Impacts of Agricultural Mechanization Adoption on Floodplain Sugar-Cane (*Saccharrum officinarum* L.) Farmers' Income in Mubi, N.E. Nigeria

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ABSTRACT

A survey was conducted in order to assess the effectiveness of agricultural mechanization adoption on floodplain sugar cane farmers' income in four (4) locations namely: Bahuli, Muchalla, Mijulu and Kirya, all within Mubi area. The survey was conducted between September, 2006 and May, 2007 growing season. Information related to the subject was sourced from target farmers (80) through purposively administered questionnaires. Information sought centered on inventory of practiced technologies, levels of adoption and its economic returns. Data generated during the study were statistically validated using the test-re-test method of reliability test and correlated positively (r=0.80). The data were analyzed and compared using simple bar charts, percentages, chi–square and Likert scaling test type. It was indicated that there was a higher concentration of traditional technologies among the farmers prior the adoption of modern agricultural mechanization as judged numerically. However, despite the awareness by the extension workers still there were about 5% of conservative farmers whom were adamant of the modern technological changes. Also, about 95% of farmer population experienced drastic rise in farm output and sales income from their sugar cane produce after the adoption process. Sugar-cane farmers' perception analysis further attested to positive effectiveness of both the modern agricultural mechanization and farm incomes during the period under study. The challenge for better prospective outputs further depends on the extent of extension awareness among practicing farmers in the study area.

Keywords: Adoption rate, Farm input, Farmers' perception, Traditional technology, Modern technology, Nigeria.

1. INTRODUCTION

Agricultural mechanization perhaps constitutes the center stage power sources for boasting agricultural production. The application of machines in agricultural production minimizes the burdens and drudgery of manual farm labor and increase farmers' income (Kepner et al, 2003). Farm machineries are collections of implements and devices for applying power on the farm. Some of the essential operations requiring farm machinery application in sugar cane production are; tillage (such as plough, harrow and ridging), irrigation, plant protection, harvesting and transportation. These items are recognized as the most costly operations in the budgets of the farmer (Igbeka, 1986; Havrland and Kapila, 2000).

Agriculture indeed constitutes the most promising vehicle for income drive among peasant farmers globally. In Nigeria for instance, it contributes more than 70% of population with habitation employment and about 40% of the gross domestic product (GDP) and contribute 88% of non-oil foreign exchange earning (Ado, 2005). Food demand growth rate of usually between 3-4% are recorded as against the annual production rate of 1% (Imam, 1984; Kwaghe, 2003). This regressive balance had long necessitated relevant authorities to formulate programmes packaged to boost food production through the adoption of appropriate technologies (Havrland *et al*, 2006). Notable of such programmes were operation feed the nation (OFN), national accelerated food production programme (NAFPP), green revolution programme (GRP), National agricultural land development authority (NALDA) amongst others. The agricultural development programme (ADP) appears the most recent farmer oriented organ for awareness creation in the Nigerian agricultural sector (Kwaghe, 2003). Olayide (1980) earlier reported that the desire to uplift Nigerian agriculture has suffered decline due to low technological ‘know how’. ICAR (2006) also mentioned that regular fall in crop yields are recorded as a result of poor adoption of appropriate technologies for food crop production.

Sugar-cane (*Saccharum officinarum L*), a heavy feeder crop grown for chewing, drinking juice, raw and centrifugal sugar, constitutes the cheapest source of energy-giving food substance to man (Onwueme and Sinha, 1999). Annually, crop returns translates into huge economic benefits among farmers, especially when grown on deep fertile soils under improved management systems (Onwueme and Sinha, 1999).

Mubi area is characterized by patched fertile grounds (floodplains) conducive for profitable sugar-cane production, where only little attention has been devoted to adoption of modern agricultural mechanization known for optimizing crop production in the past. This study was therefore designed to investigate the economic benefits achievable from adopting modern agricultural mechanization by sugar-cane farmers in the study area.

