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ECONOMICS OF POTATO PRODUCTION UNDER IRRIGATED AND RAINFED CONDITIONS IN HIGH ALTITUDE AREAS OF NIGERIA

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ABSTRACT

Potato production in Nigeria is restricted to high altitude and low altitude areas with minimum temperature of 15^0C for 3 consecutive months. Jos plateau alone accounts for over 75% of total potato produced in Nigeria. It is grown under rainfed and sometimes irrigated conditions, and has a growing cycle of 3 months. The restriction of areas of production limits the availability of potato to consumers throughout the year. Irrigation was seen as possible way of raising the productivity of the crops as well as increasing the output since it can be grown 2-3 times in a year.

This study was designed to evaluate the economics of potato production under rainfed and irrigated conditions. The study was conducted at the Research farm of the National Root Crops Research Institute Kuru, Plateau State.

Results showed that the irrigated potato farm produced higher quantity of output at relatively high unit cost of production than rainfed production. However, the per-unit net returns are much higher on the irrigated potato farm.

The economic efficiency tests showed that the irrigated potato farm has high level of technical efficiency where land, labour and capital inputs were intensively used, while the rainfed potato farm was allocatively more efficient.

INTRODUCTION

Potato (*Solanum tuberosum*) requires high altitude, about 1,000-1,800 metres above sea level, and a low temperature of 150C or less. In Nigeria, the crop is grown in Jos and Mambilla Plateau, with altitude of at least 1,400 metres above sea level, and a temperature of about $10\text{-}20^0$C. In other producing areas, such as Bauchi and Jigawa States, potato is produced under irrigation

and the production is restricted to the cold periods of the year (November – February), when the temperature is quite low.

Potato is produced in severalother Northern States such as Borno, Kaduna, Kano and Sokoto during the colds dry periods. However, production is concentrated in Jos Plateau, and this accounts for over 75% of total production in Nigeria (Okonkwo et at, 1995[a]). In 1991 alone, total production in Nigeria was estimated to about 0.4 million metric tons (Okonkwo et al, 1005[b]).

Improved potato varieties popular with the farmers include Nicola, Desiree and Famosa. There are Dutch varieties imported into the country, multiplied and released to the farmers. The others that were bred at the potato programme of the National Root Crops Research Institute (NRCRI) are RC767-2 and RC7716-4. the later varieties are currently undergoing multilocational trials prior to release to farmers.

Potato is essentially produced under rainfed condition in Nigeria. Production under irrigation is restricted to areas where facilities for irrigation are available. In the farmers system, ditches are constructed on both sides of strips of tilled land. Thereafter water is pumped into these ditches from ponds or streams. Water could equally be pumped from ground water in low lying basins popularly called Fadamas and collected with calabashes or buckets for irrigation. In some other instance, petrol-driven irrigation pumps were supplied to farmers by government.

Irrigation is sometimes advocated as a means of raising the productivity of crops and therefore an economic input. Onyenweaku (1994) pointed out that irrigation is capable of lengthening crop season in arid, semi-arid and even moist subtropical lands, as well as providing more year- round employment opportunities in agriculture. Irrigation enables crops with short growing cycle to be grown more than once in a year, rather than relying only on rainfall alone. Several studies have examined the economic efficiencies of crop production under irrigated and rainfall conditions in Nigeria (Onyemweaku, 1994; Dittoh, 1991; Onwuka, 1991; Eramie 1985; Erhaboh, 1982; Fatokun, 1980).

In studies in other developing countries (Bagi, 1981; Woodhouse and Ndiaye, 1991), technical efficiency was shown to be higher on irrigated farm. The advantages of irrigation to farmers as enumerated by Woodhouse and Ndiaye (1991) inolude:

i. Irrigation enables farmers spread cultivation over more than one season;
ii. Use of labour, particularly family labour, is made more flexible;
iii. It synchronizes farming operations in adjacent fields and makes double cropping possible.

Potato can be grown all year round, especially with irrigation. With a production period of three months, potato can be produced three times in the year. Increase in the frequency of potato production per annum will tend to increase total production and make potato available to consumers almost throughout the years, irrespective of the limited storage facilities in the country.

OBJECTIVES OF THE STUDY

The broad objective of the study is to determine the relative efficiencies of producing potato under rainfed and irrigated conditions. Specifically, the study attempts to;

- determine the returns on potato production under the two systems of production;
- compare the economic efficiencies of the two production systems;
- assess the prospects of introducing irrigation within the socio-economic framework of potato producers in the study area;
- make policy recommendations on how to improve resource allocation in the potato sub-sector.

RESEARCH METHODOLOGY

This study was carried out at the research farm of National Root Crops Research Institute Irish potato programme, Kuru, Jos in Plateau State in dry and rainy seasons. The rainy season experiment was conducted from April to July 1994, while the dry season trial was done from November 1994 to February 1995 using irrigation facilities at NRCRI. In each case, one hectare of land was planted up with the variety Nicola, which is an all season variety popular among the farmers.

