ a+ b_1LP +b_2PL + b_3fa + b_4W_1 +b_5W_2 + b_6HV + b_7TH + U$ …. ....(7)

The semi-logarithmic functional form:

$METFO = \log a+b_1 \log LP + b_2 \log PL + b_3 \log fa + b_4 \log Ha_1 + b_5 \log Ha_2 + b_6$
$\log HV + b_7 \log TH + b_7 \log$…….. (8)

$NMTFO = \log a + b_1 \log LP + b_2 \log PL + b_3 \log fa + b_4 \log W_1 + b_5 \log W_2 + b_6 \log HV + b_7 IogTH + \log U$ (9)

The double-logarithmic functional form:

$\text{Log METFO} = \log a + b_1 \log LP + b_2 \log PL + b_3 \log fa + b_4 \log Ha_1 + b_5 \log Ha_2 + b_6 \text{LogHV} + b_7 \log TH + \text{Log U} \ldots$. (10)

$\text{Log NMTFO} = \log a + b_1 \log LP + b_2 \log PL + b_3 \log fa + b_4 \log W_1 + b_5 \log W_2 + b_6 \log HV + b_7 \log TH + \log U \ldots..$ (11)

Where;

METFO	=	Mechanized total farm output (kg/hectare)
NMTFO	=	Non-mechanized total farm output (kg/hectare)
LP	=	Labour used for land preparation (man-Hours/hectare)
PL	=	Labour used for planting (man-hours/ hectare)
FA	=	Labour used for fertilizer application (man-Hours/hectare)
W_1	=	Labour used for first weeding (man-hours/hectare)
W_2	=	Labour used for second weeding (man-hours/hectare)
Ha_1	=	Labour used for herbicide application (pre-emergency) (Man - hour/hectare)
Ha_2	=	Labour used for herbicide application (post emergency) (Man -hours/hectare)
HV	=	Labour used for harvesting (man-hours, hectare)
TH	=	Labour used for threshing (man-hour hectare)
U	=	Random error term.

III. Result And Discussion

Production Costs and Return

The production costs and returns per hectare of mechanized and non mechanized rice farmers in the study area are presented in Table 1**.** The result revealed that the mean total costs of production per hectare were ₦60,500 and ₦59,000, for the non mechanized and mechanized farmers respectively. These represent a difference of ₦1,100. The mean total value of production per hectare realized were ₦96,000 and ₦144,000 and the mean return over total cost of production per hectare were ₦22,300 and ₦56,400 for the non mechanized and mechanized rice farmers respectively. This represent a differences of ₦48,000 for mean total values of production and ₦34,100 for return over total cost of production. Similarly, the mean total cost of production per man-hour were ₦67.34 and ₦159.53, while the mean total revenue per man hour were ₦106.85 and ₦386.28 per hectare for the non mechanized and mechanized rice farmers respectively. The gross margin man-hour was ₦24.82 and ₦151.49 for non mechanized and mechanized farmers in that order. The result showed that there is no much difference in the mean total cost of production per hectare between the two groups of farmers. The two groups of farmers realized a considerable profit per hectare; this scenario was manifested in the gross margin of the farmers, which was due to an appreciable increase in the current market price of rice product than the presiding years.

Further analysis revealed that there was a great absolute difference in profit realized per hectare between the non mechanized and mechanized rice farmers. The difference in absolute profit levels result from the use of herbicide and tractor in the mechanized system of farm operation: this reduces the average cost of labour expended in such farm operation. Ajao *et al,* (2005) observed that the income of farmers could be improved if resources were efficiently used at the existing technology. The mean gross ratios of 0.61 and 0.77 showed that 61% and 77% of the total revenue realized by the farmers goes to pay for the cost of production of mechanized and non mechanized farm operations respectively. These figures were reasonable considering 39% and 23% of the total revenue that were accrued by mechanized and non mechanized rice farmers. The mean gross ratio is high in non-mechanized farms due to the high total cost/revenue ratio. However, the total returns difference does not give a clear picture of the difference in the profitability of the two groups. The return per naira invested which gives the benefit accrued to every naira invested in the product is a better measure. Mechanized farmers were found to obtain ₦1.64 to every naira invested and non-mechanized ₦1.30 to every naira invested.

