ECONOMIC ANALYSIS OF IRISH POTATO PRODUCTION IN PLATEAU STATE

BY

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTERS OF SCIENCE (AGRICULTURAL ECONOMICS).

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SEPTEMBER 2005

DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work except where reference is made to published literature and duly acknowledged. It has not been presented before in whole or in part for any other qualification.

_____ _____

Ayodele Matthew Ojo **Date**

The above declaration is confirmed

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CERTIFICATION

This thesis entitled "Economic Analysis of Irish Potato Production in Plateau State" by Ayodele Matthew Ojo meets the regulations governing the award of Degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to scienctific knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to the LORD GOD ALMIGHTY who is the giver of knowledge and wisdom.

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ABSTRACT

The study investigated the economics of Irish potato production in Plateau State. Data were collected from 120 farmers selected at random from 12 villages of three LGAs purposively selected out of the six potato producing areas of the state. The data were gathered through the use of structured questionnaires during the 2003 dry and 2004 rainy seasons. The tools of analysis used were simple descriptive statistics, farm budgeting technique and linear programming models.

The result of the study indicated that the potato farmers were predominantly small-scale and fall between the age-group of 40-49 years with mean age of 41 years. However, the active and virile age groups of 20-29 and 30-39 were relatively low. The dominant cropping patterns were sole potato and potato/maize enterprises practiced in the dry and rainy season respectively.

The optimum farm plans of the basic models revealed that higher productivity and more revenue could be achieved over the unplanned farms by reorganizing resources and activities in the potato-maize production system. The resource-use efficiencies showed that land and family labour were not critical factors and that they were in surplus. However, operating capital was a critical factor, implying that farmers lack enough capital to implement an organized farm plan. The sensitivity analysis showed that a 20% increase in the cost of fertilizer reduced farm income by 5%, 9% and 10% in the 3 LGAs while a subsequent increases in both input and output prices improved farmers income appreciably.

Policy choices should therefore be geared towards encouraging more youths into farming by establishing programmes like graduate farming scheme. Research and extention intervention is required in the area of training farmers on how to re-organize farming activities and resources like labour and land to increase farmers income. To arrest the problem of high cost of production, government effort should focus on ways of

financing small scale farming, through coorperative saving schemes and input supply arrangements. Finally National Root Crop Research Institute should collaborate with International Potato Centre in the area of integrated pest and disease management to reduce the high rate potato perishability..

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CHAPTER 1

1.0 INTRODUCTION

Inspite of the tremendous human and land resources in Nigeria, food supply has continued to fall below demand level. Fabiyi and Idowu (1991) indicated that Nigeria has been finding it difficult to feed its population without recourse to massive importation of food. The food import bill for instance, increased from ₦ 15.7 billion in 1987 to ₦ 375.3 billion in 1996, while the per capita calorie food intake showed a deficit of 11.3 and 9.1 percents in the same years (Central Bank of Nigeria, 1994 and Federal Office of Statistics, 1997). Similarly, rice imports rose from ₦3.32 billion ($259 million) in 1999 to N9.615 billion ($750 million) in 2003. (Oke 2003).

Decline in food supply in Nigeria can be attributed to the apparent failure of past agricultural strategies (Saito 1994). NAERLS and PCU (2001) indicated that the production of maize, cowpea, cotton, cassava and yam was expected to increase by only 6%, 27%, 0.02%, 5% and 4% respectively, while those of sorghum, rice and groundnut are expected to decrease by 45%, 0.8% and 0.01% respectively. The report also indicated that there was low productivity of livestock, high cost of production and serious financial crises in Agricultural Development Programmes (ADPs) leading to retrenchment and reduction in extension services.

With regard to root and tuber crops, Scott, Best and Bokanga (2000) indicated that many developing countries policies towards the potato sector

is at best characterised as one of benign neglect. Whereas other commodity groups have managed to interest government to the point of garnering public financial support for integrated strategies for crop improvement, marketing schemes that include product promotion both at home and abroad and industralisation. This is the situation with cassava production in Nigeria. .Similar emphasis should also be extended to Irish potato crop.

1.1 Economic Importance of Irish Potato

The Irish potato (Solanum Tuberosum L.) is by far the most efficient tuber crop in Nigeria in terms of tuber yield and days to maturity. It matures in about 80 – 90 days as compared to 9 – 12 months respectively for yam and cassava. Therefore, because of the short maturity period, the crop it is produced almost throughout the year making it the highest yielding tuber crop in Nigeria. (Okonkwo *et al.,* 1995)

The genetic diversity found in potatoes makes it possible through breeding and selection to produce new varieties that can grow well under wide range of ecological conditions. This varietal improvement has been responsible for the expanding potato production in the world today. (Horton 1987). According to International Potato Center (2004), potato is the fourth most important food crop in the world, with annual production approaching 300 million tons. More than one-third of the global potato output comes from developing countries. For instance, in Nigeria, the establishment of the National Roots Crop Research Institute (NRCRI) in 1976 has lead to increase in the production of potato through breeding and selection of new

varieties such as Nicola, B9462, Diamond, , etc. Thus yield per hectare of potato increased from 7.92 in 1992 to 14.17 in 2000 while total production increased from 400,000 tonnes in 1991 to over 742,000 tonnes in 1996.

Table 1.1: Area Cropped and Annual Irish Potato Production in Plateau State(1991-2000).

Year	Area (ha)	Production (mt)	Yield/ha
1991	53,720	473,240	8.81
1992	68,970	546,540	7.92
1993	70,650	560,250	7.93
1994	65,650	586,250	8.93
1995	67,670	603,849	8.92
1996	74,675	742,870	9.95
1997	73,887	643,999	8.72
1998	40,637	416,122	10.24
1999	36,473	454,454	12.46
2000	33,204	470,403	14.17

Source: PADP, (2002).

Irish potato can be characterized as a high-input, high-output and high-risk crop. Its great responsiveness of yield to inputs-such as high quality seed tubers, fertilizers, pesticides, additional labour, - motivates farmers to use inputs more heavily on potatoes than on other crops. Because of the relatively high level of potato yields, the short growing period, and high market value, the potato crop generates larger returns per hectare and per day than most other crops grown in developing countries. However,

because of the susceptibility of the potato to pests, diseases, moisture stress and extremes in weather makes its yields more variable than those of many other crops. This yield variation coupled with price fluctuations and high input costs, makes potato production risky. Due to these problems, few farmers specialize in potato production; most grow potatoes with other crops. (Horton 1987).

Consumption of Irish potato in developing countries has increased from 9kg/capita in 1961-1963 to 14kg/capita in 1995-1997 according to FAOSTAT 1998 in CIP online2004. Irish potato crop produces more edible energy and protein per hectare and per unit of time than practically any other crop (CIP 1984). Over 80 percent of the potato produced in Nigeria are consumed by boiling or frying. Some of the products made from potato and their uses include: potato crisp (thin sliced and dried potatoes used as snacks); potato starch (used in pharmaceutical industries and in the production of alcoholics and wines). Others are potato (used in bread baking industries and animal feeds). Potato also constitutes a major part of diabetic diet due to its high protein content. (Okonkwo *et al.,* 1995, Scott, Best and Bokanga, 2000).

1.2 Problem Statement

The establishment of the Irish Potato Programme at Kuru, Jos by the National Root Crops Research Institute (NRCRI) Umudike in 1976 marked the beginning of rapid expansion of Irish potato production in Nigeria. Earlier on, potato has been a popular tuber crop grown among farmers on

the Jos Plateau. The crop was introduced as far back as the later part of the 19th century and early 20th century by Europeans notably the tin miners. The progamme was mandated to tackle the problems of Irish potato production in Nigeria. The problems include; low productivity of the existing potato varieties, inadequate supply of good quality true potato seed (TPS) and control of the major potato pests and diseases. (Okonkwo *et al.,* 1995).

The total land area under Irish potato production in 1986 was 20,000 hectare up from 10,000 hectares in 1973. Average tuber yield also doubled from 5 tonnes to 10 tonnes per hectare. (Okonkwo *et al.,* 1995). Similarly,Irish potato production steadily increased from over 473,000 tonnes in 1991 to over 742,000 tonnes in 1996. However, production gradually declined to about 470,000 tonnes in 2000. Hectarage under cultivation also recorded a similar trend during the same period. (PADP 2002).

Despite the efforts of the Irish Potato Programme in Kuru to improve the production of potato in Nigeria, the decreasing level of production suggests that there are problems or constraints facing small-scale potato farmers in Plateau State. Generally, the agricultural industry in Nigeria has performed below expectation despite the various efforts made by government in increasing food production. The major factors contributing to the generally low level of agricultural production in Nigeria include; poor allocation and management of resources, low level of technology, inadequate capital, poor economic infrastructure, lack of adequate

incentives among others. These drawbacks led to the sub-optional utilization of scarce resources. (Sanni 2000). The declining production of Irish potato production in Plateau State can be akin to these problems.

In order to identify the major problems of Irish Potato production in Nigeria this study will examine the Economics of Irish potato production in Plateau State. Therefore, some pertinent questions need to be asked and investigated thus:

i. What are the socio-economic characteristics of Irish potato farmers?

ii. What are the various Irish potato production system?

iii. What is the pattern of resource allocation in the potato production?

iv. What is the optimal farm plan of the potato farmers in the area?

v. How will changes in some limiting factors affect the optimal farm plan ?

vi. What are the major socio-economic and technical constraints of Irish potato farmers?

1.3 Objectives of the Study

The main objective of the study is to examine the Economics Analysis of Irish Potato Production in Plateau State. The specific objectives are to:-

i. describe the socio-economic characteristics of Irish potato farmers and the various potato production cropping patterns;

ii. determine the optimum farm plan for Irish potato production in the area;

iii. determine the resources use efficiencies under the different Irish potato production cropping patterns;

iv. to determine the effect of changes in a limiting resource and product prices on the optimum farm plan and;

v. to identify and describe the major technical and socio-economic constraints to Irish potato production in the area.

1.4 Justification of the Study

The importance of this study is basically to contribute to the accumulation of information on the resource productivity and profitability of Irish potato production in Nigeria, especially, now that the Nigerian government is trying to revamp the ailing agricultural industry by discouraging importation of popular foodstuffs and encouraging domestic production.

