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COMPARATIVE PROFITABILITY ANALYSIS OF SELECTED RAINFED AND IRRIGATED FOOD CROPS IN ADAMAWA STATE, NIGERIA

A. K. TASHIKALMA, R. M. SANI AND D. Y. GIROH

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ABSTRACT

The study aimed at conducting a comparative profitability analysis of selected rainfed and irrigated food crops in Adamawa state, Nigeria. Two hundred and ten (210) (with 105 each from rainfed and irrigated) farmers growing rice, maize, tomato and pepper were randomly sampled for the 2007, 2008 and 2009 seasons respectively. The analytical tools used to achieve the objectives of study include descriptive statistics, profit function and farm budgeting techniques. Results revealed that 54.29 % of the farmers under rainfed and 69.02 % under irrigation were in their productive years of 31-50 years. Also 74.28 % and 53.33 % of the farmers attended one level of formal education or the other. Similarly 58 % of rain fed and 78.11 % of irrigated farmers cultivated less than 2 hectares of land while 92.38 % and 89.48 % had more than 10 years farming experience. The results of farm budgeting analysis revealed an average gross margin of ₦45,448,63, ₦41,396.84, ₦40,224.81 and ₦46,340.48 per hectare for rice, maize, tomato and pepper respectively under rainfed production. While under irrigated farms an average gross margin of ₦53, 904.68, ₦43,409.65, ₦66,520.78 and ₦66,681.99 per hectare were obtained for the four crops respectively. Furthermore the results of the profit function analysis under rainfed condition shows that labour was significant at 1% level and inversely related with profit. However, farm size, seed, and fertilizer were positively related to profit and significant at 1%. Similarly under irrigated condition labour was significant and inversely related to the profit. Land, fertilizer and agrochemicals were significant at varying levels and positively related to profit. The study therefore recommends that more financial assistance in the form of credit should be given to farmers so as to expand their production. Also, a minimum guaranty price of the farm produce should be enforced.

KEYWORDS: Rainfed, irrigated, food crops, profitability, Adamawa, Nigeria

INTRODUCTION

Equitable and sustainable development cannot ignore basic food commodities, particularly in developing countries such as Nigeria. In fact, in most periods economic growth has been highly correlated with agricultural progress. Basic food crops play an essential role in economic development (Akpokodje *et al*., 2001).Since the period of Nigeria's independence in 1960 and up to the present time, Nigerian government had implemented several agricultural programmes and in most cases the small-scale farmers have been in focus (Ajibefun and Aderinola, 2003). This is because the small scale farmers who constitute about 85 % of the farmers in Nigeria occupy an important position in the food production sector and produce about 90 % of the food consumed in the country (Rae, 1995; Food and Agriculture Organization, FAO, 1997; Agbonlahor, 1999). These farmers are however, characterized by low level production. Nwosu (2005) attributed the relatively low performance of the Nigerian agricultural sector to poor government policies, lack of access to farm inputs, inadequate farm subsidies, poor input delivery system, lack of access to market and market information among other challenges. Although estimates vary from different sources, most studies shows that, Nigeria' s food production on the aggregate, has been growing at the rate of about 2.5 % per annum while demand for food on the other hand, had been growing at over 3.5 % per annum (Abubakar, 2001; Ojo, 2007). The wide gap between food production and population growth rate has led to an increase in food importation, to bridge the gap between food supply and food demand; and high rate of increase in food prices due to deficit in local food production (Akande, 2002; Ojo, 2007). Trends in Nigerian food crops (maize, rice, tomato and pepper) exhibited one common feature during the period under review (i.e. 1995 – 2007). Total production in 1995 for maize, rice tomato and pepper were 6.931, 3.203, 0.569 and 0.612 million metric tonnes and 6.491, 3.841, 1.261 and 0.865 million metric tonnes in 2000 respectively. Total production decreased with about 0.440 million metric tonnes for maize increased with about 0.638, 0.692 and 0.253 million metric tonnes for rice, tomato and pepper respectively. Similarly, in 2001 total output for the same crops (maize, rice, tomato and pepper) were 8.189, 3.103, 1.251 and 0.862 million metric tonnes and 10.370, 3.929, 2.043 and 1.406 million metric tonnes in 2005, which shows an increase of 2.181, 0.823, 0.792 and 0.544 million metric tonnes respectively (Table 1). Also in 2006 total output for the same crops were 11.087, 4.200, 2.079 and 1.430 million

A. K. Tashikalma, Department of Agricultural Economics and Extension, Modibbo Adama University of Technology, P.M.B 2076, Yola, Nigeria
R. M. Sani, Agricultural Economics and Extension Programme, Abubakar Tafawa Balewa University, Bauchi, Nigeria
D. Y. Giroh, Department of Agricultural Economics and Extension, Modibbo Adama University of Technology, P.M.B 2076, Yola, Nigeria

metric tones and 11.520, 4.366, 1.701 and 1.310 in 2007 which shows an increase of 0.433 and 0.166 million metric tonnes for maize and rice respectively. However, there was a decline in output of tomato and pepper by about 0.378 to 0.120 million metric tonnes as shown in Table 1.

