International Advance Journal of Engineering Research (IAJER)
Volume 2, Issue 4 (Apr- 2019), PP 04-07
ISSN: 2360-819X
www.iajer.com

Research Paper **Open Access**

Profitability and Energy Gaps Of Semi-Mechanized and Traditional Rice Production Technologies In North Central

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ABSTRACT: Efficient use of energies on crop production helps to achieve increased production and productivity as well as profitability and competitiveness of agricultural sustainability of rural communities. The study examined profitability and energy used of rice production under two different technologies in two States of Nigeria. Primary data through structured questionnaire and interview were administered to 265 rice farmers comprising 57 semi-mechanized (Group 1) and 208 traditional (Group 2) rice farmers in both States. Results revealed that the semi-mechanized had higher income ₦370,998.2 ($2348.1) per ha compared to ₦307,031.1 ($1943.2) per ha from traditional technology. Group 1 farmers produced a total energy output of 3730.8 kg ha-1 compared to Group 2 farmers with energy output of 3170.2 kg ha-1. Conversely, the energy use efficiency, energy productivity and net energy of traditional system indicated high energy use efficiency compared to that of semi-mechanized system. Findings also showed that non-renewable energy in semi-mechanized (72.1%) was high compared to that of traditional group (32.8%). This could be a result of high usage of chemical fertilizer, herbicide, diesel and machinery. The result also revealed that rice production was driven by indirect energy in Group 1 (58%) and largely by direct energy in Group 2 (64.2%). The study suggests that farmers should imbibe machinery for pre-planting operations and introduce integrated weed management system and farm yard manure to control weed and improve crop nutrient and to reduce cost of production.

Keywords: rice, net energy, efficiency, net margin

I. INTRODUCTION

Rice (Oryza sativa L.) belongs to the Gramineae family, which is the most important of all cultivated crops world-wide (Oladimeji et al., 2013b). Rice production started in Nigeria in 1500 BC with low-yielding indigenous red grain species Oryza glaberrima that was widely grown in the Niger Delta area (Hardcastle, 1959). Rice is cultivated in virtually all the agro-ecological zones in Nigeria. Despite this, the area apportioned for rice farming still appears small as observed by Oladimeji and Ajao (2014). Further, the shortfall in the supply of rice in Nigeria has been attributed to inefficiency in the use of resources, disincentives from macro-economic environment, continuous rise in per capita consumption brought about by increased population and rapid urbanization and partly to production in the hand of small-scale farmers who use traditional technology (Oladimeji and Abdulsalam, 2014; Oladimeji and Ajao, 2014). For the purpose of this study, a farm that used scientific chemicals (e.g. fertilizer, herbicide, insecticide) and farm machinery such as tractor, planter, combine harvester, sprayer in most of the farm operations was considered semi-mechanised. However, a farm that uses simple farm tools like hoes, cutlasses was considered as traditional technology or non-mechanised.

In Nigeria and more commonly in most developing countries, the demand for food products has outstripped supply creating a huge deficit. Although importation of food products was used partially to fill the growing deficits in the past, and presently, its continuation constitutes avoidable drain on the country's scarce foreign earnings, especially during this period of economic recession and dwindling oil prices (Oladimeji et al., 2013a). It suffices to note that Nigeria is the leading consumer and the largest producers of rice in Africa and simultaneously one of the largest rice importers in the world. Available records from FAO (2010) reported in Oladimeji et al. (2013a) revealed that the total domestic rice production in Nigeria for 2 decades period (1990-2008) averaged about 3.2 million tons per annum and ranged from 2.5 million tons in 1990 to 4.2 million tons in 2008 with a standard deviation of 429, 600 tons during the 1990 to 2008 decades. But the estimated demand for rice consumption ranged from 3.8 million tons to 14.5 million tons during the same decades with annual average of approximately 8.0 million tons and standard deviation of 3.3 million tons (Figure 1)