Despite the economic importance of Irish potato, there has not been an adequate research effort on the crop especially on economic considerations such as costs and returns, optimal crop combinations and efficiency of resources use in Plateau State. This study is aimed at bridging this research gap and the result will indicate areas of preference in Irish potato production. This may result in re-adjustments and re-allocation of resources within the farming system.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Origin, Development and Characteristics of Irish Potato in Plateau State.

Irish potato was introduced into Nigeria as far back as the later part of the 19th Century and early 20th Century by Europeans, notably the tin miners (Okonkwo, 1995). Varieties introduced then and which deteriorated in quality were Hajiya, Ampijan Kamarun, Botos, Gwaiwan Kare, Kamerun, Dafom, Kankule and Mai Tumatur. However, with the establishment of Irish Potato Programme in Kuru by NRCRI in 1976, improved varieties were imported and bred. These were screened and those found adaptable to the temperate regions of the country were released to farmers. These are RC 767-2, Rc 7716-4, Nicola, Desiree, Kondo, cliamant, Bartita, Roslin ruaka, Lady Christyl and Kennebec.

Irish potato requires an optimum temperature of 15^{o}C for tuber formation (Borah and Milthrope, 1962; Bodlaender, 1964). Jos Plateau meets this condition in both rainy and dry seasons. In the dry season potato is planted in late October or early November to take advantage of the low December and January temperatures for tuberization. Time of planting potato in the rainy season depends on the onset of rains. Generally it is planted between the last week of April and end of May each year. Off-season productions occurs between August-November. (Okonkwo *et al.,* 1995).

Potato performs best on soils rich in ferrallitic combisol Clayic soils (Enwezor, Udo, Ayotade, Adepatu and Chude 1990). The soils are shallow, yellow, mottled and poorly drained clay loam soil on weathered basit. Similarly, for optimal commercial yields, potato needs relatively high levels of chemical fertilizer and organic matter (Scott *et al.,* 2000).

2.2 Cropping Patterns and Potato Production

Choosing an appropriate cropping system in agriculture is an important strategy for maximizing limited resources and ensuring higher crop yields. Any system adopted for a particular crop depends on the production objectives, availability of resources, type of crop, perception of risk and farmers level of knowledge (Nweke *et al.,* 1990). While some systems such as shifting cultivation involves plenty of land and high labour requirements, others like mixed cropping and crop rotation allow for more efficient use of land, uniform utilization of soil nutrients, relatively lower cost as well as controlling pests and diseases (Onwueme 1978).

According to Norman, (1972) the range of possible cropping alternatives in any area is determined by physical and biological factors. The rainfall, temperature and soil social factors or customs includes personal taste, tradition, population density and local labour while the economic determinates is made up of prices, available markets, transport facilities and available capital.

In Jos Plateau, the climate has been found to be well suited to a wide range of crops particularly cereals, legumes and Irish potatoes. However,

the cropping system is influenced by the level of production technology, the socio-economic conditions, resources available and time (Horton 1987, Norman 1972).

Crops in general are either sown in sole or in mixtures. Growing crops in mixtures have been described as the practice whereby two or more crops are grown on the same pieces of land at the same time (Norman 1972).

Potato production system on the Jos Plateau is dominantly practiced under both sole and crop mixtures in the dry and rainy seasons. In other to ensure efficient use of limited resources such as water and space and as a result of other competing food crops like maize, sorghum and soya-beans, farmers cultivate potatoes as mixtures in the rainy season. While sole cropping is widely popular during the dry season. Okonkwo, *et al.,* (1995) showed that response of farmers to cropping systems adopted in potato production in four local government on the Jos Plateau are 88.4% as mixed crop in the rainy season and 80% as sole crop during the dry season.

In other parts of the world, Irish potato has expanded most rapidly in the subtropical lowlands. For instance, in Bengal India during the cool dry winter months, where the crop is grown as a monoculture under irrigated conditions, utilizing hefty doses of chemical fertilizers and pesticides and in tight crop rotations with rice. The tubers are havested 110-130 days after planting with the bulk of the output sold fresh for cash.(Scott, *et al.,2000).*

2.3 Resource Productivity and Efficiency

Resource productivity, according Olayide and Heady (1982) is the index of the ratio of the value of total farm output to the value of the total inputs used in farm production. Baumol (1977) stated that production economics is concerned with optimization and optimization implies efficiency. Production efficiency is concerned with the relative performance of the process in transforming inputs into output. The analysis of efficiency is generally associated with the possibility of farms producing a certain optimal levels of output from a given bundle of resources or certain level of output at least cost (Amaza, 1999).

Olayide and Heady (1982) posited that resource productivity is definable in terms of individual resources inputs or in terms of a combination of them. Thus, we can define labour productivity as the ratio of total output to labour inputs. Similarly, land capital, water and management productivities can be defined as the ratio of total output to inputs of land, capital, water and management respectively.

They went further to affirm that using this definition as a bench-mark change in productivity over time will depend upon changes in both the "include" and "exclude" components and maximum resources productivity will imply obtaining the maximum possible output from the minimum possible set of input. In this context optimal productivity of resources an efficient utilization of resources in the production process. This means that productivity and efficiency are synonymous in this context.

Farrel (1957) categorized efficiency into three types. Technical Efficiency (TE), Allocative or Price Efficiency and Economic Efficiency (EE) or Overall Efficiency. Technical efficiency is the measure of a firm success in producing maximum output from a given set of input (i.e. physical ratio of output to the input). The greater the ratio, the greater the magnitude of TE. This definition implies that differences in TE between firms may exist. Allocative efficiency was defined as the measure of a firm's success in choosing an optimal set of input; overall efficiency was defined as the product of technical and the price efficiencies.

2.4 Resources Use in Irish Potato Production

Resource usage in the traditional Irish potato production can be discussed as follows:

2.4.1 Seed

Good quality seed is essential for achieving high yields of potatoes. The type of production will largely determine when seed is purchased or produced. Seed for rainy season production is produced during the dry season. Okonkwo *et al.,* 1995 showed that 54% of farmers in four major producing areas of Plateau State use irrigation facilities to produce seed during the dry season, while about 21% relied on other farmers for their seed. Similarly, seed produced in the rainy season were used for the dry season production. The potato true seed are normally stored by spreading them on the floor, others stored them in baskets. It is also noteworthy, that the cost of seed is usually the largest single item among the variable costs of potato production; therefore choice of seed rate needs careful consideration for maximum economic return from the crop. Seed rate is the product of the number of sets planted per hectare and their average weight. (Ministry of Agriculture, Fishery and Food Ireland 1972).

2.4.2 Fertilization

Generous manuring is required if good yields of potatoes are to be obtained and surveys of fertilizer practices showed that potato crops receive substantial dressings of fertilizers, often with farmyard manure in addition. Potatoes are responsive to all-round manuring and need large amounts of the major plant nutrients, nitrogen(N) phosphate and potash, although the actual quantities of these nutrients which have to be applied vary somewhat from soil to soil. (Ministry of Agriculture, Fishery and Food Ireland 1972).

Most potato farmers on the Jos Plateau use NPK compound fertilizers because the soil in the area are low in nitrogen and phosphorus (Okonkwo *et al.,* 1995). Okonkwo *et al.,* (1988) found that the crop requires up to 100kg of Nitrogen/ha for sole potato and 120kg N/ha for potato produced in crop mixture with maize on the Jos Plateau. In a survey conducted on the Jos Plateau Okonkwo *et al.,* (1995) discovered that about 40% of the farmers used between 6-8 bags of NPK fertilizer per hectare.

Potato also benefit from the application of inorganic fertilizer especially poultry manure because it improves the tilth and moisture retaining properties of the soil. Ministry of Agriculture, Fishery and Food Ireland 1972, Ifenkwe, *et al.,* 1986). In addition, organic manure enhances the effect of nitrogen provided in chemical fertilizers (Horton, 1987).

2.4.3 Labour

Farm labour on the Jos Plateau is constituted of both family labour and hired labour. Family labour is the most common source of farm labour in small-scale subsistence farming (Sanni 2000). Therefore, the size and composition of the household are very important in determining the numbers of man-hour to be spent in farming operations. However, when family labour becomes inadequate, farmers resort to hire labour at the prevailing wage rates in the different communities across the producing areas.

Labour is required to carryout these farming operations: clearing, cultivation and planting; fertilizer application, weeding, harvesting, sorting

and bagging. Water application operation is mainly for dry season production.

2.4.4 Land Use

Land is one of the limiting factors in agriculture. On the Jos Plateau, farm sizes are small; this is due to the nature of the land ownership structure in the area, which is predominantly tenured. Land is inherited among family members thus leading to fragmentation of holdings. (Mbonda 1983, Sanni 2000).

NRCRI Annual Report revealed that about 50% of farmers grow potato on an average are of 2-5ha. Farmland on the Jos Plateau are categorized into two basic types; the upland and fadama lands. The upland are dry lands used mainly in producing rain fed potatoes while the fadama lands are flooded river valleys. At the onset of the dry season water comes out of the ground when ditches are made and this is an important source of water for irrigation for potato production. However, the dominant land for production is the upland because not all farmers have access to fadama land. (Okonkwo *et al.,* Ahmed, 1995,).

2.4.5 Water Use

An adequate and dependable water supply especially during the dry season production under irrigation must be available as 22,624 gal to cover one acre to a depth of 1 in. On the average, potato requires 2-3 ac/in in a normal season but requires up to 6 ac/in in very dry months. The distribution of water required the use of different equipments such as sprinkles and rainguns. (Ministry of Agriculture, Fishery and Food Ireland 1972). However, most potato farmers, in Plateau State uses pumping machines and calabash to irrigate potatoes during the dry season production. (Okonkwo *et al.,* 1995).