Table 1: Output of major food crops in Nigeria ('000 tonnes)

Year	Maize	Rice	Tomato	Pepper
1995	6,931.0	3,203.0	569	612
1996	6,217.0	3,122.0	569	633
1997	6,285.0	3,230.0	650	745
1998	6,435.0	3,486.0	810	709
1999	6,515.0	3,522.0	1,078.78	812.50
2000	6,491.0	3,841.0	1,260.79	864.77
2001	8,188.5	3,102.9	1,251.00	861.62
2002	8,527.9	3,231,5	1,284.06	901.05
2003	8,658.1	3,520.3	1,324.43	945.78
2004	9,503.4	3,713.9	1,805.09	1,009.95
2005	10,369.6	3,929.4	2,042.86	1,406.24
2006	11,087.4	4,200.0	2,079.03	1,430.05
2007	11,520.0	4,365.8	1,701.40	1,310.20

Source: FAO(2004); CBN(2007), NPAFS(2009)

Several studies revealed that, there is much need to increase food output in order to: feed the increasing population; earn the needed foreign exchange to import non-food needs; to generate savings for investment; and to preserve and conserve the natural resource base to enhance its productivity (Eugene, 2007; Stephen and Mshelia, 2008). Also, Federal Ministry of Agriculture, FMA (1993) estimated that, the annual supply of food crop would have to increase at an average annual rate of 5.9% to meet food demand and reduce importation significantly. Since the demand for food in the country as in other developing nations is increasing by the day, due to rising standard of living, rising income, increasing population and the normal long dry spell in some parts of the country, there is the need for the increasing demand to be addressed so as to bridge the shortfall (FAO, 2004; Central Bank of Nigeria, CBN, 2005; Eugene, 2007).

Consequently, the approach to increasing agricultural production in the country through irrigation farming is a major panacea, if the problem of food shortage in the country is to be addressed. Therefore, the production of stable food crops such as rice, maize, tomatoes and pepper through irrigation among farmers have open ways for the raising food supply in the nation. Also, rainfed production being a traditional farming technique has been an important way in increasing agricultural production as well as improving the farmers' output and income. Hence irrigated and rainfed agricultural production has been studied by different researchers in the country. However, Baba *et al*. (1999), have worked on factors affecting efficiency of resource use under large scale irrigation farming in Bauchi State and reported that, benefits accruable from the irrigation scheme can still be exploited with more effective management at the project and farmer's level. Also, the study revealed that, although investment in pump irrigation system was found profitable in the study area, the farmers low returns could be greatly improved through availability of water supply improved seeds and high prices during the peak harvest period. Agricultural production involves the process of combining resources (inputs) into an organized productive unit under management with the objective to maximize output, profit satisfaction and minimize cost or combination of some or all of three motives (Olayide and Heady, 1982). The major resources used in production are land, labour, capital and management. The benefit associated with agricultural production depends on cost incurred for those costs are related with the quantity of resources used in the production process. Therefore costs and returns measures profitability (Olukosi and Erhabor 1988).

Olukosi and Erhabor (1988) defined cost as the value of inputs used in production, while return refers to the gains from production. Olayide and Heady (1982) defined cost of producing any good or services as the value of the resources used in producing them in their best alternative way.Olukosi and Ogungbile (1989) have examined two major categories of cost involved in production. These are variable and fixed costs. Variable cost (VC) refers to the expenses that vary with the level of production (output). Fixed cost (FC) on the other hand refers to expenses that do not vary with the level of production. Olagoke (1991) compared the average production costs, input usage and returns for the major rice production systems in Anambra State. The study found that the highest rice yield per hectare was obtained from irrigated fields which averaged 2.19 tonnes per hectare, followed by swamp fields of 1.96 tonnes/ha, while for the upland fields gave 1.71 tonnes/ha. Irrigated rice fields also averaged the highest total production costs, largely due to the cost of irrigation water and higher labour and machine use costs. As a result of the higher production costs of irrigation, swamp rice with slightly lower yields achieved the highest net returns of the three production systems. Swamp rice also achieved the lowest production costs per kilogramme of output (₦0.92/kg), which compares with a unit paddy rice of ₦1.21/kg. He also found that weeding cost comprised the largest share of average total labour costs on upland and irrigated rice fields accounting for about 35% and 25% of total labour costs respectively. Okorji and Onwuka (1994) estimated the profitability of