1.1 Research Objectives

To assess farming technologies practiced by sugar-cane farmers in Mubi area
To determine the economic benefits of adopting modern agricultural mechanization on sugar-cane farmers’ income in the area
To recommend the most profitable modern technology for sugar-cane production in the area

2. MATERIALS AND METHODS

2.1 The Study Area

Mubi is located in the North-eastern part of Adamawa state and situated between latitudes 9^o26^1 and 10^o10^1’N and longitudes 23^o11^1 and 13^o44^1E. It has a land area of 506.40km^2 with a population size of 759.045 at a density of 160.5 persons per square kilometer (Nwagboso and Uyanga, 1999). Its eastern boundary belts the Nigeria-Cameroon boarder by the North, Askira-Uba to the West and Hong Local Government Area to the South. The climate of the area is characterized by alternating dry and wet seasons. The rains last from April to October with a mean annual rainfall, ranging from 700mm to 1050mm and sometimes ranging between 998mm and 1262mm. The vegetation is of typical Sudan Savannah type, which connotes grassland interposed by shrubs and few tress, mostly Acacia, Eucalyptus and Locust-bean trees, amongst others (Adebayo, 2004). The dominant physical feature in the area is the Mandara Mountains, which runs along the Cameroon-Nigeria boarder with height of up to 1200 to 1500mm (Hiol et al, 1996).

2.2 Research Questions

What farming technology do the sugar-cane farmers now practice in Mubi area?
What benefits do the farmers derive from adopting modern farm machineries in the study area?

2.3 Field Survey

The study was conducted in four (4) sub-locations namely; Bahuli, Muchalla, Mijilu and Kirya, all within Mubi area, between September 2006 and May, 2007. The study used two methods of purposive data collection. First, a farm visit was conducted to view and sample field information through oral interviews from eighty (80) sugar-cane farmers on the impacts of modern technologies on their farm incomes. Similarly, a questionnaire was designed and purposively administered to sugar-cane farmers in the study area.

2.4 Data Analysis

The data collected was validated using the test-re-test method of reliability test (Dixon-Ogbechi, 2002; Asika, 2008), with a strong correlation (r=0.80) between the multi-stage responses to the field questionnaires within same farmer population. The data were then analyzed using descriptive statistical tools. Also, farmers' perception on the subject was analyzed using the Likert scaling test type (Asika, 2008). The technique analyses the questionnaire responses based on four (4) grades of effectiveness in the order; 1 = not effective; 2 = less effective; 3 = moderately effective and 4 = highly effective. The Effectiveness test value (ETV) is calculated as expressed by (Asika, 2008):

$$ETV = \frac{TNR \times LSG}{TAQ} \quad \ldots\ldots (1)$$

Where: ETV = Effectiveness test value, LSG = Likert scaling grade
TNR = Total number of responses TAQ = total administered questionnaire

An ETV of 2.5 was considered as the bench mark, below which any adopted technology was termed as not effective during the study period.
Parameter computed from the field performance of the various implement employed by the farmers before and after adoption process is the effective field capacity (ha/h) as expressed by Gbadamosi *et al,* (2004); Abubakar *et al,* (2009):

Effective field capacity, EFC = A/EOT ……………………………………… (2)

Where; A = Area covered in hectares (ha)
EOT = Effective operation time (h)

3. RESULTS AND DISCUSSION

Result on the inventory of farming technologies practiced is presented in Table 1.

Table 1: Inventory of Farming Technologies Practiced in the Study Area

	Farming Locations					
Farming Technologies	**Bahuli**	**Muchalla**	**Mijilu**	**Kirya**	**Total**	**% of Total**
Traditional technologies (Farm implement)						
Indian hoe	501	406	351	156	1414	24
Axe	223	340	465	251	1219	20
Cutlass	250	152	263	386	1067	18
Matchet	53	87	300	427	867	15
Planting Rod	330	250	296	230	1106	19
Ox-drawn plough	45	72	65	61	243	4
Total	1402	1307	1680	1511	5900	100
% of Total	24	22	28	26	100	
Modern technologies (Farm machinery/inputs)						
Disc plough	14	6	2	4	26	2
Disc Harrow	10	2	3	3	18	1
Number of herbicides use	65	8	43	52	168	10
Number of pesticide use	50	47	40	41	178	11
Water pumps	30	35	35	28	128	7
Knapsack sprayers	256	369	321	321	1169	69
Total	425	467	346	449	1687	100
% of Total	25	28	20	27	100	