2.5 Empirical Studies on Potato Production

The Irish potato crop is one of the most expensive to grow and returns are subject to wide fluctuations. According to the Ministry of Agriculture, Fishery and Food Ireland (1972). seasonal factors produced considerable variations in yield from year to year and this influences the supply of potatoes to the market. The demand is relatively inelastic and consumption does respond to price changes, thus a small surplus can depress the market fore ware potatoes (that is marketable potatoes) and a large surplus lead to a marked fall in price. Ministry of Agriculture, Fishery and Food Ireland (1972). also observed that potato growing is likely to be profitable on a particular farm if the farmer should maintain a steady acreage and avoid chasing the market by increasing his potato acreage after a good year and decreasing after a poor one. Such action he concluded is

not likely to increase overall profits of the farm but will tend to aggravate fluctuations in potato prices.

Asumugha and Okonkwo (1992) study on the economic efficiency of rainy season Irish potato production in Jos South Area of Plateau State revealed that the variable cost of production per hectare was N9,899.54, while the gross return per hectare was N20, 090.78, thus the gross margin per hectare was N10, 191.38. The study also revealed that capital efficiency was N2.03, which is the earning power per N1.00 expenditure on capital input. The labour efficiency was N25.87 implying that N1.00 spent on labour earned N25.87. Similarly, land efficiency or productivity was 10,045,36kg while the price or allocative efficiency was N0.99k implying that the cost of producing 1kg of potato was N0.99k.

Although, the studies discussed above indicated some aspects of economics production of potato, they are silent on the socio-economic characteristics of Irish potato farmers; optimization of potato production and production constraints. This study intends to focus more on these issues.

2.6 Review of Analytical Techniques

The three widely used tools for assessing the efficiency of resource use in agriculture includes: budgeting or profitability analysis, production function analysis and mathematical programming. In this study, budgeting and mathematical programming tools will be used. The following is therefore a review of their uses.

Budgeting as a farm tool has been in use for a long time and proved very useful until the advent of linear programming. The method involve itemizing the costs and returns of production. The gross margins and the net farm incomes are calculated for the different enterprises on the farm. Variants of budgeting comprise complete (whole farm) budgeting dealing with new organization or major adjustment and partial and break even budgeting dealing with minor adjustments (Brown 1979).

Agrawal and Sharma (1968) compared the use of budgeting and linear programming from mathematical standpoint. They argued that budgeting and linear programming have several things in common: linear objective function, additivity and divisibility of resources and activities. Both require the same type of basic information or input/output coefficients, price and cost parameters, and both models are deterministic. However they differ in many respects. Linear programming is more efficient than budgeting when alternative activities and restrictions are large and complex. They further argued that budgeting does not provide optimal solution and shadow prices, budgeting does not identify resource constraint and has limited capacity in carrying out sensitivity analysis. In spite of these limitations, the budgeting tool is a useful tool in enterprise combination and in indicating a profitable pattern of aggregate input use.

The application of linear programming as a tool in assessing farm management related problems started in early 1950s in the United States of America. The work of Heady and Candler (1958) and Beneke and

Winterboer (1973) among others were fundamental in the application of linear programming in the field of agriculture. The tool in particular is well suited to solving the problems of optimum selection and the combination of crop and livestock enterprises throughout much of European and Japan (Baker, 1963).

The linear programming model has been widely used to examine efficiency of resources use in agriculture. Many studies in Africa (e.g. Clayton, 1961, Ogunfowora, 1970, Olayide and Olowude 1992, Shapiro 1973, Abalu, 1975, Belete, et al., 1993, Ahmed 1994 and Sanni 2000) have successfully used the technique to analysis a variety of farm management problems.

In this study a farm planning analysis will focused on the use of linear programming technique to assess the resources productivity and optimum selection and combinations of potato cropping systems.

CHAPTER 3

3.0 METHODOLOGY

3.1 The Study Area

The study was conducted in the central zone, which covers Bokkos, Mangu and Barkin-Ladi Local Government Areas (LGAs) of Plateau State. The choice of these areas was on the basis that they were the prominent potato producing areas on Jos Plateau. The Jos Plateau which accounts for over 75% of the total potato produced in Nigeria includes other LGAs as Jos North, Jos South and Bassa situated at the northern part of Plateau State. These areas lies between longitudes 8^{o} $40^{'}$ and 9^{o} $50^{'}$ E and latitudes 9^{o} and 10^{o} $45^{'}$ N (Fig. 3.1).

The Jos Plateau is bordered in the North-East by Bauchi State, in the North by Kano State, and in the North West by Kaduna State and in the South –West by Nasarawa State. Jos Plateau elevation ranges between 1100m and 1400m above sea level.

3.1.1 Climate and Cropping Pattern

The climate is characterized by two distinct seasons, the rainy season, which spans from April to October and the dry season, which falls between November and March. High temperatures are recorded in the months of March – May while the lowest temperatures popularly called the Harmattan months are between December and January. These seasons are suitable for potato production because they meet the required 15^{o}C for tuber

formation. Other crops produced in these areas include: tomato, cabbage, carrots, lettuce, cucumber, green beans and onions. Cereal crops such as maize sorghum and millet are also grown in the area. Potato producing seasons were April – July (rainy season) and September – January (dry season). Over 80% of the potato are produced as sole crop during the dry season and in mixtures during the rainy season.

3.2 Sampling Procedure

Irish potato farmers formed the sampling population. A multi-stage sampling technique was employed in selecting the sampled population.

This involves, a purposive selection of 3 LGAs Bokkos, Mangu and Barkin-Ladi out of six potato producing LGAs. The second – stage involves a random selection of 4 villages from each of the 3 LGAs. Finally a random sampling was conducted to select 10 farmers from the 12 villages selected in the study areas. Therefore, 120 Irish potato farmers constituted the sampling size used for the study.

3.3 Data Collection

Primary and secondary data were used for this study. The primary data was collected during the 2003 dry cropping season and the 2004 rainy season through the use of structured questionnaire. The data generated included:

i. Socio-economic characteristics of the farmers: these are farmers age; household size; educational level; farming experience; production goals; land ownership structure; farm

size, other occupation(s); and membership of farmers organization; cropping pattern and reasons for adopting the cropping pattern.

ii. Production variables which includes area of land cultivated (ha), labour use for land preparation, planting, weeding, fertilizer application, watering, harvesting and sorting (man hours per hectare); others includes quantity of potato output (kg), quantity and cost of inputs used namely seeds, fertilizer, manure and fuel already used. However, because of the variation of prices of agricultural inputs and output during the cropping seasons, weighted average prices was obtained and used in the study.

The secondary data was collected from Plateau State Agricultural Development Project (PADP); journals, and NRCRI annual reports; while the primary data was collected through personal interview by the researcher, trained enumerators and extension staffs of PADP.

3.4 Analytical Technique

The analytical tools employed for this study included:

i. Descriptive statistics

ii. Farm budgeting technique and

iii. Linear programming analysis.

iv. Parametric analysis.

.4.1 Descriptive Statistics

Descriptive statistics, mainly the use of measures of central tendency such as mean, frequency distribution, percentages and ratios were employed. These tools were used to discuss objectives (i) and (v).

3.4.2 Farm Budgeting Technique

The budgeting technique was used to analyze the costs, returns and profitability of Irish potato production. This involved estimating the Net Farm Income (NFI) for each of the cropping patterns prevalent in the area under study. NFI was obtained by subtracting the total cost from the gross revenue. Gross revenue represents value of agricultural outputs, while total costs is made up of variable and fixed costs.

$$GM = Qy\,Py - \sum_{i=1}^{n} Xi\ Pxi$$

Where

Qy = total output of the potato (kg).

Py = unit price of the potato (#)

Qy Py = total revenue derived (or gross returns) from sale of potato.

Xi = quantity of the ith input used

Pxi = price per unit of the ith input (N)

$\sum_{i-1}^{n}$ =Summation (inputs 1 to n)

Thus;

Gross margin = Gross returns – Total variable cost i.e. GM = GR – TVC.

NFI = Gross margin – Depreciation of fixed inputs.

3.4.3 The Linear Programming Model

Linear programming model was used to determine the optimum farm plan for Irish potato production in each of the three LGAs. The method provided answers to objectives (ii) and (iii). A central problem of quantitative managerial decision-making faced by farmers is the optimal allocation of limited resources among various competing enterprises. LP is one of he most powerful mathematical techniques of optimization used to solve this problem (Vazsonyi and Spirer 1987). It is quite efficient in handling a large number linear constraints and activities at the same time. It uses a global objective function in finding optimal farm plan or strategy by putting together the best combination of activities or objective (Thampapilai, 1978). The LP is based on the premise that peasant farmers tend to behave in a way that optimize their objectives given the constraints within which they operate. The programming procedure provides a computational method of determining the best plan among alternatives that are characterized by a specific objective, limited resources and competing means of using resources provided these requirements can be quantified (Heady 1969).

Agrawal and Heady (1972) identified seven fundamental assumptions of a static linear programming model. These are;

i. The objective function and constraints equation must be linear

ii. Activities and resources are assumed additive, implying the absence of any interaction among the activities or resources.

iii. Activities and resources are assumed to be infinitely divisible.

iv. The activities and decision variables must be non-negative.

v. The number of activities and quantities of resources are assumed finite to permit realistic programming.

vi. Activities and resources have linear relationship implying constant resource productivity and constant return to scale.

vii. Resource supplies, input-output coefficients, and prices of resources and products are known with certainty.

Analysis of a linear programming problem usually provides the following information as stated by Mbonda (1983).

i. The optimal total farm net revenue or total farm gross margin with profit derived by deducting the fixed costs.

ii. The optimum combination of activities on enterprises consistent with available resources, input output coefficients and some level of desired objective function.

iii. The optimum resource mix based on the prevailing input-output coefficient that will give the optimum objective function.

iv. Marginal value product (Shadow prices) of resources or constraints fully utilized in the solution – assuming all other coefficients are unchanged.

v. Effect of varying product and resources price ratio on the magnitude of the gross margin.