rice production in Uzo Uwani area of Enugu State. The results revealed that the total variable cost per hectare was ₦4,385.00 for non-irrigated farms and ₦ 4,688.00 for irrigated rice. The total fixed cost per hectare was ₦ 465.00 for non-irrigated rice and ₦1,554.00 for irrigated rice. They also found out that labour is the most expensive resource in rice production-constituting about 55% and 50% of the total costs of production in the non-irrigated and irrigated systems respectively. The net return per hectare for non-irrigated and irrigated rice farmers were ₦4,615.00 and ₦5,197.00 respectively. The higher return obtained from the irrigated rice system was as a result of the higher paddy yields obtained under the irrigated conditions. Nwoye (1997) investigated the economics of rice production by small-holder farmers in Anambra State. The result revealed that swamp rice yield 2 tonnes paddy per hectare, resulting in gross margin of ₦3,735.00/ha and a total production costs of ₦2.67/kg.Also, Ani (1999) analyzed performance of rural farmers in Fadama users' association (FUA) in Northern Bauchi zone. The results revealed that farmers annual income, increased substantially by participating in the Fadama User's Association programme and therefore, this programme had a positive impact on the side of farmers in raising their standard of living. Similarly, Baba *et al.* (1999) use net farm income (NI) model to determine costs and returns of irrigated farming projected over five year period. Results revealed that investment in small-scale irrigation farming was profitable when family labour was assumed to have a very low or zero opportunity cost, as the discounted average Net Present Value (NPV) was ₦15,582.64/ha but when family labour is costed the NPV dropped to ₦503.44/ha which according to them, more than half of the farmers produced at a loss because about 53% of them obtained negative NPV. Ajani and Olayemi (2002) revealed that gross margin per hectare was highest in maize/cowpea enterprise with ₦77,998.90 while it was least in cowpea enterprise with ₦61,550.20. This implies that maize/cowpea is the most profitable business followed by maize/yam in the study area.

In response to the dwindling performance of the agricultural sector, several measures have been introduced by the Federal Government to combat food problem. Unfortunately, the effort of the government over the years has not yielded the desired results, productivity has remained low. This is revealed by the actual yields of major crops compared with potential yields (FMA, 1993).The actual yields of maize, rice, tomato and pepper for example, were reported as 1.64, 2.18, 5.72 and 3.85mt/ha while the potential yields are 3.60, 4.07, 7.00 and 5.51mt/ha for the respective crops (Tindall, 1968; Onwueme and Sinha, 1991; National Programme for Agriculture and Food Security; NPAFS, 2009). Furthermore, research by Baba and Etuk (1991), Maurice (2004), Idiong *et al.* (2006) and Shehu *et al.* (2007) revealed that as far as crop production under small scale is concerned, resources were inefficiently allocated with a resultant low productivity. The implication is that there is the scope for additional increase in output per hectare if resources are properly utilized and allocated efficiently in both rainfed and irrigated agriculture. Hence, this study of comparative profitability of selected rainfed and irrigated food crops is crucial. The study was therefore conducted to compare the profitability of selected rainfed and irrigated food crops in Adamawa State. The specific objectives were describe the socio-economic characteristics of the farmers; compare costs and returns under rainfed and irrigated food crops and examine and compare the effect of productive resource inputs on profitability of rainfed and irrigated food crops.

