ECONOMIC ANALYSIS OF IRRIGATED TOMATO PRODUCTION USING PUMP AND SHADOOF IRRIGATION TECHNIQUES UNDER FADAMA DEVELOPMENT PROJECT IN BAGWAI AREA OF KANO STATE, NIGERIA

BY

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL
AHMADU BELLO UNIVERSITY, IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS AND
RURAL SOCIOLOGY,
AHMADU BELLO UNIVERSITY, ZARIA

SEPTEMBER, 1998

DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented before in any application for higher degree.

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CERTIFICATION

This thesis entitled **"Economic Analysis of Irrigated Tomato Production using Pump and Shadoof Irrigation Techniques Under Fadama Development Project in Bagwai Area of Kano State, Nigeria"**, by Ayinde, Abiodun Timothy meets the regulation governing the award of the Degree of Master of Science (Agricultural Economics) of Ahmadu Bello University, Zaria.

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ACKNOWLEDGEMENT

The successful completion of this project was due to the tremendous encouragement I receive from so many people; too many to mention individually but you all will be remembered as being my source of inspiration.

My sincere appreciation goes to my able Supervisors Prof. A. O. Ogungbile, the Chairman of my Supervisory Committee for his time and effort and Dr. M. I. Kolawole for his meaningful contributions. My thanks goes to Messrs Danladi Jarma, Joel Maidawa and John Obeameta for the Computer lessons which enabled me to analyse my data. The staff of KNARDA at Bagwai, Bichi and Kano, Mal. Ibrahim Ali Danbatta, Alh. Isa Sale and Mal. Sule Tsaye for their assistance while collecting data at the headquarters and in administering the questionnaire. To my good friends especially Gbenga, Tola, Mr. Akinola, Mr. Rapheal, Zakari, Yakurshi and Mr. Olayiwola. To all my brothers and sisters, my mother and my wife for their encouragement.

The Federal College of Education (Technical) Bichi is acknowledged for the sponsorship. I also wish to acknowledge the contribution of Mr Ogunleye Isaac (FCE, Kano) who patiently typeset this project.

Finally, I also appreciate the prayer of First Baptist Church Bichi. Above all, I am grateful to Jesus Christ the Author and Finisher of my faith. My Almighty God, My El-Shaddi, Alpha and Omega for seeing me through this programme.

ABSTRACT

The study was designed to study the economic analysis of tomato production under Fadama Development Project using pump and shadoof method of irrigation in Bagwai area of Kano state. The objectives of this study are; to identify and describe the most important resources used by the farmers in tomato production; estimate the production function in order to determine the economic efficiency of different resources used in tomato production, determine the cost and returns associated with tomato production; identify the constraints to increase in tomato production under the project and make recommendations that could enhance increased tomato production by farmers in the areas.

The data necessary for the analysis were obtained through a survey of 70 farmers, comparing farmers using pump and those using shadoof methods of irrigation for the cultivation of tomato. The analytical tools employed include, simple descriptive statistics, Cobb-Douglas (power) production function models and the farm budget.

The Cobb-Douglas production function analysis revealed that fertilizer was under-utilized. The marginal productivity of labour was positive but lower than the average acquisition cost for both techniques of irrigation. The results tend to indicate an improvement in labour productivity over the excessive use of labour in traditional agriculture. The marginal value product of resources used by farmers are

statistically different with the two methods of irrigation. Both techniques of production exhibited increasing return to scale, more inputs can be added to production to increase crop output. The farm budget analysis revealed that all farmers produced at a profit and it is more profitable to grow tomato using pump method of irrigation. There was however, a very high variability in yield, prices, costs and returns among the respondents. The test of significance of net farm income confirmed that there is a significant difference in the mean net farm income of farmers in favour of farmers using pump.

The major problems identified by farmers includes non-availability, high costs and delays in supply of farm inputs, inadequate supply of water, pump maintenance, lack of tractors, incidence of pest and diseases.