Linear programming consists essentially of the objective functions, the activities/resources and the linear constraint components. The difficulty in ascertaining the objectives of traditional small-scale farmers make the definition of a meaningful and objective function a difficult problem in the application of a linear programming technique (Sanni 2000). Farmers are faced with different objectives in their choice of enterprise. The two main goals of Irish potato farmers identified in the study are maximization of food security and profit maximization. The maximization of gross margin (or NFI in some cases) and household food security objectives was incorporated in the objective functions of this study. The objective are in different dimensions thus, the constraint optimization was used. This method known as the lexicographic approach has been used for similar optimization studies by Ahmed (1995) Sanni (2000) Husseini (2002). This approach involved optimizing the different objectives in a single decision criterion by employing a hierarchy of objectives and treating all but one as constraints. The return maximization objective was specified as the objective function while food security objective was treated as a constraint to force the production of necessary amount of output for meeting family consumption levels.

Linear programming method has several advantages over other analytical methods. First, it allows for several production activities at the same time. Secondly, it gives room for the use of seasonal labour and land constraints. Thirdly, more than one production technique is allowed in

addition to the substitution between land, labour and capital under different economic, resources and behavioural constraints (Mudahar, 1974). Others include changes in net revenue of each enterprise needed to bring about a change in the activity level can be determined from the optimum farm plan. Lastly, the productivity of farm resources as well as the constraints facing the optimum farm plan can be evaluated. The limitations of linear programming as a tool rest almost entirely on the assumptions of linearity, additivity, single value expectation and simplification of reality.

Activities included in the model includes: crop production labour hiring, seed buying and use of owned seed, others are selling and consumption activities. The restraints employed includes: resources, restriction (land, labour and operating capital), food consumption restriction and owned seed restriction.

3.4.4 Parametric or Sensitivity Analysis

Estimates of quantities of inputs and output are usually approximates and the prices are subject to change. The parametric or sensitivity analysis is a tool used to explore how sensitive benefits are to change in assumed level of inputs, outputs and prices. (Ahmed 1995).

In this study, the effect of increasing input and output prices by 20% was used to determined changes on the optimum farm plan thus providing answer to objective (iv).

3.5 Specification of the L P Model

The task ahead in this study is to maximize an objective function (Net Income) subject to the limitations imposed by n resources. The general form of the LP model for the potato farmers is as follows.

$$\text{Maximize } Z = \sum_{j=1}^{n} CjXj \quad (j = 1,2 \ldots n)$$

Subject to

$$\sum_{i=1}^{m} aij \, x \, j \leq bi \; (i = 1,2 \ldots n)$$

and $Xj \geq O$ for the js

Where

Z = Objective function (Net income)

Xj = The activities, where there are n activities to be considered.

Cj = Net price per activity with n activities. It measures the marginal contribution of each decision variable i.e. gross margin.

bi = Total amount of i.e. resource available (constraints).

aij = Resource requirement per unit of activity. It represents how much of a resources is required for each activity unit (e.g. amount of labour required to produce one hectare of crop).

n = Number of activities

m = Number of resources.

3.6 Activities in the Model

The following activities were identified and included in the model.

3.6.1 Crop Production Activities

The dominant or common crop production activities identified in the various LGAs were used in the optimization process. Each crop production pattern constituted an enterprise. The crop enterprises were sole Irish potato and potato/maize mixture.

They are represented in the matrix as columns X_1 to X_2 respectively. (Appendix 1). These are the most important crop production opportunities in the 3 LGAs in terms of contribution to household income and food. For each activity, the unit of production is one hectare.

3.6.2 Labour Hiring Activities

Labour hiring activity was introduced into the model to ensure that shortage of family labour does not seriously constraint the capacity of farm household to produce. The survey showed that hiring of labour for farm work was very popular during dry and rainy seasons. The hired labour was represented as an activity in the matrix, while the family labour was represented as a constraint. The period covers September, October, November, December and January months for dry season production and from April to November for the rainy season farming. This is represented as columns X_3 to X_{13} in the matrix (Appendix 1). The coefficients in the family labour row are negative meaning that an increase by one unit relaxes family labour constraint by one unit. The activity unit is one man-hour while the wage rate (Wt) is given as Naira per hour. Wt is negative in the objective function implying that it decreases the return by its value.

3.6.3 Seed Buying and Use of Owned Seed Activities

The model allows the farmers to use seeds from their farm (previous farm harvest) and also to buy from the market. The seed buying activities are shown as columns X_{14} to X_{16} in (Appendix 1).

While the use of owned seed activities are shown on the same appendix as columns X_{17} to X_{19}. The value of seed buying activity in the objective function represent the unit purchase price and it is negative. In the rows, the values are also negative which implies that it takes from the resource available on the farm. For the use of own seed, their objective function values were zeros since they have already been accounted for by the individual crop balance rows. However, their values in the seed balance rows were negative meaning that the resources have been used up.

3.6.4 Selling Activities

Provision was made in the model to allow the farmers to sell their outputs but only after meeting their minimum requirement for home consumption. Crop selling activities were represented in the models as columns X_{20} to X_{22} (Appendix 1). The objective function values of each activity represent the unit selling price of the crop at their harvest time. Their values were positive on the transfer rows.

3.6.5 Consumption Activities

The farm household consumption of carbohydrate was derived mainly from maize and Irish potato while that of protein was derived from protein food crops purchase from the markets and from the livestock kept

by the farmers. The objective function values for Irish potato and maize consumed were zero. The row values of consumption activities of the potato and maize were positive in both the transfer and balance rows. The activities were represented as columns X_{23} to X_{24} (Appendix 1).

3.7 Resource Constraints in the L.P Model.

Farmers are often constrained in their production activities due to certain factors which becomes limiting. In the model, the following constraints were identified and specified at some levels using maximum ($\geq$) minimum ($\leq$) or equality (=) signs as the case may be. The resource constraints include land, labour, operating capital and output allocation constraint was included to ensure that all that is produced is either consumed or transfer into selling activity. Other constraints are food consumption and owned seed (or seed balance).

3.7.1 Land Restriction

Farmland in the study area were classified into two basic types; the upland and fadama lands. The upland are dry lands used in producing rainfed Irish potato and maize while the fadama lands are flooded river beds used mainly to produce sole Irish potato during the dry season months. However, during the survey, it was discovered that the dominant land for production during the rainy season was the uplands, while both the uplands bordering riverbanks and fadama lands (for those opportune to have) were used during the dry season production.

The average farm size observed in each LGA was taken as the limit of land available for cultivation. Thus the average land area available for cultivation in the basic models was restricted to 3.5, 4.0 and 4.5 hectares in Bokkos, Mangu and Barkin-Ladi respectively. This was specifies as row S_1 in the model.

3.7.2 Labour Restrictions.

Both hired and family labours were used for production activities in the study area. The amount of labour restriction was obtained by adopting the method used by Ahmed (1995) and Sanni (2000). The amount of labour provided by the family source was determined by the composition and size of the farm household. The average household was found to be made up of 7, 5 and 7 man-equivalent in Bokkos, Mangu and Barkin-Ladi respectively. The potential labour supply was obtained by assuming that each man will work on the farm for about 70% of the total number of days in each period because of fatigue, illness and other incidentals. It is also assumed that he works for 5 hours a day. Thus for Bokkos the potential labour supply was 0.7 x 30 days x 5hours x 7 man – equivalent to 735 man-hours, while for Mangu the labour supply was 0.7 x 30 days x 5hours x 7 man- equivalent to 525 man-hours. B/Ladi's labour supply was 0.7 x 30 days x 5 hours x 7 man equivalent to 525 man-hours.

A total of eleven labour constraints periods were identified and represented in the models as row S_2 to S_{12}. The period starts from September to January for dry season production and April to November for

rainy season, which overlaps the dry season production from September to November. (February – March months corresponds to the off – season for most of farmers.

3.7.3 Operating Cash Restrictions.

The level of cash available to an average household represents the cash constraint. This was the amount used to purchase fertilizer, manure, seeds and payment for hired and family (assumed) labour. No provision was made for capital borrowing in the models because none of the respondent borrowed capital for their production activities. The row values in the matrix are the variable cost per hectare for the purchase of fertilizer, manure, seeds and payment for both hired and family labour for the specified production activities (S_{13}).

3.7.4 Output Allocation Restriction (or Balance Rows)

These restriction was induced in the models to ensure that the total quantities of each crop produced were accounted for in the model. Thus, restriction level is zero implying that all that is produced is sold after deducting the quantities consumed at home. The row coefficients are the yield per hectare of the specified crop activities. (i.e. $S_{14} - S_{16}$). Similarly, owned seed restriction represent seed balances. The rows are $S_{20} - S_{22}$ and have zero values in their restriction levels.

3.7.5 Consumption Restriction

Consumption of staple foods in the household was specified in the matrix as constraint for the production of necessary amount of food crops

for meeting minimum family consumption requirement. It was assumed that some energy requirement in the household was obtained from Irish potato and maize. According to Aduku (1993) an average adult of about 65kg body weight would require a minimum energy of 2550 kcals and 56gms of protein per day or 930750 kcal protein and 20.44kg protein annually. The Food and Agriculture Organization (FAO) and World Health Organization WHO (1973) report showed that a subsistence consumption of 1kg each of potato and maize daily would supply 3610 kcal and 1800 kcal respectively. Therefore, the minimum requirements for each crop is determined as follows: the average consumption unit in a household was calculated as 8.5, 8.25 and 8.5 for Bokkos, Mangu and Barki- Ladi LGAs respectively. (Table 3.4). In arriving at the consumption unit, it was assumed that the male adult and working youth consumes equal amount of food. While the working female and female youth consumes the same quantity of food, but this amount is only 75% of the male consumption. Children consume the same quantity, which were assumed to be 50% of the male adult consumption (Ahmed 1995 and Sanni 2000).

From the crop choice interview, the preference given to the consumption of Irish potato and maize were in the ratio of 40:60 for all the three LGAs.

Table 3.4: The Ages/Sex Composition of Household and the derived Consumption Unit for Bokkos, Mangu and B/Ladi LGAs.