Table 1: Cost And Returns analysis of Mechanized and Non Mechanized rice farmers in Nassarawa State

	Naira per hectare	
Cost / Returns Component	**Non- Mechanized**	**Mechanized**
Total cost	60,500	59,400
Total cost man-hours $^{-1}$	67.4	159.55
Total revenue	96,000	144,000
Total revenue man hour $^{-1}$	106.85	386.78
Gross margin	22,300	56,400
Gross margin man-hour $^{-1}$	24,82	151.49
Gross ration	0.77	0.61
Returns on naira invested	1.30	1.64

Source: Field Survey 2013.

Socio-economic factor that determine Labour utilization by the sampled farmers

Linear algebraic regression model was used to determine farmers labour utilized against some socio-economics variables of farmers in the study area. The regression result is shown in Table 2. The result revealed a positive and significant influence of farm size ($P< 0.01$) and experience in rice farm ($P <0.05$) on the amount of labour utilized in non-mechanized farms. The variables explained 89.90% of the total behaviour of farmers in the utilization of labour under non mechanized operation in the study area. The positive significant relationship in farm size and farming experience in rice farms with the amount of labour utilized in non mechanized could be attributed to the fact that increased farm size poses greater labour input as the operation is done manually. This may have confirmed a mean total labour of 898.49 man-hours per hectare utilized by the non-mechanized farmers. The behaviour of farmers in the utilization of labour shows positive significant relationship with farming experience ($P < 0.01$), farm size ($P<0.05$) and membership of cooperative societies. The positive significant relationship between farm size, farming experience and experience in rice farm with the amount of labour utilized in mechanized farm could be attributed to the fact that large farm size poses greater labour input which the farmer try to solve through the use of machinery, putting into consideration their previous experience with regards to labour demand of non-mechanized farms. The positive and significant relationship between memberships of cooperative societies indicates that members have more access to agricultural information and credit to procured production inputs and farm machineries.

Table 2: Regression Result of Socio-Economic Characters of Mechanized and Non Mechanized rice farmers that determine labour utilization in rice Production in Nassarawa State

Estimated parameters	**Non- Mechanized**	**Mechanized**
Constant	1,421^{NS}	0.743^{NS}
	(19.114)	(128.161)
Farming experience (F_1)	-0.894^{NS}	1.646***
	(-6.721)	(28.161)
Household size (F_2)	-0.338^{NS}	0.225^{NS}
	(-0.267)	(22.330)
Household in rice farm (F_3)	0.163^{NS}	-2.250**
	(0.517)	(-227.625)
Farm size (F_4)	206.003***	2.394**
	(964.366)	(353.503)
Distance to rice farm (F_5)	-0.866^{NS}	-0.725^{NS}
	(-6.323)	(-24.605)
Membership of cooperative	(-1.169)	(2.649)***
Societies.(F_6)	-0.86	0.073
R^2	**89.90**	**53.10**

Source: Field Survey 2006.

Note: Figure in bracket is standard errors

*** Significant at $P < 0.01$

** Significant at $P < 0.05$

* Significant at $P < 0.1$

Number of Labourers Employed

The number of labourers employed to carryout various farm operations among mechanized and non mechanized rice farmers in the study area is presented in Table 3. The result indicated a mean of 35 farm labourers were employed for all the farm operations by mechanized farmers, 23 labourers (65.72%) were adult male, 9 labourers (25.71%) were adult female and 3 labourers (8.57%) were children. The non mechanized rice farmers employing a mean of 60 farm labourers, 33 labourers (55.00%) were adult male, 21 labourers (35.00%) were adult female and 6 labourers (10.00%) were children. From the mean total of labour of 60 labourers employed per hectare by non mechanized rice farmers, 20 labourers (33.34%) were engaged in weeding operation, 13 labourers (21.66%) were engaged in threshing, 10 labourers (16.67%) were engaged in land

preparation, 8 labourers (13.33%) were engaged in harvesting, 5 and 4 labourers (8.33% and 6.67%) were engaged in fertilizer application and planting respectively. From the mean total of 35 labourers employed per hectare by mechanized rice farmers, 12 labourers (34.28%) were engaged in harvesting operation, 10 labourers (28.57%) were engaged in threshing operation, 6 labourers (17.14%) were engaged in fertilizer application, 4 labourers (11.43%) were engaged in planting, 2 labourers (5.72%) in herbicide application and 1 labourer 2.86%) in land preparation.