The result indicated that more farmers used traditional implement than the modern farm implements. This event could have been due to habitual use and accumulation of ancient farm tools by traditional farming systems (Agboola, 1979). The traditional implements used among sugar-cane farmers accounted the Indian hoes (24%), as the most widely spread, followed by axe (20%) and planting rods (19%). However, Ox-drawn ploughs exhibited low percentage (4%) concentration in the locations studied. This was as a result of its low numerical availability in the study areas. Study conducted in the location indicated that Mijilu had the largest concentration (28%) of traditional farm tools in use prior to adoption process. It was followed by Kirya (26%), Bahuli (24%) and Muchalla (22%) with the least estimates.

A different trend occurred with the adoption of modern technologies, where locations like Mijilu that earlier had the largest (28%) number of traditional tools, now recorded the least concentration (20%) and paving way for other locations like Muchalla to record the largest adopted modern technologies by 28% followed by Kirya (27%) and Bahuli (25%). This leaves Mijilu location farmers as the laggards in the adoption process. Knapsack sprayer adoption rates recorded about twice the cumulative size of other modern technologies in all the locations studied. This was a rather high figure, suggestive of wider applicability of this modern equipment in crop production (Goni, 1983).

The farmers' adoption of modern agricultural mechanization in the study area is presented in Table 2 below. The result indicated that only few farmers were conservative towards the adoption. For instance, out of the 80 sampled sugar-cane farmers, only 5% of the farmers neglected the adoption of disc plough for cultivating their sugar-cane farms; while 95% of them adopted the use of the technology for same application. Similar wide adoption margins existed for water-pump, mineral fertilizers and pesticides with 20, 15, and 14 of farmers respectively, which negated the technologies.

Table 2: Results on farmers' adoption of the modern technologies (Farm machinery/inputs)

S/No.	Farm Machinery/ Inputs	Farming experience (years)	Adoption rate		Percentage adoption	
			Before	After	Before	After
1.	Tractor:					
	(i) Disc Plough	20	5	95	5	95
	(ii) Disc Harrow	20	6	94	6	94
2.	Water pumps	10	20	80	20	80
3.	Mineral fertilizer	15	15	85	15	85
4.	Pesticide	8	14	76	14	76
5.	Herbicide	6	22	78	22	82
6.	Sugar-cane (hybrid) sets	12	28	72	28	72

A higher rate of 80, 85, and 76 farmers later adopted the water pump generators, mineral fertilizers and pesticide use respectively. Results on Herbicides use indicated up to 22% of the sugar-cane farmers were late adaptors, though, a higher number of the farmers (28%) equally negated adoption of hybrid sets of sugar-cane for cultivation. However, larger portion of the farmers sampled adopted both herbicides application (78%) and hybrid sets of sugarcane (72%) on their commercial farms. Also, the chi-square analysis accounted the adoption of every technology assessed as highly significant (P = 0.05).

Most importantly, Table 3 presented the results of farmer income accruable from the adoption of these modern technologies on their small farm sizes, ranging between 2 to 10 hectares. It was observed that on a general note, the numerical size of farmers that earlier used the traditional technologies declined sharply on realization of increasing income among the early adaptors of the newer agricultural mechanization, since the input impact cannot be assessed until after the user (farmer) applies some of the inputs (Zijp, 1991; Samndi, et al, 2007). Prior the adoption process about 63% of the farmers earned below $100.00 from the sales of their sugar-cane products. Trial adoption of the modern facilities further exposed the farmers to generate relatively higher incomes (Table 3).