On the basis of the findings, it has been realized that farmers are willing to use information and modern techniques made available to them to maximize their production but institutional constraints have been a bottleneck. Therefore, farm inputs should be made available to farmers at the right time and right quantities.

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ABBREVIATIONS AND ACRONYMS

ADP	Agricultural Development Project
AERLS	Agricultural Extension and Rural Liaison Services
FIG	Figure
FUA's	Fadama Users Association
GNP	Gross National Product
Ha	Hectare
KASCO	Kano State Agricultural Supply Company
Kg	Kilogram
KNARDA	Kano State Agricultural and Rural Development Authority
LGA	Local Government Area
MFC	Marginal Factor Cost
MVP	Marginal Value Product
N	Number
NFI	Net Farm Income
N.A.	Not Available
N.B.	Note Well (nota bene)
NPK	Nitrogen, Phosphorus and Potassium Fertilizer
SAP	Structural Adjustment Programme
SD	Standard Deviation
TC	Total Cost
TFC	Total Fixed Cost
TVC	Total Variable Cost
VC	Variable Cost

Chapter 1

INTRODUCTION

1.1 Background Information

Tomato which is grown in home gardens and commercially is one of the world's most popular vegetable. They are good source of Vitamin A and C and can help alleviate deficiencies in these vitamins in many developing countries. Tomato is an attractive cash crop for small farmers and a potential source of employment (Villareal, 1980).

The intervention of government in tomato production is mainly to use modern techniques in tomato production. This will lead to increase in productivity, higher standard of living for the farmers and increase in Gross National Product (GNP). It will also eliminate or reduce to the bearest minimum the importation of tomato puree hence conserving foreign exchange.

The potential of tomato growing with respect to tomato processing led to the establishment of Cadbury Nigeria Limited which initially was importing tomapep (mixture of concentrated tomato and hot pepper) but later with the increase in tariffs on importation, the company established an extracting plant in Zaria. Similarly over the years many companies such as Ikara Tomatoes Limited of Kaduna state, Vegfru of Bornu and Antonella in Kano state came into existence.

1.1.1 Importance of Tomato in Bagwai Local Government Area

Tomato is grown in the study area as food and cash crops. it is processed into paste or puree which are cooked to make stews, soup, etc, for home consumption.

Tomato is one of the widely cultivated crops among vegetables grown in the study area. About 90% of the farmers cultivate tomato along with other vegetables during the dry season. In view of the bumper harvest normally experienced here, tomatoes are sold in both rural and urban areas and even transported to places like Ibadan, Lagos and Port-Harcourt in the southern part of the country. The cultivation of the crops serve as a means of employment and a source of income to the farmers.

Since tomatoes can be cultivated twice in a year, it played an added role of stabilizing tomato prices which enables its consumption throughout the year.

1.2 Fadama Development Project

The Kano State Agricultural and Rural Development Authority (KNARDA) was established in 1982 together with the Kano State Agricultural Supply Company (KASCO) as its commercial arm for the execution of a state-wide Agricultural Development Project (ADP). The broad objectives of the authority were to increase agricultural production, improve rural incomes and standard of living in the rural areas. The programme consists of a package of services designed to assist farm and crop development with strategic investment in supporting infrastructure like feeder roads, boreholes, wells and

farm centres. It is also required to train and establish an effective authority that will continue the programme in perpetuity.

Before the project started, there were about 13,000 hectares of Fadama areas being cultivated each dry season by approximately 130,000 farmers growing vegetables and cereals. The majority of farmers used the traditional shadoof method of irrigation which involved considerable labour in lifting small amount of water. This restricts farmers to irrigating very small areas.

KNARDA has introduced a cheap and effective means of tapping sub-surface aquifer in river-bed and flood plains to extract water from depth of 3-6 meters for both irrigation and domestic purposes during the dry season. During the dry season, the riverine water source exploited for irrigation dries up, although in many river beds the flow continuous beneath the soil. The sub-surface water tapping technique is called washbore. The washbore can irrigate ½ - 1 hectare (Muhammed, 1987). In 1986, 1,846 washbores have been installed and by 1991 the number has increased to 3,938. Following the Structural Adjustment Programme, most of the input, e.g. pumps, washbores, tube-wells, etc. are expensive and cannot be subsidized by KNARDA. Farmers are therefore expected to make direct purchase from the market. One of the measures adopted to alleviate the problem of purchasing inputs is the formation of Fadama Users Association (FUA's).