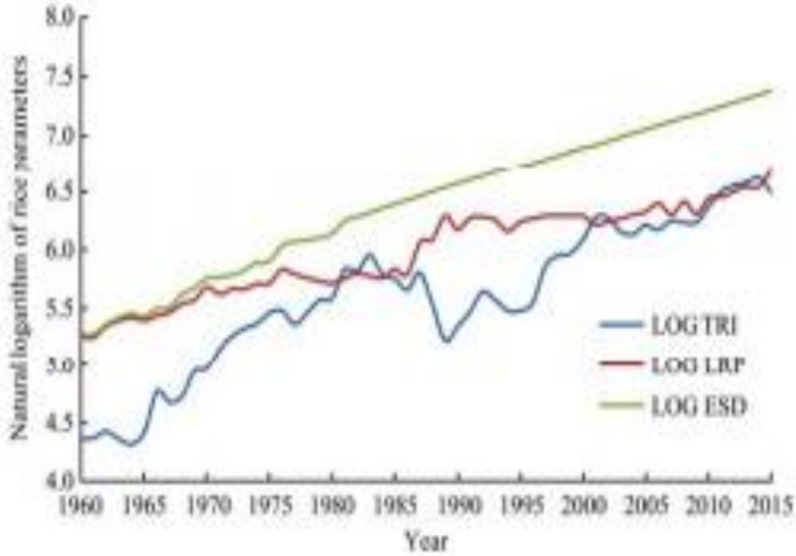

Figure 1 Trend analyses in Local Rice Production (LRP), Total Rice Imported (TRI) and Estimated Demand (ESD) in rice production in Nigeria (1960 - 2015)

Therefore, it becomes imperative to examine energy use in two different technologies that could enhance both small and large scale farmers to be more efficient in the use of available resources which is a major pivot for a profitable farm enterprise at microeconomic level and increased self-sufficiency and export at macro-level. Further, the subject of energy analysis of rice production in Nigeria has received substantial attention in the literature; however, fewer of such studies had estimated energy use and efficiency in rice production. The objectives of this study were to examine profitability and estimate energy use production for two groups of rice farmers with different level of production technology and machinery ownership status in Kebbi and Kwara States, Nigeria.

It is pertinent to note that the sample size from the two States (Kwara and Kebbi) was determined by adopting Ozkan et al. (2004) and Namdari (2011) method of sample determination given as:

$$n = \frac{\sum N_{cw} S_d}{N_{cw} D^2 + \sum N_{cw} S_d^2} \qquad (1)$$

where, n is the required sample size (farmers); N is the sample frame (number of farmers in target population); Ncw is the number of the population of rice farmers in the North-central and North-western Nigeria; Sd is the standard deviation in the two zones (North Central and North West Nigeria); S2 d is the variance of in the two zones; d is the precision level, z is the reliability coefficient (1.96 which represents the 95% reliability); $D2 = d^2 / z^2$.

Classification of rice farmers was based on level of farming technology. Semi-mechanised technology consist of farmers who owned or rented machinery such as tractor and imbibed modern management practices such as chemical fertilizers, herbicides, hybrid seeds, knapsack sprayers, irrigation equipment and received extension services. Traditional technology farmers were made up of rice farmers who used solely crude implements such as hoes and cutlasses hence which referred to as non-owners of machinery or imbibed low level of farming technology (Zangeneh et al., 2010; Namdari, 2011), seldom receive extension contacts and low level of hybrid input usage.

This experiment was conducted at Teagasc Grange (53o 30'N, 6o 40'W, 83 m above sea level) using three plots (each 10 m × 2 m) of perennial ryegrass (Lolium perenne L., an equal mixture of the late diploid varieties Denver, Soriento and Tyrella) and three plots of Timothy (Phleum pratense L., an equal mixture of the varieties Comer, Erecta and Promesse) within each of four replicate blocks. Each plot received 120 kg N, 28 kg P and 120 kg K ha-1 in mid-March. Immediately prior to each harvest, grass growth stage was determined for 20 randomly selected tillers per plot according to Moore et al (1991). One plot per grass species was harvested within each block on 14 May (early), 28 May (intermediate), and 11 June (late). Consecutive regrowths of the plots harvested on the 28 May (Cut 1) were subsequently harvested on 16 July (Cut 2), 03 September (Cut 3), and 28 November (Cut 4). Each plot received 100, 80 and 60 kg N ha-1 immediately after Cuts 1, 2 and 3, respectively, as well as 10 kg P and 43 kg K ha-1 on each of these three occasions. Plots were harvested using a Haldrup forage plot harvester (J. Haldrup, Løgstor, Denmark) cutting to an average 5 cm stubble height and the herbage was weighed and precision chopped (Pottinger Mex VI; Grieskirchen, Austria). A representative sample of harvested herbage was stored at –18° C for chemical analysis.