METHODOLOGY

The Study Area

Adamawa State is located in North-eastern part of Nigeria. It lies between Latitude 7^{o} and 11^{o} N of the Equator and between longitude 11^{o} and 14^{o} E of the Greenwich Meridian (Adebayo 1999a). It shared boundaries with Taraba in the South and West, Gombe State in the North-West, Borno State to the North and the republic of Cameroun in the East. Adamawa State has a total land area of about 38,741km^2 with a population of 3,168,101 million (National Population Commission; NPC, 2006). Using the national annual population growth rate of 3.2% the projected population of Adamawa State for 2010 is 3,593,501 people. The state is divided into 21 local government areas. There are two notable vegetational zones in the state: The Southern Guinea Savannah and the Northern Guinea Savannah. The topography is essentially picturesque mountainous land traversed by valleys of rivers Benue, Gongola and Yedzeram. The highlands of Cameroun, Mandara and Adamawa Mountain form part of this undulating landscape (Adamawa Agricultural Development Programme, AADP, 1996).The state has tropical climate marked by distinct dry and rainy seasons. The rainy season commences in April and ends in late October. The average rainfall in the northwestern part of the state is 700 mm and 1600 mm in the southern part. The wettest months are August and September while the driest months are January and February (Adebayo, 1999b). Temperature varies from place to place with minimum recorded temperature 18^{0}C and a maximum of 40^{0}C. Mean monthly temperature in the state ranges from 26.7 ^{o}C in the south to 27.8 ^{o}C in the northeast part of the state (Adebayo, 1999c). The state has a large number of ethnic groups and most widely spoken languages are Hausa, Fulfulde, Kilba, Margi, Higgi, Bura and Bwatiye. The predominant occupations of the people in the State are farming and livestock herding. Some of the agricultural crops grown are maize, rice, sorghum, groundnut, cowpea, cotton and vegetables (AADP, 1996).

Sampling Procedure and Method of Data Collection

A multi stage random sampling technique was employed in selecting the sampled farmers. First, the study area was stratified based on the four AADP Agricultural zones namely Zone I: Madagali, Maiha Michika, Mubi North, and Mubi South, Zone II: Girei, Gombi, Hong, and Song Zone III: Fufore, Ganye, Jada, Mayo Belwa, Toungo, Yola North, and Yola South and Zone IV: Demsa, Guyuk, Lamurde, Numan and Shelleng. Secondly 40% of the Local Government Areas in each of the Agricultural zones were randomly selected. In all, five local government areas were selected namely: Mubi North (Zone I), Gombi (Zone II), Ganye and Yola North (Zone III), and Demsa (Zone IV)

respectively. The third stage was the purposive selection of villages based on their relative importance in irrigation and rainfed crop production. A total of ten villages were selected from the five local government areas; these included Yelwa - Yebbi and Sugu (Ganye LGA), Boggare and Geriyo (Yola North LGA), Dwam and Dong (Demsa LGA), Garkida and Gombi (Gombi LGA), Mayo-Banni and Wuro Gude (Mubi North). Information on the population of the villages and importance of farming were obtained from the AADP. Finally, a sample of 240 households, 120 rainfed and 120 irrigation farmers were selected from the villages in proportion to their population size where 120 questionnaires were administered to each category of the sampled farmers to collect primary data. The primary data was a pre-tested structured and validated questionnaire on household production activities on irrigated and rainfed maize, rice, tomatoes and pepper respectively. Input-output (panel data) data for the period of three years (2007, 2008 and 2009) production seasons were collected on rainfed and irrigated maize, rice, tomato and pepper respectively on each farm. These include production cost, farm size, farm output and their market prices, sources of credit, tenurial arrangement, family and hired labour availability and cost. Information was also obtained on household heads characteristics such as age, family size, education and farming experience. The collection of data was facilitated by the use of the services of four trained research assistance, one in each AADP zone. However, 105 questionnaires each from rainfed and irrigated farmers were correctly filled and returned and used for analysis.

METHOD OF DATA ANALYSIS

Data collected were analyzed using descriptive and inferential statistics. Descriptive statistics such as means, frequency distribution and standard deviations were computed to achieve objective one of the study. Budgeting technique was used to assess the profitability of production enterprises. This analytical tool was used to determine costs and returns in rainfed and irrigated farming. Farm budgeting technique was used to calculate the costs and returns to the factors of production. The analysis provides measures of profitability of the enterprise that the farmers are engaged in. The budgetary analysis was carried out on per hectare basis for the different enterprises in the two production systems by estimating their gross margins. The gross margin of an enterprise measures the contribution of that enterprise to the farms total gross margin. Giving the fixed cost of production, the larger the total gross margin from all the enterprises on the farm, the larger is the farm net income. Gross margin represents the difference between the monetary value of all the output per hectare (gross returns) and the total variable cost per hectare (Jongur, 2006). The gross return is obtained by multiplying the total quantity of output produced by the average market price prevailing during the survey period. While the total variable cost is obtained by summing up the costs of labour, seeds, herbicides and all the other costs that varied with the level of output incurred during production. The gross margin of an enterprise is expressed as:

$$GM = \Sigma P_i Y_i - C_i \ (I = 1, 2, \ldots, n) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where GM = Gross margin in naira / ha, P_i = the market price of the i^{th} crop (₦/unit) in the enterprise, Y_i = the annual yield of the i^{th} crop (unit/ha) and C_j = the inputed variable cost of producing the i^{th} crop (₦/ha).