The common purpose of the association include:

(a) Pool purchase of drilling services

(b) Transportation of inputs such as fertilizer

(c) Loan disbursement and repayment

(d) Regulation of water use

(e) Maintenance of Fadama Infrastructure including roads, pumps and storage facilities

(f) Transport and marketing of output (Fadama Products).

The formation of FUA's formally registered with appropriate authorities as co-operatives provides a measure of security in issuing individual loans for equipment and working capital and is a financing organization in managing debts repayments.

Fadama farmers that required assistance in irrigation can only benefit from the loan package if they belong to the FUA's. They are expected to make a down payment of at least 25% of the full cost of the pumps and repayment of loans within four (4) years. Contacts are later made with the irrigation unit of KNARDA for drilling and provision of pump. This programme has contributed in no small way in boosting dry season farming and the production of vegetables including tomatoes.

1.3 Problem Statement

In recent years, tomato production has been unable to meet the increasing demands in Bagwai area. This is evident in the rising prices of tomato in this area. A number of factors considered responsible for this poor performance include; low productivity of farmlands as a resulit of decreasing soil fertility borne out of the limited use of fertilizer, inadequate extension services and the use of simple manually operated tools. In its bid to improve

this situation, policies and programmes aimed at increasing productivity and hence supply of agricultural products have been developed and are still being developed by the government.

Despite the effforts made by government, production of tomato in the Fadama area of Bagwai have suffered a set back in terms of productivity.

From records obtained from KNARDA (see Table 1.1), the number of hectarages cultivated and the output obtained are increasing over years in absolute terms but output per unit area have been falling. For instance, between 1982 - 1984, the total area cultivated was 1.8 hectares and the output per hectare was 20.48 tonnes. From 1985 - 1990; there was an appreciable increase in output and yield per hectare. A total of 5 hectares of land was cultivated with an output of 30.42 tonnes per hectare.

Between 1991 and 1996, a total area of 11 hectares was cultivated with a yield of 22.5 tonnes per hectare. Though, there is an appreciable increase in output of tomato, the output per hectare was however low compared to the previous years. The low output per unit area cultivated have contributed to the low supply of tomato in this area.

Table 1.1: Average Output in Metric Tonnes of Tomato Produced in Some Areas of Kano State

Year	LGA	Output	Area Cultivated (Ha)
1982 - 84	Bichi	107.34	3.85
	Bagwai	51.28	1.8
	Gezawa	45.42	2
	Dambatta	572.38	23
1985 - 90	Bichi	361.51	13.5
	Bagwai	152.36	5.0
	Gezawa	136.22	5.45
	Dambatta	2374.88	72.5
1991 - 96	Bichi	456.89	18.9
	Bagwai	247.86	11
	Gezawa	150.88	7.6
	Dambatta	2685.38	119.9

Source: KNARDA (1982 - 1996)

A conspicuous aspect of the farming system in the study area is the dominance of small holders using simple technology such as hoes and cutlass. The average farm family cultivates small parcel of land (about 0.2 hectares) there is minimum use of capital and technology by the farmers. Also capital is a major factor limiting the adoption of improved practices among the farmers. Farm income from sales of farm commodities is usually low and farmers can rarely afford to meet the annual farm expenditure required to improve the level of productivity. These factors are directly responsible for the poor performance of the project at the village level, thereby leading to the present low supply of tomato.

From the foregoing discussion, tomato proudction under pump

techniques is presumed to be more economical in terms of productivity and returns when compared with shadoof techniques. Although no information presently exist on the economics of tomato production at the farmer's level, this study tries to examine input-output, cost-returns relationships with a view to identify the economic factors that influence the level of tomato production and supply at the farm level in Bagwai area.