The recommended agronomic practices were carried out. Ridges of 40cm high were prepared with spacing of impart between rows; within row spacing was 30cm apart. The sett size of seed tubers was 50g. planting depth was 8-10cm. Mixed NPK fertilizer (20-10-10) was applied at 2 weeks after planting in a single dose at the rate of 400 kg/ha. The other inputs used were seed potato, Insecticide (Nuvacron) applied at 700 mls/ha to control aphids and herbicide (Lasso-Atrazine) applied pre-emergence at 4l/ha to control weed.

In the irrigated experiment Ridges 0.75cm between rows were prepared. Sprinkler irrigation was used and water was applied 3 times per week.

Data Collection Procedure

Data collected were the labour inputs from land preparation until harvesting and storage of produce.

Other data include the capital operating expenses on fertilizer, agrochemicals and potato seeds. The irrigation system, other tools and equipment were depreciated using the straight line method. The running costs (diesel, engine oil and pump operation) for the period were recorded. Also the tractor hire service was noted. The land rent for the area was estimated and this formed part of the fixed cost items. Finally, the opportunity costs of capital for both the variable and fixed costs were determined at he prevailing interest rate.

Data Analysis

Enterprise budgeting was used to estimate and compare the production costs and returns. Also using economic efficiency indices of technical and allocative efficiencies, the rainfed system was compared with the irrigated system at the 1995 factor cost. Technical efficiency refers to the ability to obtain the highest amount of output with given amount of factor inputs (Onyenweaku, 1994). It refers to the ability of farms to employ the best practice in an industry so that not more than the necessary amount of a given set of inputs is used in producing the best level of output (Timmer, 1970; Carlsson, 1972). The degree to which technical efficiencies are achieved is equivalent to production efficiency (French, 1977). In allocative efficiency, resources are allocated in the profit maximizing sense. This is the choice of optimum combination of inputs consistent with relative factor prices. Allocative efficiency is a measure of a firm's success in choosing optimal set of inputs.

For technical efficiency measurement, our pattern followed that of Adesimi (1988). Thus labour efficiency is given as the value of output per naira wage bill since the irrigated and rainfed potato farms in this study faced the same product and factor markets. Capital efficiency denotes the value of output per naira capital input; while land efficiency is given as the physical output per cropped hectare. Allocative efficiency, on the other hand, is derived as the ratio of total cost to actual yield. In this case the cost of producing a unit of potato in the two systems is derived.

RESULTS AND DISCUSSION

The production costs and returns for the two systems of potato production are presented in Tables 1 and 2.

Table 1: Cost and Returns for a hectare of Irrigated Potato Farm, Plateau State, 1994/95

	Unit per Hectare	Value per Hectare (₦)
Cross Revenue		185,400.00*
Production Costs		
Capital operating expenses:		
Potato seed (1.6t at N12,000/t)		19,200.00
Fertilizer: 13 (50kg bag) at N150/bag		1,950.00
Agrochemicals (Nuvacron) Insecticide	1 litre	800.00
Tractor hire		945.00
Irrigation running costs (diesel, engine oil, operating pump)		41,220.00
Other (servicing of water pump and sprinklers)		10,000.00
Opportunity cost of variable capital at 22%		16,305.30
	TOTAL	**₦ 90,420.00**
Labour Input (man-days	187.7	9,000.00
Total variable Cost		99,429.30
Fixed Cost:		
Depreciation:		
Irrigation system		666.67**
Other tools and equipment (hoe, diggers, matchets)		166.51
Land Rent		2,500.00
Opportunity cost of fixed capital 22%		733.30
Total Fixed Cost		₦4,066.48
Total Cost		₦ 103,495.78
Net Returns		₦ 81,904.22

Source: 1994/95 Field trial

Note: *Output = 18.54 at ₦ 10,000.00/t

** Capital Cost of irrigation pump was ₦ 20,000 in 1979 with a useful life of about 30 years.

Table 2. Cost and Returns for a Hectare of Rainfed Potato Farm, Plateau State, 1994 .

Item	Unit per Hectare	Value per hectare (₦)
Gross Revenue		100,500.00*
Capital Operating Expenses:		
Potato seed (1.6t at N12,000/t)		19,200.00
Fertilizer: 13 (50kg bag) at N150/bag		2,100.00
Agrochemicals (Insecticide + herbicide)		
Insecticide (Nuvacron)	700mls	1,000.00
Herbicide (Lasso + Atrazine)	4L	1,050.00
Tractor charge (land preparation)		945.00
Labour input (mandays)	97.08	4,368.60
Opportunity cost of variable capital at 22%		16,305.30
TOTAL variable cost		₦ 34,970.00
Fixed Cost::		
Depreciation: of tools		166.00
Land rent		2,500.00
Opportunity cost of fixed capital at 22%		586.52
Total Fixed Cost		₦ 3,252.52
Total Cost		₦ 38,222.52
Net Returns		₦ 62,277.48