Table 3: Distribution of farmer income derived from adoption of modern agricultural mechanization

Farmer income	Before adoption process		After adoption process	
($)	Frequency	Percentage (%)	Frequency	Percentage (%)
< 100	50.0	62.50	0.0	0.0
100-500	20.0	25.0	30.0	37.50
500-700	8.0	10.0	35.0	43.75
700-1,000	2.0	2.50	10.0	12.50
>1,000	0.0	0.0	5.0	6.25
Total	80.0	100	80.0	100

In the successive harvest, none of the farmers' income recorded below $100.00 as compared to their previous income, when up to about 63% often only earned below $100.00 from their sugarcane sales. After the adoption process, 37.5% of the farmers generated between $200 and $500 seasonally. While larger percentage (43.75%) of the farmers earned between $500.00 and $700 during the period under study. However, it was observed that only 8% of the farmers realized between $700 and $1,000 and 6% of them generated beyond $1,000 from their sugarcane sales. Generally, the chi-square analysis recorded a significant (P = 0.05) rise in farmers' income as a result of the adoption of modern technologies on their farms.

Results on farmers' perceptions on the effectiveness of the adopted technologies on the sugarcane farmers' income are presented in Table 4 below. It indicates that the use of tractor implements, mineral fertilizers and improved sugarcane sets were all effectively influential on the economy of sugarcane producers in the study area. Only few negations were recorded for water pump, pesticides and herbicides application on sugarcane farms. Only Bahuli location indicated negative effectiveness of pesticides, likely due to its less or none application in the location. Both Muchalla and Mijilu locations indicated poor adoption of herbicides for controlling weeds on their sugarcane farms, while Kirya recorded lowest quantity of water pump generators for their sugarcane irrigation farming practices.

Table 4: Likert scaling test for effectiveness of adopted technologies on Sugar-cane production/farmers' income.

Adoption Parameter	Bahuli ETV	Bahuli ER	Muchalla ETV	Muchalla ER	Mijilu ETV	Mijilu ER	Kirya ETV	Kirya ER
Implement/Input Adoption:								
Tractor Implements	2.694	E	3.997	E	3.05	E	2.940	E
Water Pump	2.721	E	3.997	E	2.051	E	2.056	NE
Mineral Fertilizer	2.617	E	3.094	E	3.056	NE	2.944	E
Pesticides	1.657	NE	3.333	E	2.889	E	2.667	E
Herbicides	3.475	E	2.033	NE	2.222	E	2.670	E
Sugar-cane (hybrid) sets	2.678	E	3.056	E	2.664	NE	2.786	E
Adoption effectiveness:								
Implement output	2.788	E	2.951	E	2.615	E	2.512	E
Income rise on implement	3.751	E	3.815	E	3.101	E	2.613	E

Key: ETV=effectiveness test value; ER=effective rate; NE=not effective; E=effective

Ultimately, the generally high adoption benefits evidenced in the locations studied, encouraged most sugarcane farmers to expand their farm sizes as usual with agricultural adoption (Osaji, 1983; Williams, 1989; Tekwa and Abubakar, 2008), which reflected in the general rise in farm outputs and farmer incomes during the study period (Table 3).

The capacity of field machines in hectare per hour (ha/hr), according to Buckingham (1976) and Maduako *et al* (2004), is the function of non operating time due to idle travels such as; traveling to the field and turning at the ends. Fig 1 shows the field capacity of traditional farm tools used by the farmers prior adoption process and it was observed that the highest field capacity of 0.4ha/h was attained from the matchet, then followed by planting rod and cutlass that recorded 0.3ha/h each, with the lowest capacity of 0.1ha/h obtained from axe and mould board plough as similarly observed by Abubakar *et al* (2009) in Yola environment. The lower productivity experienced by the farmers before adoption could be attributed to the low field capacities obtained from the traditional tools since the power sources is human or animal efforts and the power obtained from man or animal is too dismal as compared to machine. A human can only develop 0.08 kW of power for some few hours due to fatigue but this, of course, varies with environmental conditions and the type of food intake (Ojha and Michael, 2003). Similarly, It was also observed (Fig. 2) that after adoption process (modern technologies) higher field capacity that ranged between 1.1 to 1.5ha/h was achieved when employed power tools (tractors) to drive implement such as disc ploughs and harrows where man can only serves as a controller of the machine, rather than the sources of power and the work can be accomplished within a reasonable time. Also the use of knapsack sprayers had improved their crop yield, whereby a farmer can spray chemicals (herbicides or pesticides) at a field capacity of 0.6ha/h to suppress weeds and pest infestation. However, the higher crop yield and income observed after adoption process could be attributed to the higher field capacity attainment from the adopted modern technology. It was also observed that none of the farmers employed cane harvester to harvest their sugar cane even after the adoption process this was as a result of non availability of the implement in the studied areas.