Profit function analysis was used to examine and compare the effect of productive resources on profitability of rainfed and irrigated food crops. A profit function was developed within the framework of the Cobb-Douglas production function (Ajani and Olayemi, 2002; Sanni *et al.,* 2003). Three functional forms were used in order to select the equation with the best fit, these are the semi logarithmic, exponential and double logarithmic functions. A lead equation was chosen, based on economic, statistical and econometric criteria (Olayemi, 1998). The specification of the profit model function is:

$$\ln \pi = b_o + b_1 \ln P_1 + b_2 \ln P_2 + b_3 \ln P_3 + b_4 \ln P_4 + b_5 \ln P_5 + e \quad \ldots (2)$$

Where: π = profit (gross margin), P_1 = farm size (ha), P_2 = Cost of seed (₦), P_3 = Cost of fertilizer (₦), P_4 = wage rate (naira/manday), P_5 = Cost of agrochemicals (₦), ln = log form of the respective parameters, b_o = constant, b_i = regression coefficients and e = disturbance term.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Farmers

Farming activities require manual labour, the provision of which is partly determined by age (Jongur, 2006). The distribution of respondents based on socio-economic characteristics is presented in Table 2. The mean age of farmers who were engaged in rainfed production was 48.26 years while, farmers involved in irrigation had a mean age of 45.02 years. Majority (54%) of the farmers under rainfed and 70% under irrigation were in their productive years of 31 -50. In both production systems, it suggests that the average farmer in the study area is active and still in his/her productive years. This finding is in agreement with Adeoti (2001) who reported that, the average farmer in Kwara State is 42 years old. Also this finding conforms to the report of Stephen and Mshelia (2008) in which they found that, majority (54%) of the cowpea farmers in Adamawa State were within the age of 31 -50 years. The significance of this active age range is that, able-bodied manpower would be available for production. Hence increased level of output resulting to high income is possible.

Table 2: Distribution of respondents based on socio-economic characteristics

Variable	**Rainfed**		**Irrigated**	
Age range (year)	Frequency	Percentage	Frequency	Percentage
21 – 30	3	2.86	6	5.71
31 – 40	10	9.53	26	24.76
41 – 50	47	44.76	47	44.76
51 – 60	39	37.14	19	18.10
61 – 70	6	15.71	7	6.67
Total	105	100	105	100
Minimum	23		27	
Maximum	77		72	
Standard deviation	8.34		9.5	
Mean	48.26		45.02	
Gender				
Male	91	86.67	102	97.14
Female	14	13..33	3	2.86
Family size				
1 – 5	5	4.76	11	10.48
6 – 10	37	35.23	26	24.76
11 – 15	32	30.48	44	41.90
16 -20	16	15.24	14	13.33
21 and above	15	14.29	10	9.53
Total	105	100	105	100
Minimum	2		3	
Maximum	22		19	
Standard deviation	5.83		5.37	
Mean	9		10	
Education				
No formal education	27	25.72	49	46.67
Primary education	56	53.33	33	31.42
Secondary	17	16.19	20	19.05
Tertiary	5	4.76	3	2.66
Marital status				
Married	84	80	91	86.66
Single	14	13.33	10	9.52
Widowed	5	4.76	2	1.91
Divorced	2	1.91	2	1.91
Source of land				
Inheritance	69	65.71	60	57.14
Rented/leased	13	12.38	28	26.67
Gift	5	4.76	2	1.91
Purchase/freehold	18	17.15	15	14.28
Farm size				
Less than 1	30	28.57	39	37.14
1.0 – 1.99	31	29.53	43	40.95
2.0 – 2.99	9	8.57	17	16.19
3.0 – 3.99	15	14.29	3	2.86
4.0 – 4.99	5	4.76	1	13.33
5.0 – 5.99	10	9.52	1	0.95
6.0 and above	5	4.76	1	0.95
Total	105	100	105	100
Minimum	0.5		0.25	
Maximum	11		7.5	
Standard deviation	1.74		0.95	
Mean	1.96		1.55	
Farming experience(years				
1 – 10	8	7.62	10	9.52
11 – 20	28	26.67	41	39.05
21– 30	40	38.10	37	35.24
31 – 40	25	23.80	14	13.33
41 and above	4	3.81	3	2.86
Total	105	100	105	100
Minimum	5		4	