Source: 1994 Field Trial
Note: *Output = 10.05t at ₦ 10,000/t

The results show that the gross revenue for irrigated system is N185, 400/ha compared with N100,500/ha for the rainfed system at the 1995 market price of N10,000 per tonne of produce. The output per hectare is 18.54t in the irrigated system and 10.05t in the rainfed system. Similarly, the total cost of production is N103, 222.52/ha for the rainfed farm. The resultant net returns are N81,904.22/ha for the irrigated farm and N62,277.48/ha for the rainfed farm. The irrigation running cost of diesel, engine oil, and pump operation constitute the highest operating expenses (about 40% of the total variable cost) in the irrigated system.

Table 3 summarizes the input-output data in the irrigated system as compared to the rainfed system. On total cost per unit of output, the rainfed potato farmer will spend N3.80 to produce one kilogram of potato, while his counterpart in the irrigated potato farmer will spend N5.58 to produce the same quantity. The above results imply that the

irrigated potato farm produces higher quantity of output at relatively higher unit cost of production than rainfed potato farm. However, the net returns are much higher on the irrigated potato farm. This is because the greater output from the irrigated farm offsets the high cost of production.

Table 3: ***Summary of Input-Output data in irrigated system compared to rainfed system***

Item	Rain-fed	Irrigated
Output/ha	10.05t	18.54t
Man-days/ha	97.08	187.7
Output/manday (kg)	103.52	98.77
Value ouput/ha (₦)	100,500.00	185,400.00
Value of output/manday (₦)	1,035.23	987.75
Variable cost per hectare (₦)	34,970.00	99,429.30
Variable cost per unit output (₦)	3.48	5.36
Total fixed cost per hectare (₦)	3,252.52	4,066.48
Total cost of production/ha (₦)	38,222.52	103,497.78
Total cost per unit of output (₦)	3.80	5.58
Net return/ha	62,277.48	81,904.22

Source: Derived from tables 1 and 2.

In table 4, the measurements of technical and allocative efficiencies between the two production systems are given. The table indicates that the labour efficiency gives N20.58 for the irrigated potato farm as against N17.42 for the rainfed farm. Thus, one naira (N1) spent on labour earned N20.58 in the irrigated system as against N17.42 in the rainfed system of production. Labour was measured in mandays of eight hours work. The labour mandays was 187.7 in the irrigated system and 97.08 in the rainfed system. Both systems attracted the same wage rate in 1994/95 production season. Similarly, the capital efficiency was computed to be N45.59 (irrigated) and N30.89 (rainfed). These are the earning powers per N1 expenditure on capital input. From these figures, one naira expenditure on irrigated potato system had higher earning power than one naira expenditure on rainfed system. The land efficiency is given as the yield per hectare. This is $18.54tha^{-1}$ in the irrigated potato farm and $N10.05tha^{-1}$ in the rainfed potato farm. Thus, given the same in the quantities of measurable inputs, the irrigated potato system becomes more efficient in terms of output

Table 4: *Indices of Economic Efficiency*

	Rainfed	Irrigated
Labour efficiency (₦)	17.42	20.58
Land efficiency (t ha –1)	10.05	18.54
Capital efficiency (₦)	30.89	45.59
Allocative efficiency (₦)	3.80	5.58

Source: Computations described in – text.

On the allocative efficiency test, the cost of producing 1kg of potato was N5.58 in the irrigated system while it is N3.80 in the rainfed system. The test gives the ratios of total cost to actual yield or output. In this regard, the rainfed potato farm could be said to be allocatively more efficient. (Bagi 1981) reported that in crop production, irrigation is expected to improve the relative allocative efficiencies of variable inputs alone. However, the results of our technical efficiency tests conform with that of Onyenweaku (1994). Onyenweaku reported that irrigated farms have higher level of technical efficiency where land, capital and labour inputs are intensively utilized, while the allocative efficiency favours unirrigated farms.

IMPLICATIONS OF THE STDY

The result of this study has shown that irrigated potato farm seemed to be relatively more technically efficient in labour, land and capital use than the rainfed potato farm. It makes sense therefore that this system, with its high profit margin, should be disseminated to potato farmers. Potato growers in Nigeria already practise some form of small-scale irrigation especially in the northern states (Okonkwo *et al,* 1995[b], Onyenweaku, 1994).

To exploit the full potential which irrigation can offer to potato growers, this improved small scale irrigation system should be integrated into the farmers practice. It should, however, be followed by improved technological packages of inputs which potential irrigators could afford in order to increase their output. The true potato seed (TPS) currently being extended to potato growers in Nigeria is expected to add to this benefit. Support could be provided in form of soft loans for growers to adopt this technology and expand the scale of farm operations. They should also be taught the operation and maintenance of this irrigation facilities to minimize breakdowns.

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