The result revealed that male labour is the most predominantly employed labour in land preparation, planting, fertilizer application and harvesting by the two groups and female labour is mostly employed in weeding and threshing operations. However, this study agrees with David and Adamu (1988) women contribute most labour in transplanting, weeding, threshing and grain processing. Chdebelu (1991) conclusion; that farmers believe women are better than men in weeding because they are more painstaking and can bend down for hours.

Table 3: Category of Labour employed by Mechanized and Non Mechanized rice farmers for various Farm operations in Nassarawa State

	LABOUR MAN-HOURS PER HECTARE UTILIZED							
	NON - MECHANIZED				MECHANIZED			
Farm operation	**Adult Male**	**Adult female**	**Child**	**Total**	**Adult male**	**Adult female**	**Child**	**Total**
Land preparation	10(100)* (30.30)**	-	-	10(100)* (16.67)**	1(100)* (4.35)**	-	-	1(100) (2.86)**
Planting	2(50.00)* (6.06)**	1(25.00)* (4.764)**	1(25.00)* (16.67)**	4(100)* (6.67)**	2(50.00)* (8.70)**	2(50.00)* (22.22)**	-	4(100)* (11.43)**
Fertilizer application	3(60.00)* (9.09)**	1(20.00)* (4.76)**	1(20.00)* (16.67)**	5(100)* (8.33)**	4(66.66)* (17.38)**	1(16.67)* (11.11)**	1(16.67)* (33.33)**	6(100) (17.14)**
1st weeding	4(40.00)* (12.13)**	5(50.00)* (23.81)**	1(20.00)* (16.67)**	10(100) (16.67)**	-	-	-	-
2nd weeding	3(30.00)* (19.09)**	6(60.00) (28.57)**	1(10.00)* (16.67)**	10(100) (16.77)**	-	-	-	-
Herbicide App. Pre	-	-	-	-	1(100)* (4.35)**	-	-	1(100) (2.86)**
Herbicide App. Post	-	-	-	-	1(100)* (4.35)**	-	-	1(100) (2.86)**
Harvesting	8(100)* (24.24)**	-	-	8(100) (13.33)**	12(100)* (52.17)**	-	-	12(100) (34.28)**
Threshing	3(23.08) (9.09)**	8(61.54)* (23.10)**	2(15.38)* (21.66)**	13(100) (2166)**	2(20.00)* (8.70)**	6(60.00)* (6.67)**	2(20.00)* (8.70)**	10(100) (28.57)**
Total	**33(55.00)* (100)**	**21(35.00)* (100)**	**6(10.00)** (100)**	**60(100) (100)**	**23(65.72)* (100.)**	**9(25.71)* (100)**	**3(8.57)* (100)**	**35(100) (100)**

Notes: * Values in bracket are percentages of row total ** Values in bracket are percentages of column

Labour Utilization in Rice Production by the Sample Farmer (Man-hrs/HA)

The amount of labour man-hours per hectare utilized for various farm operations among mechanized and non-mechanized rice farmers in the study area is presented in Table 4. The result showed that mechanized farmers utilized a mean total of 372.30 man-hours per hectare for all the farm operations. Male labour accounted for 243.79 man-hours per hectare (65.48%), 120.18 man-hours per hectare (32.28%) of adult female labor and 8.33 man hours per hectare (2.24%) of children labour. The non-mechanized rice farmers utilized a mean total of 898.49 man-hours per hectare for all the farm operations. Male labour accounted for 548.86 man-hours per hectare (61.09%), 330.01 man-hours per hectare (36.73%) of adult female labour and 19.62 man hours per hectare (2.18%) of children labour.