1.4 Objectives of the Study

The broad objective of the study is to analyse the economics of irrigated tomato production using pump and shadoof irrigation techniques under Fadama Development Project in Bagwai Area of Kano State. The specific objectives are to:

(i) identify and describe the most important resources used by the farmers in tomato production;

(ii) estimate the production function in order to determine the economic efficiency of different resources used in tomato production;

(iii) determine cost and returns associated with tomato production, using shadoof and pump irrigation systems;

(iv) identify the constraints to increased tomato production under the project; and

(v) make recommendations that will enhance increased tomato production.

1.5 Justification of the Study

The study is worthwhile from the fact that agricultural sector has for a long time now been regarded as the mainstay of the Nigeria economy. Even though among vegetables, the output of tomatoes in Nigeria is low and less than 30 tonnes per hectare (Ofojekwu, 1982). It is still below the average output of 30 - 40 tons per hectare under irrigation when properly managed in Zaria (Quinn, 1977). In other words, the increase in output are largely due to expansion in acreage than increases in output per hectare.

Also, the choice between various types of irrigation, cropping pattern and optimum resource use, must be based on economic evaluation if it is to be widely accepted. Therefore, there is the need to investigate how resources are organized and to assess and measure the economic efficiency and profitability with which such resources are utilized for tomato production in the Fadama area. It is envisaged that the study will provide an insight into the efficiency and productivity of resources used in the production of the crop. This is with a view to proposing appropriate re-adjustments of specific resources used for the production of the crop. The study will also provide an indication of the types of government assistance required for the crops produced under Fadama.

1.6 Statement of Hypothesis

The hypothesis put forward for this study are that:

(i) The stated production indicators have no significant influence on tomato output under both irrigation systems.

(ii) There is no significant difference in resource productivity between farmers using pump and farmers using shadoof system of irrigation.

(iii) There is no significant difference in net farm income position of the farmers using pump and those using shadoof.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Increasing concern is being expressed about the need to increase food production in many countries of the developing world. This had led to discussion on methods to achieve such increases as well as reasons for not having achieved substantial improvements in the past (Bunting, 1970). Furthermore, it is observed that in many effective technology in the form of seed varieties and other complementary package inputs are available but the ultimate result in terms of higher yields has not been forthcoming.

The importance of irrigation in facilitating double cropping, increasing area for crop production and more especially encouraging dry-season cropping for such crops as tomatoes, onion, sugarcane and rice by the local farmers cannot be over-emphasized. It however, tends to introduce a change in Nigerian agricultural system. In order to sustain the production of such crops like tomatoes under irrigation for both industrial and local consumption, it is necessary that adequate care be taken in planning the project and evaluating the economic viability of crops grown under irrigation system (Ofojekwu, 1982).

To eliminate or at least narrow the gap between farmers yields and those obtained at research stations (Norman, et al, 1976) initiated a number of investigations aimed at examining the problems of using technologies on

farmers field under his own environmental conditions.

Tomato is increasingly gaining importance as an irrigated crop in most of the irrigation schemes in Northern Nigeria. This development is not surprising since previous investigation (Quinn, 1971; 1974) showed that production conditions for tomatoes are best in drier areas of the Northern States. The optimum planting dates in these areas suited for tomato production are between the months of October and January (Quinn, 1974). These are months without rainfall and irrigation thus become necessary for tomato production. Most of the tomato production in Nigeria is by peasant farmers and small scale holders using the traditional shadoof or surface irrigation methods in Fadama areas (Quinn, 1974). Orewa (1978) worked on the economics of dry season tomato production under the Cadbury Tomato Schemes in Zaria area. His main area of concentration though on input-out, cost-returns relationships with the view to identify the economic factors that influence the level of tomato production and supply at the farm level in Zaria area but did mainly emphasize the use of shadoof irrigation system.