	BOKKOS		**MANGU**		**BARKIN –LADI**	
AGE/SEX	Average household composition	Adult man equivalent	Average household composition	Adult man equivalent	Average household composition	Adult man equivalent
Male adult	3	3	2	2	3	3
Male working youth	2	2	2	2	2	2
Female adult	3	2.25	4	3	2	1.5
Female working youth	1	0.75	1	0.75	2	1.5
Children	1	0.50	1	0.50	1	0.5
	10	**8.5**	**10**	**8.25**	**10**	**8.5**

Source: Field survey 2003/2004

Based on these assumptions, the minimum quantity of each crops per annum per household were estimated based on Ahmed (1995)'s formula as follows:

$$\frac{\text{Average Adult minimum energy per annum X potato ratio}}{\text{Energy supplied by 1kg of each crop per day.}}$$

BOKKOS.

$$\text{Potato (kg): } = \frac{930750 \times 0.4 \times 8.5}{1800} = 1758 \text{ kg.}$$

$$\text{Maize (kg): } = \frac{930750 \times 0.6 \times 8.5}{3610} = 1315 \text{ kg.}$$

MANGU:

$$\text{Potato (kg): } = \frac{930750 \times 0.4 \times 8.25}{1800} = 1706 \text{ kg}$$

Maize (kg): = $\frac{930750 \times 0.6 \times 8.25}{3610}$ = 1276 kg

BARKIN – LADI:

Potato (kg): = $\frac{930750 \times 0.4 \times 8.5}{1800}$ = 1758kg

Maize (kg): = $\frac{930750 \times 0.6 \times 8.5}{3610}$ = 1315kg

These values were used as the restriction levels in the model. They were represented as row $S_{17} - S_{19}$.

CHAPTER 4

4.0 RESULTS AND DISCUSSIONS

4.1 Socioeconomic Characteristics of Irish Potato Farmers

The socio-economic characteristics of the farmers in the study area were examined with respect to farm size, age, level of education, household size, farming experience and other occupations apart from farming. Other characteristics are land ownership structure, production goal and membership of farmers organization.

4.1.1 Farm Size

From the analysis presented in Table 4.1,the mean farm size was 3 ha with most of the farmers cultivating between 2 – 2.99ha (31.7%) and this is closely followed by 3 – 3.99ha (22.5%). It is obvious from this result that most of the farmers were small-scale based on classification Olayide and Heady (1981) which put small scale farmers in Nigeria into 0.1 – 6ha.

4.1. 2 Age

The mean age of the respondents was 41 years with majority of them (50.8%) in the age group 40 – 49 years. The maximum age of the farmers was 60 years while the minimum was 25 years. The most active and virile age group of 30 – 39 and 20 – 29 were relatively low. This may be due to the increasing level of enrolment in formal education and preference for white-collar jobs.

4.1. 3 Level of Education

About 31.7% of the farmers had no any form of education, while 68.3% had one form of formal education or the other. Out of this, 43.3% and 4.2% attended primary school and adult school respectively. 13.3% went to secondary and 7.5% attended post secondary institutions. This implies that few graduates of higher institutions in the state are employed in agriculture.

4.1. 4 Household Size

The mean household size of the farmers was 6 persons while the maximum and minimum household size were 20 and 1 persons respectively.

4.1. 5 Farming Experience

The mean years of farming experience was 18 years with a maximum of 40 years and a minimum of 5 years. Thus, the farmers could be categorized as experienced based on FAO (1992) report that says 15 years is regarded as experienced farmer.

4.1. 6 Other Occupations

More than half of the farmers 52.5% engaged in livestock husbandry apart from crop production, while 29.2% trade in agricultural products and processing. Only 7.5% are civil servants.

4.1. 7 Land Ownership Structure

The land ownership structure reveals that majority of the farmers (95.8%) acquired their land through inheritance while less that 5% of the

plots in the area were purchased or pledged. The implication of this form of land tenure system is that although every member of the family can get land for farming, the size of holding is often small and the farms are scattered.

4.1. 8 Production Goal

With regard to production goal, 46.6% of the respondents produced for profit maximization and food security while 36.7% and 16.7% produced only for profit and food security respectively. It was observed during the survey that the farmers produced Irish potatoes solely for profit maximization during the dry season (i.e 36.7%) while others (63.3%) for either profit and security or solely for food security. The implication of this result is that only 36.7% produced sole Irish potatoes during the dry season and 63.3% produced mostly mixtures of Irish potato and maize during the rainy season. This is due to the fact that few farmers have access to Fadama lands and pumping machine.

4.1. 9 Membership of Farmers Organizations

Majority of the farmers (66.6%) either belonged to Fadama User Association or Thrift and Credit Association while 33.3% did not belong to any association at all.

Table 4.1: Analysis of Socio-economic Characteristics of Potato Farmers in the Study Area.

Characteristics	Frequency	Percentage
Farm Size (ha)		
Below 1	3	2.5
1 – 1.99	24	20.0
2 – 2.99	38	31.7
3 – 3.99	27	22.5
4 – 4.99	15	12.5
5 – 5.99	7	5.8
6 and above	6	5.0
Mean = 3.00 ha, minimum: 0.5, maximum 15		
Age (year)		
10 – 19	0	0
20 – 29	5	4.2
30 – 39	46	38.3
40 – 49	61	50.8
50 and above	8	6.7
Mean = 41 years, minimum = 25, maximum 61		
Level of Education		
No formal education	38	31.7
Primary	52	43.3
Adult Education	5	4.2
Secondary	16	13.3
Post Secondary	9	7.5
Household size (N0)		
1 – 4	50	41.7
5 – 8	47	39.2
9 – 12	14	11.6
13 – 16	6	5.0
17 – 20	3	2.5
Mean: 6, Minimum 1, maximum 20		
Farming Experience (Years)		
1 – 10	27	22.5
11 – 20	48	40.0
21 – 30	35	29.2
31 and above	10	8.3
Mean: 18 years, minimum 5, maximum 40		
Other occupation apart from farming		
Livestock husbandry	63	52.5
Trading in Agric products/processing/milling	35	29.2
Civil servant	9	7.5
Self employed (e.g tailoring etc)	5	4.2
Trading in Non – Agricultural products	8	6.6
Land ownership structure		
Inheritance	115	95.8
Purchased	3	2.5
Rented	0	0
Pledge	2	1.7
Production Goal		
Profit maximization	44	36.7
Food security	20	16.7
Profit maximization and food security	56	46.6
Membership of Farmers Organization		
Fadama User Association	52	43.3
Thrift and Credit Association	28	23.3
Produce marketing	0	0
Multipurpose cooperative society	0	0
Do not belong to any association	40	33.3

Source: Field Survey 2003/2004

4.1.10 Cropping Pattern

The ranges of possible cropping alternatives in any particular area are determined by the climate (rainfall and temperature), soil, personal taste, tradition, labour availability, available market, transport facilities and available capital (Sanni, 2000). The dominant cropping pattern identified in the study areas were Irish potato –maize and sole potato enterprises.

The analysis of the cropping pattern adopted by the respondents in each of the cropping seasons revealed that 98.7% of the rainy season farmers practice Irish potato/maize cropping pattern while in the dry season production was sole potato cropping. This result confirms Okonkwo *et al*., (1995) results that said potato was grown only as a sole crop in the dry season. However, potato-maize crop mixture was the dominant intercrop in the areas surveyed. This was because, maize is the major crop produced in the LGAs during this period.

Table 4.2: **Cropping Pattern Practiced in each of the Cropping seasons**.

Cropping Pattern	**Frequency**	**%**
Rainy season		
Potato/Maize	75	98.7
Potato/Maize/Sorghum	1	1.3
Dry Season		
Sole Potato	44	100
Total	**120**	**100**

Source: Field survey 2003/2004

4.2 Costs and Return Analysis

The profitability of Irish potato production was obtained by estimating the average costs and revenue on per-hectare basis for the two dominant production systems. The gross margin (or Net Farm Income) were estimated for the average household in the LGAs. The average prevailing market prices of the input and output were used in estimating the values of costs and returns. The result is presented in Tables 4.3 - 4.6 for sole potato and potato/maize cropping systems respectively.

4.2.1 Cost

The cost items consisting of the total variable cost were for seed, fertilizer, manure and labour (i.e both family and hired). Other costs are for fueling, rentage and depreciation of pumping machine especially for irrigated production during the dry season. The average wage rate prevailing in the areas were used in computing the labour cost. Family labour was costed (shadow wage) even though not paid for by the farmer. The wage rate were N35.00 each for Bokkos and Barkin – Ladi and N40.00 for Mangu.

Table 4.4 showed that the average total variable cost per hectare was N77,050 in Bokkos, N61,123 in Mangu and N63,183 in Barkin Ladi. Labour cost accounted for the highest cost in all the LGAs (57%, 45% and 39%) with hired labour accounting for the highest proportion. The cost of seed accounts for (22%, 32% and 28%) for Bokkos, Mangu and Barki – Ladi respectively

The analysis of the potato/maize enterprise (Table 4.6) showed that the average total variable cost per hectare was N74,905, N71,690 and N62,974 for Bokkos, Mangu and B/Ladi respectively. Similarly, labour cost accounted for the highest cost only in Bokkos and Mangu (45% and 37%) followed by fertilizer cost in all the three LGAs (30%, 34% and 36%).

The high proportion of labour cost to the total variable cost confirms the assertion that labour constitutes a high proportion of costs in traditional agriculture (Sanni 2000). This is due to numerous farming operations involved in the production of agricultural products. For instance, in the production of Irish potato, labour use is composed of land preparation, cultivation, planting, fertilizer application, weeding, water application (in case of dry season production), harvesting, sorting and bagging. These operations are paid for as labour cost in man-hours.

Table 4.3 Estimated Average Cost for Sole potato Enterprise Across the LGAs

Items	Bokkos	Mangu	Barkin-Ladi	State value
Average farm size (ha)	3	2.74	3.5	3.08
Variable Cost:				
Labour:				
Family (Man-Hour)	326	211	222	253
Hired (Man-Hour)	919	471	485	625
Total labour (man-hour)	1,245	682	707	878
Wage rate (N/hour)	3,5.00	40.00	3,5.00	3,6.67
Family labour cost N	11,410 (14.8)	8,454 (13.83)	7,770 (12.3)	9,277..51
Hired labour cost N	32,165 (14.75)	18,848 (30.84)	16,975 (26.87)	22,918.75
Total labour cost (₦)	43,574 (56.6)	27,302 (44.7)	24,745 (39.17)	32,196.26
Others:				
Fertilizer	10,610 (13.77)	9,108 (14.90)	13,257 (21.00)	
Manure	2,516 (3.27)	2,085 (3.41)	3,000 (4.75)	
Seed	17,240 (22.38)	19,379 (31.70)	17,816 (28.20)	
Fuel	3,109 (4.04)	3,249 (5.32)	4,365 (6.90)	
Total variable Cost (TVC)	77,050 (100)	61,123 (100)	63,183 (100)	67,118.67
Fixed Cost:				
Depreciation	699	730	425	
Total fixed cost	699	730	425	618

Source: Field survey 2003/ 20004

NB: Figures in brackets are percentages of variable cost items.