It sufficed to note that traditional rice production technology largely have limitations towards achieving self-sufficiency in rice production viz. drudgery nature, limited size holdings, time consuming and more labour fatigue which results in low yields. Several studies (Ahmadu and Erahabor, 2012; Oladimeji and Ajao, 2014) adjudged that the bulk of rice production in Nigeria lied with small scale farmers with average size holding of 2.0-5.0 ha. Therefore, government policy must promote gradual technology shift to semi-mechanized farming and in the long run total mechanized, to achieve self-sufficiency in rice production. This result agreed with the finding of Cherati et al. (2011), Oladimeji and Abdulsalam (2014), Oladimeji et al. (2016) that reported significant net margin difference between mechanised and traditional technologies in rice production in Iran and vegetable and melon production respectively in Nigeria.

The energy productivity (kg MJ-1) of inputs used for the two rice production technologies denoted by ratio of rice output (kg ha-1) to each energy input (MJ ha-1) was presented in Table 4. The value of energy productivity for the semi-mechanised inputs ranged from 0.30 (machinery) to 7.11 (rice seed) compared to energy productivity of traditional technology which ranged from 0.31 (water) to 9.11 (herbicide). Therefore, the summary statistics of the energy productivity (EP) of inputs used in both technologies indicated that farmers could improve their EP by using more improved and sophisticated inputs which could boost their rice output. For example, traditional farmers obtained 9.11 kg per MJ of herbicide used. Similarly, semi-mechanised farmers obtained 7.11 kg per MJ for sowing hybrid seeds. However, low EP in semi-mechnised farming was recorded in usage of machinery, diesel fuel and nitrogen fertilizer contrary to a priori expectation. Several studies adduced reasons for low EP in aforementioned inputs. These included non-compliance with recommended fertilizer rate and requirement (NCRI, 2004; Oladimeji and Ajao, 2014) of 250-350 kg ha-1 (used 185 kg ha-1), average seed rate (Wilson and Wilson, 1999) of 45-65 kg ha-1 (used 35.7 kg ha-1), quite often, surpassed uses of herbicide of 7.4 litres contrary to 4 litres recommended for rice production (NCRI, 2008) and the excessive uses of labour resource in rural areas tend to be a common occurrence due to rather low opportunity cost for the input (Ladipo et al., 1992; Oladimeji et al., 2013a, 2013b). Family labour cannot sensibly be 'laid off'. For instance, in agricultural activities even when it is making a negative contribution, it still had to be catered for whether it is employed or not. Besides, the existence of disguised unemployment and under-employment of labour in rural areas of the country necessarily promoted excess labour in agriculture and fishing enterprises (Oladimeji et al., 2013a).

Nigeria lies between Longitudes 2°49'E and 14°37'E and Latitudes 4°16'N and 13°52' North of the Equator. The climate is tropical, characterized by high temperature and humidity as well as marked wet and dry seasons, though there are variations between South and North. It has a total land area of 923,768.6 km2 and 139 million people in 2006 (NPC, 2006) with average population an agricultural densities of 150 person km-2 and about 3.3 farm families km-2 respectively. The latest United Nation estimate at growth rate of 2.48% put the country at about 190 million people with average human density of 204 person km-2. The study was conducted in North-central and North- western Nigeria 40°00'N and 75°09'W. The two region falls within the tropical Guinea and derived savannah zone of Nigeria which combined to form woodland and tall grass savanna.

II. CONCLUSION AND RECOMMENDATIONS

The study examined profitability and energy use of rice production between semi-mechanized and traditional technologies in two States, Nigeria. The results revealed that the net farm income (profit), energy used per ha, energy output per ha and specific energy were higher in semi-mechanized sector than traditional method. However, renewable energy, direct energy, energy productivity and net energy thrived better in traditional method than semi-mechanized unit. In all, rice farmers are encouraged to shift to semi-mechanized farming for high energy output and increase profitability. Yet, the results of this study also signify that there is need to critically find a way of increasing low energy productivity in both sectors on one hand and increasing renewable energy in semi-mechanize farming on the other hand. Semi-mechanized system should adopt more organic agriculture and local resources to maintain soil fertility and natural processes to manage pests and diseases. The study also suggests that rice farmers should imbibe machinery for pre-planting operations (plough, harrowing and ridging if needed) and introduce integrated weed management system and farm yard manure to control weed and improve crop nutrient and to reduce cost of production. All these could be an impetus to achieve sustainable food sufficient, food security and improve living standard among rice farming households, and possible transition of Nigeria agriculture from subsistence to commercial production to support inclusive economic and human development of new sustainability development goals in developing countries.

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