From the mean total of 372.30 man-hours labour per hectare utilized by mechanized farmers 151.20 man-hours per hectare (40.61 %) was utilized in harvesting operation, 126.36 man-hours per hectare (33.94%) utilized in threshing, 87.54 man-hours per hectare (23.51%) utilized in fertilizer application and planting, 7.2 man-hours per hectare (1.94%) utilized in land preparation and herbicide application. From the mean total of 898.49 man hours per hectare utilized by non mechanized farmers, weeding operation accounted for 364.72 man-hours per hectare (40.60%), 176.40 man-hours per hectare (19.63 %) utilized in land preparation, 133.66 man-hours per hectare (14.87%) utilized in threshing, 151.20 man-hours per hectare (16.83%) utilized in harvesting, 72.51 man-hours per hectare (8.07%) utilized in fertilizer application and planting.

However, adult male labour was utilized more in land preparation, planting, fertilizer application and harvesting in both groups, while adult female labour was utilized more in weeding under non mechanized and threshing in both groups and adult male in herbicide application. Weeding was the major labour demanding operation and adult female were mostly utilized. This agrees with Idi (2004) non-adopters have weeding as the major labour demanding operation with 158 man-days (61.70%) of the total. Chidebelu (1991) added that applying fertilizer makes extra weeding necessary and women do most of the weeding. Hamidu (2000) gives

another dimension to it by stating that weeding and harvesting were two farm operations on which about 50% of the total labour input for both hired and family were expended.

Table 4: Category of Labour Man-Hours Per Hectare Used by Mechanized and Non Mechanized rice farmers for various Farm operations in Nassarawa State

	Labour man-hours per hectare utilized							
	Non - mechanized				Mechanized			
Farm operation	**Adult male**	**Adult female**	**Child**	**Total**	**Adult male**	**Adult female**	**Child**	**Total**
Land preparation	176(100)* (32.14)**	-	-	176.40(100)* (19.63)**	2.48(100)* (1.02)**	-	-	2.48(100) (0.67)**
Planting	18.96(57.32)* (3.45)**	11.68(35.31)* (3.54)**	2.44(7.37)* (12.43)**	33.08(100)* (3.68)**	20.41(49.06)* (8.37)**	21.19(50.94)* (17.63)**	-	41.60(100) (11.17)**
Fertilizer application	25.84(65.53)* (4.71)**	11.19(28.38)* (3.39)**	2.40(6.09)* (12.23)**	39.43(100)* (4.39)**	32.66(71.09)* (13.40)**	10.91(23.75)* (9.08)**	2.37(5.16)* (28.45)**	45.94(100) (12.34)**
1st weeding	79.10(43.31)* (14.41)**	98.82(54.21)* (29.94)**	4.71(2.58)* (24.01)**	182.63(100) (20.33)**	-	-	-	-
2nd weeding	60.81(33.40)* (11.08)**	116.57(64.02) (35.32)**	4.71(2.58)* (24.01)**	182.09(100) (20.27)**	-	-	-	-
Herbicide App. Pre	-	-	-	-	2.40(100)* (0.98)**	-	-	2.40(100) (0.62)**
Herbicide App. Post	-	-	-	-	2.32(100)* (0.95)**	-	-	2.32(100) (0.62)**
Harvesting	151.20(100)* (27.55)**	-	-	151.20(100) (16.83)**	151.20(100)* (62.02)**	-	-	151.20(100) (40.61)**
Threshing	36.55(27.35) (6.06)**	91(65.64)* (27.18)**	5.36(4.01)* (27.32)**	133.66(100) (14.87)**	32.32(25.58)* (13.26)**	88.08(69.71)* (73.29)**	5.96(4.71)* (71.55)**	126.36(100) (33.94)**
Total	**548.86(61.09)* (100)**	**330.01(36.73)* (100)**	**19.62(2.18)* (100)**	**898.49(100) (100)**	**243.79(65.48)* (100.)**	**120.18(32.2)* (100)**	**8.33(2.24)* (100)**	**372.30(100) (100)**

Notes: * Values in bracket are percentages of row total ** Values in bracket are percentages of column