Table 4.4 Estimated Average Costs for Potato/MaizeEenterprise Across the (LGAs)

Item	Bokkos	Mangu	Barkin – Ladi	State value
Average farm size	4	4.4	5.0	4.0
Variable Cost:				
Labour:				
Family labour (man – hour)	280	300	235	272
Hired labour (man – hour)	674	358	358	463
Total labour (Man – hour)	954	658	620	735
Wage rate (₦)	35.00	40.00	35.00	36.67
Family labour cost (₦)	9800 (13.1)	12000 (16.7)	8225 (13.1)	9,974.24
Hired labour cost (₦)	23590 (31.5)	14,320 (20.0)	13474 (21.4)	16,978.21
Total labour cost (₦)	33390 (45)	26320 (37)	21699 (35)	26,952.45
Others:				
Fertilizer	22074 (29.5)	24,234 (34%)	22500 (36.0)	
Manure	1223 (1.6)	2940 (4.1)	5880 (9.3)	
Seed	18218 (24.3)	18,196 (25)	12895 (20.5)	
Total Variable cost (TVC)	74905 (100)	71690 (100)	62974 (100)	69,856.33

Source: Field survey 2003/2004
NB: Figures in brackets are percentages of variable cost items.

4.2.2 Gross Margin

Gross margin represents the difference between the total value of all output (gross return) and the total variable cost incurred. This was used for the potato-maize enterprise, while NFI was used for the sole potato enterprise because of fixed expenses that were incurred. However, in the potato-maize enterprise, majority of the cost item were variable, fixed cost item are very negligible.

The State average NFI for the sole potato enterprise was ₦41,615,

while those of Bokkos, Mangu and B/Ladi were ₦35,408, ₦37,458 and ₦51,978 respectively. It can be deduced from these value that the farm income in both Bokkos and Mangu were below the state average, only that of B/Ladi was higher. The reason for the low values in Bokkos and Mangu could be as a result of the high total labour cost in both LGAs (i.e 57% and 45% of the TVC), whereas that of B/Ladi was lower (39%). Another reason for the high value in B/ladi is that the weighted average price for potato was higher (₦22.69) than the state average (₦21.36).

However, average gross margin for potato/maize enterprise in the state was ₦39,274, while those of the three LGAs were ₦27,153, ₦47050 and ₦43,620 respectively. Only that of Bokkos was lower than the state average. This can be attributed to the high total labour cost when compared to that of the state. (Table 4.4).

Table 4.5 Estimated Returns for Sole potato EnterprisesAacross the LGAs

Items	Bokkos	Mangu	B/Ladi	State value
Net Farm Income (NFI):				
Average Yield (kg)	5217	5018	5117	5117
Price (#/kg)	21.69	19.79	22.59	21.36
Gross Revenue (GR)	113,157	99311	115,586	10,9299
Gross Margin (GM): GR-TVC				
Net farm Income	36107	38,188	52,403	42,233
GM-Fixed Cost	35,408	37,458	51,978	41,615
GM/Naira Invested	0.47	0.62	0.83	0.63
GM/Total labour (man hours)	29.00	56.0	74	48
GM/ Average Land Cultivated	12,035.67	13,937.23	14,972.29	13,712

Source: Field survey 2003/2004

4.6 Estimated Returns (GM) for Potato/Maize Enterprise Across the (LGAs)

Items	Bokkos	Mangu	B/Ladi	State value
Gross margin:				
Average Yield (kg)				
Potato	2771	2950	2686	2802
Maize	2944	3086	2826	2952
Price (₦kg) Potato	10.27	10.96	12.33	11.18
Maize	25.00	2800	26.00	26.00
Gross Revenue (kg) (₦)				
Potato	28458	42292	33118	34623
Maize	73600	86408	73476	77828
Total Gross Revenue	102058	118740	106594	109130.66
Gross Margin	27153	47050	43620	392274.33
GM/Naira Invested	0.36	0.66	0.69	0.56
GM/Total labour (man – hours)	28.46	71.50	70.35	56.77
G/M/ Average land cultivated	6788.25	10.693.18	8,724	8728.0

Source: Field survey 2003/2004

4.2.3 Resource Use Efficiency:

In order to assess the efficiency pattern of the resources used in the two production enterprise, the return to the individual factors of production were estimated. The analysis in Tables 4.5and 4.6 indicates the GM per average land cultivated was ₦13,712 for the state and ₦12,03.67, ₦13,937.23 and ₦14,972.29 for Bokkos, Mangu and B/Ladi respectively in the sole potato and ₦8728 for the state, ₦6,788.25, ₦10,693.18 and ₦8,724 for the respective LGAs in the Potato/maize intercrop. The comparison of the result indicate that land was more efficiently used in the sole potato crop enterprise than the potato/maize enterprise. The Gross Margin per Naira invested on variable items were 0.47, 0.62 and 0.83 in the three respective LGAs for sole potato and 0.36, 0.66 and 0.69 in the Potato/maize system. The implication of this is that a naira invested would yield high losses in the sole potato compared to the potato/maize intercrop when the state values compared. In essenece, almost all farmers in the areas could not cover their variable expenses, this can be attributed to the high cost of production.

The gross margin per total labour (man-hour) in the sole potato enterprise were 29.00, 56.00 and 74.00 for the three respective zones while the values in the potato/maize enterprise were 28.46, 86.64 and 70.35 for Bokkos, Mangu and B/Ladi LGAs. Comparing the gross margin per total labour values with their corresponding wage rates in the two cropping pattern, indicates that there was inefficiency in labour use in Bokkos LGA as the estimated ratios were lower than the wage rate in the LGA. This

implies that the farmers could not cover the cost of labour. However, there was efficiency in labour use in Mangu and B/Ladi LGAs.

4.3 Analysis of the Linear Programming Model

This section presents the empirical results of the linear programming model specified. The basic structures of the matrices for each of the three LGAs (Bokkos, Mangu and Barkin – Ladi) are presented in appendix 1a, b and c respectively. The outputs generated from the analysis are the optimal and dual solutions. The optimal solution gives the value of the objective, function, optimum enterprise combinations and non-optimal activities. The dual solution on the other hand provides the level of resources used in the optimum plan with their respective marginal value products.

4.3.1 Optimum Farm Plan

The basic model in each producing area was designed to represent the average household constructed from the survey.

4.3.2 Activities in the Optimum Plan

The activities in the optimum farm plan for the potato production are presented in Table 4.7 for Bokkos, Mangu and Barkin Ladi local government areas.

Table 4.7: Real Activity Levels in the Optimum Farm Plan of the Basic Models for the Selected LGAs

Activities	Unit	Bokkos	Mangu	B/Ladi
Crop Production				
Potato/maize	Ha	2.03	1.85	2.00
Use of Own seed				
Potato seed	Kg	166.35	153.25	240.4
Maize seed	Kg	60.86	51.50	80.13
Selling Activities				
Potato	Kg	5621.35	5133.56	5380.91
Maize	Kg	5972.31	5454.06	5661.38
Total Return	**N**	**324,688.50**	**409,062.30**	**396,525.30**
Consumption				
Potato	Kg	3956	3839	3956
Maize	Kg	1315	1276	1315

The average farm size of 3.5, 4.0 and 4.5 hectares in the respective LGAs were not completely used up in the optimum plan. The feasible enterprise potato/maize used only 2.03, 1.85 and 2.00 hectares in Bokkos, Mangu and B/Ladi LGAs. This result does not deviate much from the existing cropping pattern and land use of the farmers.

Farming labour was not augmented with hired labour in the optimum farm plan. This implies that family labour constitutes the major source of labour supply in small scale agriculture. Family labour used was at the prevailing wage rate in the respective LGAs. Similarly, seed buying activity did not enter the optimum plan. However, 166.35kg, and 60.86kg/ha in Bokkos, 153.25kg and 51.50kg /ha in Mangu, 240.40kg and 80.13kg/ha in B/Ladi of Irish potato and maize respectively of farmers own seed were used. Potato and maize were offered for sale in the optimum plan as indicated in Table 4.7 to give a total returns of N324,683.50, N409,062.30 and N396,525.30 for Bokkos, Mangu and Barkin – Ladi

LGAs respectively. The minimum food consumption requirements specified for potato and maize were met in the optimum plan.

4.3.3. Resource use Levels in the Optimum Plan.

The resource use levels in the optimum plan of the basic models are presented in Table 4.9. Land use in the optimum farm plan was not a limiting factor because the total available land in the respective Bokkos, Mangu and B/Ladi LGAs (3.5, 4.0 and 4.5 hectares) were not completely used-up in producing the feasible potato/maize enterprise. Only 2.03, 1.85 and 2.00 hectares were used in Bokkos, Mangu and B/Ladi LGAs respectively.

Table 4.8: Resource Use levels in the optimum Plan of the Basic Models

Resource	Unit	Bokkos	Mangu	B/Ladi
Land	Ha	2.03	1.85	2.00
Family Labour				
April	Man – hr	109.55	83.37	116.19
May	Man – hr	160.26	133.39	162.27
June	Man – hr	225.18	200.08	256.42
July	Man – hr	172.43	150.06	156.26
August	Man – hr	322.55	276.04	320.53
September	Man – hr	101.43	64.84	84.14
October	Man – hr	40.57	27.79	70.12
November	Man – hr	123.75	111.16	112.19
Total Labour	Man – hr	**1255.72**	**1046.73**	**1278.12**
Operating Capital	₦	262,167.50	252,599.00	206,633.40
Gross Return	₦	324,683.50	409,062.30	396,525.30
Gross Margin (GM)	₦	62,516.00	156,463.30	189,891.90
Gross Margin/ha	₦	30,796.06	84,574.76	94,945.95

The labour profile of the optimum plan revealed that a total of

1255.72, 1046.73 and 1278.12 man – hours were used between April and November in Bokkos, Mangu and B/Ladi LGAs respectively. The pattern of labour use did not differ from that of the existing cropping system in which the peak period, were in June and August.