Maximum	60		52	
Standard deviation	9.8		9.25	
Mean	23.98		21.12	
Sources of capital				
Personal	89	84.76	97	92.38
Borrowed	16	15.24	8	7.62
Access to farm extension				
Yes	96	90.48	92	85.71
No	9	9.52	13	14.29

Source: Field Survey, 2009

Gender is an important aspect of farming since farm operations vary from stage to stage. The study revealed that about 87 % of the respondents were males and 13 % were females under the rainfed production system, while under the irrigation production system about 97 % were male farmers and three percent were female farmers. This study shows that there are more males in both systems of production than the females (Table 2).This finding is in agreement with Jongur (2006) who reported that 90 % of Masakwa farmers in Adamawa State are males. This result is a further confirmation of evidences that, suggested gender inequality in agricultural production where men are more favoured than women. Reij and Water-Bayer (2002) and Giroh *et al.* (2010) attributed the lack of self esteem among women with respect to their farming activities to the traditional beliefs and attitudes regarding women's role in the society as well as the; low level of education; poor access to external information; and small size of plot allocated to women that seldom attract the attention of extension workers, hence limiting their access to extension activities. Overcoming these barriers would lead to more participation of women in food production.

Majority of the households, 66% under rainfed and 67% under irrigation production system have household size of between 6 and 15 persons (Table 2). The mean household size 9 persons under rainfed and 10 persons under irrigation production systems respectively. The number of persons in the household is very important in determining labour availability for farm work. Greater family size of average working age increases efficiency because most farmers are financially constrained. However, this factor can contribute to the low income status of farmers, since meeting all the family expenses will reduce greatly the income that will be left for subsequent production. Hence in the family, the consumption unit is also regarded as the production unit, especially under African culture (Olukosi and Erahbor, 1988). These household members contribute labour for both rainfed and irrigated farm productions in the study area. This is a common feature in Adamawa State under small-scale farming where household members provide most of the labour required for farming. This finding is in conformity with findings of Tashikalma (1998).

Education plays a significant role in skill acquisition and knowledge transfer (Ogundele, 2003). Education enhances technology adoption and ability of farmers to plan and take or averse risks. A summary of the distribution of respondents based on educational status is given in Table 2. The table revealed that 26% and 47% of the respondents practicing rainfed and irrigation systems of production had no formal education. Majority of the respondents, 74% and 53% respectively were found to have attended one form of formal education or another. High level of literacy among the farmers would not only enhance the adoption of new technology, but would also increase their ability to understand, and evaluate information on new techniques of production. This finding agrees with Stephen and Mshelia (2008) who reported that 72% of cowpea farmers in the study area are literate. Also Ajibefun and Aderinola (2003) reported that, educated farmers are expected to be more receptive to improved farming techniques and therefore showed higher level of technical efficiency than farmers with less education. Farmers with low level of education or without education would be less receptive to improve farming techniques. The marital status of farmers shows that, majority 78% and 87% of the respondents under rainfed and irrigation systems respectively are married. The greater proportion of married people under the two systems of production indicated that both systems are accepted and valued means of livelihood among the respondents (Table 2). This finding agrees with the observation of Contando (1997), who stated that, the bulk of agricultural production comes from farm families in the developing economies. This is also in line with Cunningham and Saigo (1999) who reported that, in developing communities the family size is heavily dependent on the income of the households which is derived mainly from agricultural practices. The distribution of respondents in relation to the sources of land shows that 66% and 57% of rainfed and irrigation farmers acquired their land through inheritance. About 12% and 27% had their land through leasing, while 17% and 14% of the respondents obtained their lands through purchase in both systems of production (Table 2). The distribution shows that, majority of the respondents under both systems of production acquired their land through inheritance. The implication of land ownership through inheritance, to agricultural development is that, it helps to limit farmers production potentials due to fragmentation of farm lands. Land control is always in effective, subdivision may occur at least once in each generation. This according to Johnson (1990) helps to discourage investment in land improvements. The summary of distribution of respondents' farm size is shown in Table 2. The size of the holdings for both rainfed and irrigated systems ranged from less than 1 to 6.0 hectares and above. About 58% of rainfed farmers and 78% irrigated farmers have farm sizes of less than 2 hectares respectively. Only five percent and one percent of respondents in the