Labour Cost

The cost of labour per hectare expended by mechanized and non-mechanized rice farmers for various farm operations is presented in Table 5. The result revealed that farmers operating under non mechanized system expended ₦6,185.49 in land preparation. ₦10,640.48 in first and second weeding, ₦5,956.50 in threshing and harvesting, ₦2146.96 in planting and fertilizer application. The mechanized rice farmers expended ₦6,072.11 in threshing and harvesting, ₦3,393.36 in land preparation, ₦2286.96 in planting and fertilizer application, ₦808.17 in herbicide application. This implies that labour per hectare was expended more in weeding and land preparation under the non-mechanized system. While under the mechanized system labour was expended more in threshing and land preparation. The high expended difference in land preparation and weeding in both groups were attributed to the used of mechanization.

Table 5: Cost of Labour per hectare expended by Mechanized and non Mechanized Rice Farmers in Nassarawa State

	Labour Cost Per Hectare (₦)	
Farm operations	**Non- mechanized**	**Mechanized**
Land preparation	6185.49	3393.36
Planting	1136.98	1229.33
Fertilizer application	1009.98	1057.63
1st weeding	5346.99	-
2nd weeding	5293.49	-
Herbicide application (pre)	-	409.19
Herbicide application (post)	-	398.98
Harvesting	2475.82	2611.21
Threshing	3480.68	3460.90
Total	**24929.31**	**12560.90**

Source: Field Survey 2013.

Labour Saving in Rice Production

The savings in labour of mechanized and non-mechanized rice farmers in the study area were analyzed by finding the difference in the number of labourers employed, man-hour utilized and cost of labour expended.

The differences between mechanized and non mechanized rice farmers in the number of labourers employed, man-hour utilized and cost of labour expended for various farm operation is presented in Table 6. The result revealed that 20 labourers were saved in weeding operations, 9 were saved in land preparation and 3 in threshing operations. A mean total of 25 labourers were saved from the used of mechanization. A mean total of 526.19 man-hours were saved from which 364.72 man-hours and 173.92 man-hours were saved in weeding and land preparation. A mean total of ₦12,368.71 of labour cost were saved; ₦10,640.48 and ₦2,792.13 were saved from weeding and land preparation respectively.

This disparity between mechanized and non mechanized rice farmers manifested as a result of the use of tractor and herbicide which substitute hand weeding and manual land preparation. The use of tractor and herbicide reduces the number of labourers employed, the average working hours and the cost of labour expended. Okoruwa *et al,* (2006) asserts that in the face of scarcity and increasing wage rate of farm labour, the use of herbicides has been observed as a major labour saving device as the labour requirement always accounts for a higher proportion of the total farm labour cost in rice production. As labour saved from weeding accounted for ₦10,640.48 out of the mean total of ₦I2,368.71 saved from the cost of labour expended. Olayide and Heady (1982) added that large scale production with traditional equipment will definitely require for stumping and weeding unless economical herbicide are available. The amount of labour utilized in man-hours per hectare that was saved come from weeding and land preparation, Dey (1985) that high labour input of 128-220 labour -day per hectare are due mainly to the lack of mechanization, the intense hand weeding and the thorough all round cultural operations. The labour input is higher for hand weeding, land preparation and harvesting in that order. Falusi and Olayide (1980) gives another dimension to it by stating that human labour accounts for almost 90% of all farm operations in non-mechanization; and where mechanization is possible, human labour requirement make up to 50 - 65 percent of all farm operations.

Table 6:The Amount Of Labour Saved from the use of mechanization for various farm operations in Nasarawa State

Farm Operation	Labour saved per hectare		
	No of labourers Employed	Man Hour Utilized	Cost of Labour Expended
Land preparation	9	173.92	2792.13
Planting	-	-8.52	-92.35
Fertilizer application	-1	-6.51	-47.77
1st weeding	10	182.63	5346.66
2nd weeding	10	182.09	5293.49
Herbicide application (pre)	-1	-2.40	-409.19
Herbicide application (post)	-1	-2.32	-398.98
Harvesting	-4	-	-135.39
Threshing	3	7.30	9.78
Total	**25**	**526.19**	**12368.71**

Source: Field Survey 2013.