The operating capital was a limiting factor because the amount of N151,955.00, N132,813.00 and N126,157.00 and Bokkos, Mangu and B/Ladi were completely used up in the optimum plan. The amount of capital used in the potato/maize enterprise in the optimum plan were N262,167.50, N252,599.00 and N206,633.40 for Bokkos, Mangu and B/Ladi respectively. This amount consists of cost incurred on family labour fertilizer, manure and seed.

The gross margin in the optimum plan were N62,516.00, N156,463.30 and N189,891.90 for Bokkos, Mangu and B/Ladi respectively. Land use efficiency was highest in Barkin –Ladi, followed by Mangu and Bokkos based on the gross margins/ha. (Table 4.8).

4.3.4 Resource Use Efficiencies

The efficiencies of the farm resources were evaluated by their Marginal Value Product (MVP). The MVPs of the resources which were also the dual values of the solution were the same as the shadow prices on the disposable activities of the linear programming model. The shadow prices of the disposable activities show the resources that could best be expanded in order to increase the income from the farm. The shadow prices show the productivity of each resource and thus, how the farm income can

be expanded by utilizing an additional unit of the resource. The values were zero for excess (slack) resources and positive for the limiting or constraining resources. A higher MVP indicates the degree of scarcity of the resources (Etuk, 1979). Thus the more limiting a resource, the higher the MVP.

Table 4.9: Marginal Value Product (MVP) of Resources in the Optimum Plan.

Resources	Unit	Bokkos	Mangu	B/Ladi
Land	N	0	0	0
Family Labour				
April	N	0	0	0
May	N	0	0	0
June	N	0	0	0
July	N	0	0	0
August	N	0	0	0
September	N	0	0	0
October	N	0	0	0
November	N	0	0	0
Crop Output				
Potato	N	10.27	10.96	12.33
Maize	N	25.00	28.00	26.00
Operating Capital	N	1.73	2.37	2.39

Table 4.9 revealed that, land was not a critical factor in all the three LGAs. This is apparent by its zero shadow price implying an under use of land in the areas. Similarly, April – November family labour was in surplus in the potato/maize enterprise in the optimum plan. This is evident by their zero shadow prices. This means that family labour was under-employed and an increment of labour would not add to the value of the farm income.

It was also apparent from the result that the shadow prices of the potato and maize are not different from their unit selling prices in the optimum plan. Thus a unit increase in yield of the respective crop will not

make any difference on the value of farm income.

However, the MVPs of operating capital were 1.73, 2.37 and 2.29 for Bokkos, Mangu and B/Ladi LGAs respectively. This implies that operating cash (i.e cost of production) was a production constraint in all the Irish potato producing areas. The implication is that any additional incurement of cost on the purchase of fertilizer, seed etc would increase farm income by 1.73, 2.37 and 2.29 per Naira at Bokkos, Mangu and B/Ladi respectively.

Dung, Okonkwo and Lang (2002) confirms that the limiting factor to potato production particularly in Nigeria have been the high cost of inputs such as seeds and fertilizers.

4.4 Sensitivity Analysis

The initial farm plan was subjected to two parametric models. The result of the analysis are presented as follows:

4.4.1 Optimum plan with variation in fertilizer cost.

In this model, the price of fertilizer (NPK and urea) was raised by 20% to reflect the inflationary rate in the country. (CIA world factbook 2004). That raised the price of fertilizer from ₦2,500/bag to ₦3,000 while the price of potato and maize remains constant. The optimum farm plan as presented in Table 4.10 revealed that the activities and resource use levels of the feasible enterprise potato/maize remained unchanged when compared with optimum plan of the basic models in Table 4.8. The exception was in the total operating capital which increased by 20% in all

the three LGAs. This increase was caused by the increase in the price of fertilizer. The gross margin declined to ₦29256 in Bokkos; ₦76,963 in Mangu and ₦8545 in B/Ladi. This represents 5%, 9% and 10% reduction respectively. The consequences of this is that an increase in the cost of fertilizer without a corresponding increase in output price resulted in lower gross margin even though the level of real activities and resources use remained unchanged.

Table 4.10: Resources Use Levels when Fertilizers Prices were increased by 20% and Output Prices remaining constant.

Resource	Unit	Bokkos	Mangu	B/Ladi
Land	Ha	2.03	1.85	2.00
Family Labour				
April	Man – hr	109.55	83.37	116.19
May	Man – hr	160.26	133.39	162.27
June	Man – hr	225.18	200.08	256.42
July	Man – hr	172.43	150.06	156.26
August	Man – hr	322.55	276.04	320.53
September	Man – hr	101.43	64.84	84.14
October	Man – hr	40.57	27.79	70.12
November	Man – hr	123.75	111.16	112.19
Total Labour	Man – hr	**1255.72**	**1046.73**	**1278.12**
Operating Capital	₦	314,601	303119	247,960
Gross Return	₦	373,991	445,500	418,863
Gross Margin (GM)	₦	59,390	142,382	170,903
Gross Margin/ha	₦	29,256	76,963	85,451

4.4.2 Optimum plan with variation in both input cost and output prices.

In this model, the prices of fertilizer (NPK and Urea) were raised by 20%, while the prices of potato and maize were also raise by 20%. The optimum plan under this model showed that there was no significant changes in the farmers activities and resource use levels in all the LGAs when compared with the model in 4.4.1. The operating capital also, increased by 20% thus, the MVP of capital increased to a higher level of 2.27, 288 and 3.06 in Bokkos, Mangu and B/Ladi LGAs respectively. However, the gross margin per hectare also increased to ₦66,666, (128%) ₦111,843 (45%) and ₦139,220 (63%) in Bokkos, Mangu and B/Ladi LGAs respectively.

Table 4.11: Resource Use Levels when Fertilizer, Irish potato and Maize Prices were Raised by 20% .

Resource	Unit	Bokkos	Mangu	B/Ladi
Land	Ha	2.03	1.85	2.00
Family Labour				
April	Man – hr	109.55	83.37	116.19
May	Man – hr	160.26	133.39	162.27
June	Man – hr	225.18	200.08	256.42
July	Man – hr	172.43	150.06	156.26
August	Man – hr	322.55	276.04	320.53
September	Man – hr	101.43	64.84	84.14
October	Man – hr	40.57	27.79	70.12
November	Man – hr	123.75	111.16	112.19
Total Labour	Man – hr	**1255.72**	**1046.73**	**1278.12**
Operating Capital	₦	314,601	303119	247,960
Gross Return	₦	450,498	510029	526400
Gross Margin (GM)	₦	135,331	206,910	278440
Gross Margin/ha	₦	66,666	111843	139,220

The results from the linear programming analysis shows that potato farmer who plan his farm properly would utilize his resources better in terms of income and operating expenses. Thus, through farm planning, the Irish potato farmer's income in the state was more than when it was unplanned. The sensitivity analysis also showed that, the farmers income is highly dependent on the prices of fertilizer and output. Thus, a substantial increase in the price of fertilizers would reduce farmers' income while an increase in the prices of the produce will increase it.

4.5 Technical and Socioeconomic Constraints of Potato Production

Certain constraints are inherent in the production of Irish potatoes in the study area. These constraints are broadly categorized into technical and socio-economic problems. Respondents were asked to rank the constraints according to their order of seriousness. The result of the survey is presented in Tables 4.14 and 4.15.

The result showed that the difficulty in maintaining seed quality due to susceptibility of potato to pest and diseases ranked as the most serious technical constraint (67%); perishability ranked second with 61%, while low multiplication rate for seed (54.2%) and bulkiness of seed (43%) ranked third and fourth respectively. Among the socioeconomic constraints (Table 4.13), high cost of input ranked the most serious problem (66%), while unstable prices ranked second (57%). Lack of storage facilities ranked third, while lack of finance and lack of market ranked fourth and fifth respectively (that is 45% and 33%).

Table 4.12: Rank Order of Technical Constraints of Irish Potato Production in the Selected LGAs (n= 120).

Constraints	Rank Order*	Frequency	Percentage **
Difficulty in maintaining seed quality due to diseases	1	80	67
Perishability	2	73	61
Low multiplication rate of seed	3	65	54
Bulkiness of seed	4	50	42

Source: Field Survey 2003/2004

* Rank are in descending order of magnitude of constraint.

** Multiple choices and responses existed, hence total frequency exceed the actual sample size and percentage

Table 4.13: Rank Order of Socioeconomic Constraints of Irish Potato Production in the Selected LGAs.(n=120)

Constraints	*Rank order **	*Frequency*	*Percentage***
High cost of input (fertilizer and seed)	1	79	66
Unstable price	2	68	57
Lack of storage facilities	3	64	53
Lack of operating capital	4	54	45
Lack or market	5	40	33

Source Field Survey: 2003/2004

NB for * and **, see footnote in table 4.12

CHAPTER 5

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION.

5.1 Summary

Agriculture plays an important role in the economic development of Nigeria in terms of stamping out poverty and ensuring food security for the ever growing population. However, of the various efforts made by past Nigerian government, the required and expected improvement in food production has not been realized. Failure in achieving this goal should not discourage policy makers, however, better and more efforts should be geared towards better planning in arriving at our destination of achieving self-sufficiency in food production. That is why the present government, should emphasis the need for improving the optimal allocation of scarce resources in some important food crops- especially potato.

This study was designed to assess the problems militating against the production of Irish potato in Plateau state. It was anticipated that the study will try to answer some pertinent questions: (a). What are the socio-economic characteristics of potato farmers? (b). What are the various potato production system? (c). What are the pattern of resource allocation in the potato production practices? (d). What is the optimal farm plan of potato farmers? (e). How will charges in a limiting constraints affect the optimal farm plan? (f). And what are the major socio-economic and technical constraints of Irish potato farmers in Plateau state?