Similar work by Ofojekwu (1982) whose work was also on the economic aspect of dry season tomato production but with emphasis on the use of surface irrigation method. He concentrated his work on the input quantities, input costs, output quantities and prices, and profitability of tomato production under the small scale surface (Furrow) irrigation system by the local framers under the Ministry Organizational set-up. The study also identify production resources that were not efficiently utilized in tomato production under the system. Lastly, Ofojekwu's study did identify the economic factors

that influence the level of tomato production under the Ministry Organization.

Since there was no study of tomato production under surface scheme in Zaria it was not possible to draw on bench mark data from a previous study. And since irrigation was the major focus of this study it was decided that detailed data on irrigation activities will be collected (Ofojekwu, 1982). In his analysis two different methods were developed. First was the estimation of the cost of input and output prices of tomato production under irrigation scheme, the farm budget model was used for the net farm income. Second, the production function model was used in estimating the input relationship. Ofojekwu found out that there was yield variation between farms. He stated that among the individual respondents there were variation in total yields, gross and net income due to difference in farm size, quantity and prices of input as well as output prices. Yield of tomato varied between 8.16 and 28.0 tons per hectare. Though the yield was encouraging, it is still below the average yields of 29 tons per hectare (Abalu, et al, 1979) or 30 to 40 tons per hectare under irrigation when properly managed (Quinn, 1977).

Ofojekwu's work revealed that prices of output varied in different geographical markets. Within the harvesting period. It was observed that prices of output varied from 3.00 to 3.40 for a basket of 30 kg at farm gate markets to 4.40 to 5.00 at Sabon Gari market in Zaria to 7.00 - 8.00 at big market places like Ilorin, Ibadan. The cost of transportation was observed 30 kobo per 30 kg basket to Southern markets (Ilorin and Ibadan). Taking these costs into consideration, it could be inferred that farms with higher yield have high return when sales were made at distant market than at farm gate. The

variation in return among farmers partly due to variation in markets where sold.

2.2 Cropping System

Yayock et al (1988) defined cropping system as the process of production of one or more crops, including the variety(ies), the operation and management system in which it is carried out to achieve the given objectives. That means a cropping system is just that aspect of crop management that involves the arrangement or combination of crops in space and time within a given farming system.

Okigbo (1978) described different cropping system in Africa and classified the major ones as being sole cropping, mixed cropping and interplanted cropping system. The commonly practised ones in Bagwai are the sole cropping and mixed cropping of tomato.

For their production, tomatoes are no exception from the fact that profitable agriculture is dependent on productive soils. Other factors of economic importance include the plant vigour, insect control and climatic conditions. Aside from weather according to Purseglove (1974) productive methods such as planting and cultivation determines the success of tomato production.

Despite the above condition, tomatoes are known to be adopted to wider range of climate and soil conditions; these are warm season plants reasonably resistant to heat and drought. They are not sensitive to day length but thrive best in clear and rather dry weather with uniform moderate

temperature of about 18^0 - 30^0C. Tomato can neither withstand very low temperature (below 0^0C nor very high temperature above 35^0C) Purseglove, 1974). Tomatoes can grow on many kinds of soil ranging from sand to heavy clay, with no water - logged conditions.

In tomato farms, insufficient water supply will retard development and also favour blossom-end rot of fruits which reduces yield (A.E.R.L.S. (1985), although irrigation is essential, excessive amount of water can be deleterious and should be avoided. Excessive irrigation makes harvesting difficult because of the excessive vine growth and reduces the soluble solid content of the fruit (Flocker et al, 1961). Over irrigation results in rotting of early maturing fruits. Water deficit during main period of flowering (40-70) days may cause excessive shedding of young fruits. Optimum production appeared to be favoured by high level of soil moisure throughout the vegetative and early flowering periods followed by reduction during fruit development and lower level during ripening (Martin, 1966). Chappel, (1967) from his work in Upper Murry confirmed these and suggested that a constantly available water is more beneficial to tomato than periodic flooding.