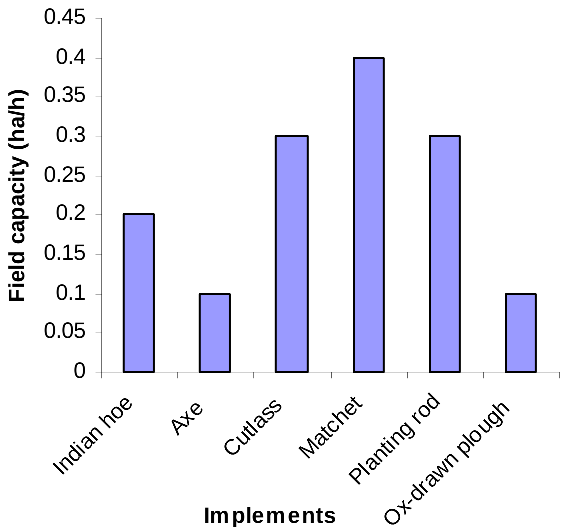

Fig.1: Effective field capacity of various farm tools employed by the farmers before Adoption

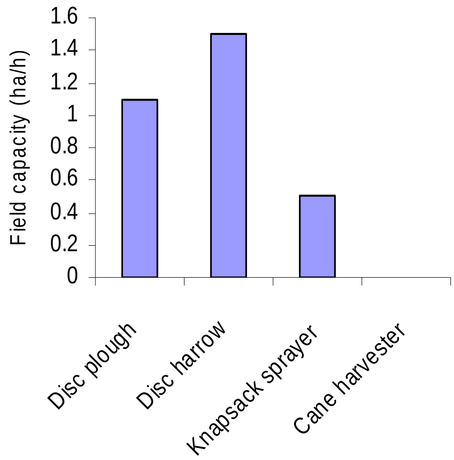

Fig 2: Effective Field capacity of various implement employed by the farmers after Adoption

4. CONCLUSION AND RECOMMENDATION

The technology is a system of many inputs (independent variables) and outputs (dependent variables). Six (6) different mechanized technologies were conceived as provided with various operations and inputs: Tractor Implements, Water Pump, Mineral Fertilizer, Pesticides, Herbicides and Sugar-cane (hybrid) sets. The high inventory of traditional technologies earlier in practice, recorded low in both farm outputs and farmers' income compared to the modern technologies that were later adopted. The result indicated that only few farmers were conservative towards the adoption process. For instance, out of the 80 sampled sugar-cane farmers, only 5% of the farmers neglected the adoption of disc plough for cultivating their sugar-cane farms; while 95% of them adopted the use of the technology for same application. Similar wide adoption margins existed for water-pump, mineral fertilizers and pesticides with 20, 15, and 14 of farmers respectively, which negated the technologies. Seasonal boost in farmers' income after adoption process are driving forces for farmers' high recruitments into adoption of modern agricultural mechanization. It suffices to recommend that extension works be devoted into wider farmer awareness education in order to achieve higher adoption of modern agricultural mechanization which proved rewarding to the sugar-cane farmers' income profiles in this study. Field trials of recently uncommon technologies could prove profitable on the available sugar-cane farms in Mubi area.

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