This study therefore is expected to provide the economic information necessary to evaluate the performance of the existing Irish potato production system in Plateau state. The data used were collected

through structured questionnaire from 120 farmers in three selected Local Government Areas out of the six LGAs noted for potato production on the in Plateau state. The tools of analysis were simple descriptive statistic, farm budgeting technique and linear programming analysis. The results from the analysis are summarized below.

5.1.1 Socioeconomic Characteristics of Potato Farmers

The study revealed that most of the farmers were small scale because the mean farm size was 3ha with most of the farmers cultivating between 2-2.99 ha (31.7%) and closely followed by 3-3.99 ha (22.5%). The mean age of the farmers was 41 years with majority of them (50.8%) within the age group of 40-49 years, while the active and virile age group of 30-39 and 20-29 were significantly low implying that many of the youths in the area were not engaged in farming. This development threatens the future of food production in the area. The mean household size was 6 persons, while the maximum was 20 persons. Farming experience was average 18 years implying that the farmers are experienced based on FAO (1992) report. The land ownership structure showed that majority of the farmers 95.8% acquired their land through inheritance. These correspond to why the farmers are small scale with scattered farms.

The result also revealed that 36.7% of the respondents produced sole potato for purely profit during the dry season while 63.3% for profit and food security motives during the rainy season. Majority of the farmers

(66.6%) either belong to FUA or Thrift and credit Association, while 33.3% do not belong to any association at all.

With regards to the cropping pattern in the area 98.7% of rainy season production adopts potato/maize enterprise while 100% of the dry season production was dominantly sole potato.

5.1.2 Cost – Return Analysis.

The average total variable cost per hectare for sole potato enterprise was ₦67,110 for the state and ₦77050, ₦61123 and N63,183 for Bokkos, Mangu and Barkin-Ladi LGAs respectively. While that of the potato/maize enterprise were ₦69,85 for the state and 6 ₦74,905, ₦71,690 and ₦62,974 for the respective LGAs. The analysis showed that labour cost accounted for the highest cost, closely followed by fertilizer and seed cost respectively in both cropping patterns in the LGAs.

The average NFI for sole Irish potato enterprise was ₦41,615 for the state and ₦35,408, ₦37,458 and ₦51978 for Bokkos, Mangu and B/Ladi, while that of the potato/maize enterprise in the respective LGAs, were ₦27,153, ₦47050,000 and ₦43,620 and that of the state was ₦39,274. Gross margin per hectare which indicates land efficiency, revealed that land efficiency was more in sole potato enterprise than in the potato/maize enterprise. The gross margin per naira invested on variable items was 0.47, 0.62 and 0.83 for sole potato and 0.36, 0,80 and 0.69 for potato/maize system in the respective LGAs.

This implies that a Naira invested yield higher losses in the sole potato enterprise compared to the potato/maize enterprise for Bokkos and Barkin-Ladi LGAs. In essence all potato farmers were not able to cover their variable expenses. Labour efficiency was more in Mangu and B/Ladi than in Bokkos LGAs in both sole potato and potato/maize enterprise.

5.1.3 Activities and Resource Use Levels in the Optimum Plan

The LP analysis, conducted to determine the optimum farm plan for Irish potato farmers in the area of study, revealed that potato/maize enterprise was feasible using 2.03, 1.85 and 2.00 hectares in Bokkos, Mangu and B/Ladi LGAs respectively. The result did not deviate much from the dominant existing cropping system in the study area. Family labour was not augmented for by hired labour activities in the optimum plan. Selling activities enter the optimal plan with different quantities of potato and maize to give a total revenue of N324, 683.50, N409,062.30 and N396,525.30 for Bokkos, Mangu and B/Ladi LGAs. The food consumption requirement specified for potato and maize were met in the optimum plan.

The resource use levels showed that land was in surplus, while the labour profile revealed a total of 1255.72, 1046.73 and 1278.12 man-hours only of family labour was used in the respective LGAs with the peak period in June and August. However, operating cash was a limiting factor because the cash constraint specified in the basic models were completely used up. The operating capital in the optimum plan were N262,167.50,

N252,599 and N206,633.40 used for the potato/maize enterprise in the respective LGAs.

Therefore, the gross margin in the optimum plan were N62,516.00, N156, 463.30 and N189, 891.90 for Bokkos, Mangu and B/Ladi respectively. This implies that land efficiency was higher in Barkin-Ladi LGA followed by Mangu and Bokkos LGAs in that order when the gross margin/ ha were compared.

The marginal value product (MVP) for all the resource except for potato and maize output and operating capital were zero. Implying that land and family labour were in surplus and any increase in their use will not add to the value of farm income. And since the shadow price of crop output are not entirely different from their selling prices, any variation in yield do not have any effect on farm income. However, since the shadow prices of operating cash were 1.73, 2.37 and 2.29 for the respective LGAs, it means that cash was a limiting constraint in the potato/maize enterprise. Any increase in cost of production will increase farm income by the amounts specified above.

5.1.4 Resource and Activities Levels in the Parametric Models

The optimum plan for all the three LGAs revealed that the activities and resource use levels of the feasible enterprise potato/maize remained uncharged when prices of fertilizer were raised by 20% with output prices reaming constant and when both fertilizer and output prices were also increased by 20%. However,

gross margin declined by 5%, 9% and 10% in Bokkos, Mangu and B/Ladi LGAs in the former case. But in the later case gross margin increased by 128%, 45% and 63% respectively in the three LGAs.

The implication of this analysis is that farmers income is highly dependent on the prices of fertilizer and output.

5.1.5 Technical and Socioeconomic Constraints of Potato Production.

The result showed that the order of seriousness of the technical constraints as: difficulty in maintaining seed quality due to susceptibility to diseases: 67%; perishability 61%; low multiplication rate of seed 54%; and bulkiness of seed 42%. Similarly, the order of the seriousness of the socio-economic constraints are: high cost of inputs 79%, unstable prices 68%; lack of storage facilities 64%; lack of finance 54% and lack of market 40%.

5.2 Conclusion

The conclusions from the study showed that most of the farmers were small- scale; within the age group 40-49 years, while the active and virile age groups (30-39 and 20-29) were relatively low. Similarly, the findings showed that the best optimum plan for potato farmers was the potato/ maize enterprise implying that productivity and farmers income will improve in the planned enterprise.

Further more, insufficient cash, high cost of production, difficulties of maintaining seed quality, perishability, unstable prices and lack of storage facilities are the major technical and socio-economic constraints of potato farmers in the study area. Efforts should therefore be made to confront this problem to ensure a more efficient production of potato in the state.

5.3 Policy Implication And Recommendations

There are many findings from the study which have policy implications.

1. The finding that the majority of Irish potato farmers (51%) were in the age group 40-49 years, while the most active and virile age group of 30-39 and 20-29 were relatively low, have implications for the future of farming in the State. It is expected that the younger generation will take over from the older generation. However, the finding suggests that this might be difficult to achieve. Thus large hectares of farmland might be abandoned thereby leading to drastic reduction in food production in the state. Efforts should therefore be made to encourage and attract the unemployed youths to farming. Both the government and non-governmental agencies have a role to play in this regard. For instance, the on-going: graduate farming programme of National Directorate of Employment should be vigorously pursued in the state.

2. Though the potato-maize production system is predominant and the best enterprise in the study area, however, the existing resources such as land and family labour were not being used to their optimum capacity. Efforts geared at encouraging farmers to reorganize activities and available resources will increase agricultural productivity in this production system. Research and extension interventions will be required in the area of improved crop production practices.

3. The finding that operating cash was a limiting resource in the study area implies that Irish potato farmers do not have enough capital to produce the optimum farm plan – potato/ maize enterprise. Further more, the high cost of fertilizer as discovered in the study will aggravate the availability of operating capital. Therefore, efforts should be concentrated towards reducing cost of fertilizer and better ways of financing cost of fertilizer and better ways of financing small scale farming. Such options could involve helping farmers Cooperative groups of develop low-cost credit, saving schemes and

input supply arrangements in the area. Similarly, the use of organic manure should be vigorously be encouraged to augment the use of chemical fertilizers.

4. The difficulties associated with maintaining seed quality due to susceptibility to diseases and high rate of perishability ranked high among the major technical constraints. This has implication on the supply of good quality true potato seed (TPS). Therefore, the National Roots Crop Research Institute of Nigeria could collaborate with International Potato Center(CIP) in research in the area of Integrated Control of major soil and airborne diseases affecting potato production in Nigeria.

5.4 Limitations

The dependence of Information gathered in a year is a limitation of this study. The changing nature of agricultural production in terms of variation in output due to the vagaries of nature and dynamic price situations may limit the scope to which results of this study can be applied. Similarly, there was the problem of data quality due to lack of adequate record keeping by the respondents of the study. As a result, the researcher had to rely on farmers memory recall abilities to gather details of the data required for the study.

Furthermore, the linear programming model was based on the representative farm which in reality is non-existent. The interpretation of the results and their applications on a wider basis would have to be done with caution. The result of this study need to be complemented with the results of similar studies. In spite of these limitations the study has achieved the purpose of highlighting the socioeconomic characteristics of potato farmers resource use efficiencies in potato production and problems militating against the crop in Plateau state.

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APPENDIX 2: LIST OF ABBREVIATIONS IN THE BASIC LP MODELS

FL	-	Family labour
HR	-	Hired labour
SPO	-	Sole potato enterprise
PO/MZ	-	Potato/maize enterprise
RPO	-	Dry season potato
BPOPSD	-	Buy potato seed; rainy season
BMZS	-	Buy maize seed
B-POSR	-	Buy potato seed; rainy season
UPOSR	-	Use potato seed; dry season
UMZS	-	Use maize seed
UPOSR	-	Use potato seed; rainy season
SLPOD	-	Sell potato; dry season
SLMZ	-	Sell maize
SLPOR	-	Sell potato; rainy season
CPOD	-	Consume maize
CPOR	-	Consume potato- rainy season.