2 production systems had land area of 6.0 ha and above. This implies that both rainfed and irrigation production systems in the state is essentially done by small scale farmers. This finding is in agreement with Tashikalma (1998) who reported that groundnut farming in Adamawa State is almost entirely by small-scale farmers with limited resources. Also Stephen (2006) reported that about 94 % of cowpea farmers in Adamawa State are small-scale farmers who cultivate between 1 and 4 hectares or less. Also Jongur (2006) reported that 66 % of Masakwa farmers in Adamawa State have farm sizes of less than 2 hectares. The distribution of respondents based on years of farming experience as shown in Table 2 revealed that most of the sampled farmers 92% rainfed farmers and 88% of irrigation farmers had more than 10 years of farming experience. These figures imply that farmers under both production systems are capable of taking good decision and could be expected to know the right management practices; since they have been in the production systems for quite sometimes .The number of years which a farmer had to spend in farming gives an indication of practical knowledge which has been acquired. This therefore shows that farmers with many years of experience might know better how to handle various farming operations than the farmers with few years of experience, and this would have an effect on the levels of output each year.

According to Ajibefun and Aderinola (2003) more experienced farmers are expected to have higher technical efficiency than farmers with low farming experience given that farming business involved annual routine activity. Similarly, Adebayo (2005) reported that experience is very important, and that the longer a person stays on a particular job, the better the job performance tend to be. The source of capital for farming is either through personal or borrowed sources. In this study, 85% and 92% of the rainfed and irrigation farmers depended on personal savings only. While only 15% and 8% of the farmers in the two production systems have borrowed money from both the formal and informal sectors (Table 2). This farmer's lack of access to bank loan/credit is attributed to lack of collateral and high interest rate charged by the financial institutions. This reveals the farmers lack of access to bank loan/ credit, which may be attributed to lack of collateral or high interest rate charged by financial institutions. This finding is in agreement with Stephen (2006) who reported that 97 % of the farmers in Adamawa State depend on personal savings. The implication of dependence on personal savings is low level of investment in agricultural sector. Hence low level of output and income. The distribution of the respondent based on contact with extension agents, revealed that 90% and 86% of the farmers under rainfed and irrigation systems respectively had contact with extension agents. Only 10% and 14% of the farmers had no contact with extension agents at all (Table 2). Access to extension services by farmers tends to increase their efficiency. Extension visits affords the farmers opportunity to learn improved technologies and how to acquire the needed inputs and services. The use of agricultural technologies is believed to be a strategy for making small-scale farmer economically viable (Bzugu and Gwary, 2005). Similarly Ogungbile and Olukosi (1992) asserted that the use of agricultural technologies will substantially increase farm production.

Costs and Returns of Rainfed and Irrigated Crops

The summary of costs and returns associated with rainfed and irrigated rice, maize tomato and pepper is presented in Tables 3 and 4 respectively. The estimate of gross margin under the rainfed production is presented in Table 3. Food crops considered under both systems were rice, maize, tomato and pepper. Pooled results revealed that, pepper has the highest gross margin of ₦46,340.48 per hectare and was the most profitable while tomato has the lowest gross margin of ₦40,223.81.

Enterprises gross margin for Irrigated crops

The gross margin per hectare of crops under irrigated production system is shown in Table 4 pooled results shows that pepper has the highest gross margin of ₦ 66, 681.90 per hectare and is also most profitable while maize has the lowest gross margin of ₦43,409.68. Enterprises under rainfed production system generally have lower gross margins when compared with those of irrigated production system. The reason for higher gross margin under irrigation condition is as a result of higher yields obtain under the irrigation condition as reported by some studies. For instance Okoji and Onwuka (1994) estimated that profitability of rice production in Enugu State. Results revealed the net return per hectare for non-irrigated and irrigated farmers were ₦4,615.00 and ₦5,177.00 respectively. The study revealed that the higher return obtained from irrigated rice system, was as a result of higher paddy yields obtained under irrigated condition. Similarly, Adeoti (2001) reported that enterprise under irrigation production system have the highest average gross margin when compared with rainfed enterprises.

Table 3: Gross margin per hectare of enterprises under rainfed production system pooled

Production input	Rice	Maize	Tomato	Pepper
Variable costs (₦)				
Yields (kg)	2,513.10	2,970.12	6,405.13	4,253.40
Seed	9,957.29	6.986.67	5,512.38	4,788.33
Fertilizer	16,479.61	14,025.86	19,029.78	13,210.17
Family labour	42,256.54	44,600.45	51,731.67	38,080.46
Hired labour	37,591.93	22,088.03	39,643.28	41,333.85
Ploughing	5,720.10	5,841.33	6,565.00	6,868.33
Agro-chemical	12,432.37	7,445.53	12,653.33	11,037.00
Transportation	8,415.44	7,070.7	14,939.81	11,607.22
Others	3,679.14	2,594.80	4,008.12	4,502.33
Total variable costs	136,532.42	110,653.72	154,083.38	130,166.45
Returns				
Total revenue	181,981.05	152,050.56	194,308.19	176,506.93
Gross margin	45,448.63	41,396.84	40,224.81	46,340.48