Note: Negatives values indicates labour for mechanized is greater than non mechanized farm operations:

Effect of labour use in various farm operations for rice on output

The relationship existing between total farm output (Kg ha) with labour (man-hours per hectare) utilized for various farm operations were determined by an estimating linear equation in Table 6. The result indicates that there is a positive and significant relationship between labour in fertilizer application ($P< 0.01$) and harvesting ($P< 0.05$) with total farm output for non-mechanized rice farms. Total farm output has a negative and significant relationship with labour utilized in second weeding ($p< 0.1$). The estimated parameters explained 63.00% of the total variation in farm output is due to them. The relationship has shown that the amount of labour used in fertilizer application and harvesting has significant influence on the amount of total farm output, which means increase in output pose greater labour input in harvesting and fertilizer application. The significant negative influence of labour used in second weeding indicate high labour demand of manual operation in weeding which delay the time of completion of operation and encourage plant -weed nutrient competition which retard plant growth and finally reduces yield in non-mechanized farms.

There is a positive and significant relationship between labour used in land preparation ($P< 0.1$) planting ($P< 0.1$), pre-emergency herbicide application ($P< 0.05$) post-emergency herbicide application ($p<0.01$) and harvesting ($p< 0.05$) with mechanized farm output. The R^2 was found to be 67.10%. The positive and significant influence of labour utilized in land preparation, planting, pre and post emergency - herbicide on the amount of mechanized farm output was as a result of the timely completion of land cultivation with uniform and timely completion of planting and weed control which add vigour to the plant, no plant -weed nutrient competition which invariably increases yield in mechanized farm. The positive significant influence of labour utilized in harvesting implies that greater labour inputs in harvesting poses greater yield. The greater variation in

labour utilized on mechanized farms implies that farm mechanization. -allows for more efficient farm operation which in turn positively affect yields as well as allows for timely completion of farm operations.

Table 7: Regression Result of Relationship between Labour use in various farm operations and total farm output of rice in Nasarawa State

Estimated parameters	Non- Mechanized	Mechanized
Constant	5.128^{NS}	1.29^{NS}
	(884.976)	(997.211)
Land preparation	-0.335^{NS}	1.061*
	(-4.914)	(2.205
Planting	0.123^{NS}	9.459*
	(0.199)	(2.857)
Fertilizer application	1.807***	0.798NS
	(3.524)	(3.967)
1st weeding	-0.261^{NS}	-
	(-4.070)	
2nd weeding	-2.116*	-
	(-3.124)	
Herbicide application (pre)	-	1.239**
		(1.469)
Herbicide application (post)	-	2.116*
		(3.124)
Harvesting	2.515**	1.249*
	(2.330)	(2.663)
Threshing	-0.317^{NS}	0.765^{NS}
	(-0.295)	(2.240)
R^2	63.00	67.10

Source: Field Survey 2006.
Note: Figure in bracket are standard errors
*** Significant at P < 0.01
** Significant at P < 0.05
* Significant at P < 0.1

IV. Conclusion

The study analysed the mechanized rice production in comparison with the non-mechanized rice production. Based on the results obtained it can be concluded that, the use of mechanization have positive impact on land preparation and weeding, which reduces the number of labourers employed, the average working hours and the cost of labour expended, which in turn, have positive impact on profit as well as allow for timely completion of farm operations.

Policy Implication

The level of higher productivity of mechanized rice farmers informed the need for policy makers to obtain a better understanding of the technical inefficiency facing the non-mechanized farmers. Based on the findings of this research, the following are recommended:

i. All rice farmers should be encouraged to adopt mechanized system of rice production. This will enhance the resource use efficiency and subsequently more farm returns thereby improving their standard of living.
ii. Due to the nature of small land holdings, small farm machineries should be fabricated to meet the needs of small farmers in the study area.
iii. Farmers organization or cooperatives should be formed among farmers, particularly in setting up joint use of farm machineries.
iv. Strong extension services should be provided to enable effective training of farmers on the use of application of herbicide to avoid chemical wastage and untimely application in case of labour shortages.

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