Source: Field Survey, 2007-2009

Profit Function Analysis

In determining the nature of relationship between the production resources used and profit level, a multiple regression model using ordinary least squares method was employed. The Cobb-Douglas production function gave the best fit and was selected and used in this analysis. The result of the analysis is presented in Table 5. Under rainfed production, the coefficient of multiple determination (R^2) was 0.73 implying that about 73 % of the variation in profit made by the rainfed farmers could be explained by the variation in the prevailing land area, cost of seed, fertilizer, agrochemical and wage rate. Also all the variables included in the model jointly influenced profit significantly as indicated by the significance of the F ratio. The regression coefficient of the Cobb-Douglas function represents direct elasticity of response of profit to increase in the explanatory variables in the model (Table 5). Labour was significant at 5 % and has inverse relationship with profit implying that unit increase in labour would result in decrease in profit. Farm size was positive and significant at 1% level, which implies that unit increase in farm size would result in increase in profit. Similarly fertilizer and seed were positive and significant at 1%. Increase in the quantities of fertilizer and seed hence increase in cost would bring about increase in level of profit (Table 5). Under irrigated production (Table 5), the coefficient of multiple determination R^2 was 0.79 implying that about 79 % of the variation in profit could be explained by variation of selected variables. Labour was significant at 1% and inversely related with profit. This implies that an increase in labour use would bring decrease in profit. However, land, fertilizer and agro-chemicals had positive relationship with profit and are significant at 1 and 5 % respectively. This indicates that increase in farm size, fertilizer and agrochemicals would bring about increase in profit. This finding is in agreement with Sanni *et al.* (2003) who reported significant relationship between capital, wage rate and farm size among farmers in Kaduna state.

Table 4: Gross margin per hectare of enterprises under irrigated production system pooled

Production input	Rice	Maize	Tomato	Pepper
Variable costs (₦)				
Yields (kg)	3,575.22	3,870.30	8,415.13	5,760.21
Seed	10,172.46	7,477.37	6,385.92	6,903.13
Fertilizer	14,772.50	11,992.15	17,622.53	14,239.40
Family labour	39,832.75	39,248.57	59,648.10	39,136.57
Hired labour	42,073.77	30,788.72	36,368.65	42,573.07
Agro-chemical	14,547.19	10,987.90	15,578.72	15,723.41
Transportation	18,815.35	13,558.53	16,928.75	15,794.97
Irrigation water	20,081.77	17,591.40	17,463.68	20,025.13
Others	4,416.67	3,698.87	5,061.60	3,918.73
Total variable costs	164,712.46	135,343.51	175,057.95	158,314.4
Returns				
Total revenue	218,617.08	178,753.19	241,578.73	224,996.4
Gross margin	53,904.68	43,409.68	66,520.78	66,681.99

Source: Field Survey, 2007-2009

CONCLUSION

This study has revealed that, food crop production under both rainfed and irrigated conditions is relatively profitable. The significance of variables such as land, seed, labour, fertilizer in the profit function has indicated their importance as policy variables that could be designed to raise the current profit of the farmers. The enterprises were profitable in all the areas under rainfed and irrigation production.

Based on the findings of the study, the following recommendations are made: Financial institutions such as banks and other agricultural agencies should provide funds in the form of capital or kind for example the provision of herbicides, pesticides, and tractors to farmers at affordable prices. Guaranteed minimum prices of farm produce be enforced, this would encourage farmers to remain in production.

Table 5: Results of the regression estimate of the profit function for rainfed and irrigated food crops

Variable	Parameters	Rainfed	Irrigated
Constant	P_o	4.1389***	4.178***
		(16.782)	(5.132)
Land	P_1	0.764***	0.424***
		(9.094)	(3.185)
Seed	P_2	0.275***	0.002
		(4.540)	(0.020)
Fertilizer	P_3	0.196***	0.106**
		(2.663)	(1.912)
Labour	P_4	-0.074**	-0.104***
		(-2.106)	(-2.909)
Agro-chemical	P_5	-0.056	0.093**
		(-0.0967)	(1.966)
R^2		72.6	79.2
F-ratio		43.251***	4.394***
SE		0.1670	0.3045

Source: Field Survey, 2007 -2009 *** = significant at 1%, ** = significant at 5%, * = significant at 10%
NB: figures in parenthesis are t-values

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