Two irrigation per week should be supplied to crop on sandy soil. However, on other soils one weekly will be sufficient (A.E.R.L.S., 1985). Till, (1969) also confirmed the frequency of about 6 days interval. Dunkel, (1966) gave the level of soil moisture for successful tomato production to be about 70 percent of field capacity as the most appropriate but not as low as 50 - 60 percent nor high as 80 - 100 percent of field capacity.

2.2.1 Transportation and Marketing of Tomatoes

Tomato being one of the perishable fruits, there is need for fast, safe and economical transport services to bring the crops to consumers. The transportation of tomato is highly influenced by the level of production and means of transportation. While peasant farmers use motorcycle, bicycle, donkeys, or head for transportation to nearby markets, some use rail and truck to transport the product to far market.

In marketing the crops farmers could sell it directly to the final consumer on retail basis or could sell it to the consumer through collectors (Dillalais) who are responsible for disposing the product once they are received.

2.2.2 Handling and Storage of Tomatoes

Tomatoes are very susceptible to mechanical injuries and subsequent deterioration because of their shape, structure and soft texture associated with high moisture (Akinbolu et al, 1991; Erinle, 1986). The injuries inflicted through scratches, abrassions, compression, creates points of entry for spoilage by micro-organisms and ultimate decay.

MacDonald (1984), observed that losses may result from harvesting fruits in red ripe condition. However, Erinle (1982), observed that tomato cultivars differs in handling and keeping qualities. He found out that the hard tomato cultivars are superior over the processing and fresh market type.

Losses during storage are often due to factors such as fruit quality, environment and pathogenical condition of the fruit as well as the

physiological changes within the fruit. Mapson, (1970) reported that the rate of oxidation or depletion of Vitamin C depends on the following: the time, temperature, oxygen, Ph and extent of cell damage and presense of oxidase enzymes, ascorbic acid oxidase which causes significant loss in nutritional value of the produce.

Onesiroson, et al (1976) reported that fungal pathogens are mainly responsible for storage rots in tomatoes, Tomskin (1963) reported that tomatoes at low temperature (less 10 per cent) are susceptible to fungal attack.

2.3 Factors Critical to the Success of Irrigation Schemes

There are numerous critical factors for the success of irrigation schemes. These factors include the following:

2.3.1 Research

For best utilization of any irrigation scheme, a relatively higher degree of technical and scientific knowledge need to be developed. For example, small differences in the depth of irrigation where applied or number of irrigation may result in drastic difference in yield of crops (Falaki et al, 1979). This implies that knowledge of depth of irrigation water to be applied and number of irrigations are very important in order to avoid losses in yield of crops. Thus, without research knowledge considerable risks are involved particularly in large scale irrigation projects where larger hectarages are managed at least for water input.

Knowledge of cropping patterns are very important to the success of the schemes. Since there are considerable variations in cropping pattern between small and large-scale irrigation schemes, Chari and Maurya (1982) suggested that 200 - 400% cropping intensity is suitable in small scale irrigation schemes with small farm holdings whereas, maximum of 200% is possible on large scale irrigation farms. Cropping pattern should be designed in a way that available irrigation water is used up effectively and economically.

Research on supplementary irrigation has shown that irrigation water supplementation during the raining season in the Sudan and Sahel Vegetation Zones was quite beneficial.

Furthermore, poor knowledge and adaptability of the installed irrigation system, lack of know-how for alternative replacement and substitution with local component and spare parts, improper identification of cropping system best suited to an area, lack of on-farm selection, protection, production and handling technology inadequate understanding of the effect of irrigation on ecology and environment (Singh, 1979) and want of knowledge regarding detailed socio-economic impact of irrigation has resulted partly to complete failure of irrigation schemes in general and large scale irrigation projects in particular, thus, elucidating the importance of research in these areas for the success of irrigation schemes in the country.

2.3.2 Land Tenure

The structure of land tenure in Nigeria has very strong influence on the efficiency and utility of irrigation scheme in general and large scale irrigation in

particular. Generally, the developed land is distributed in small pieces to the farmers under various tenancy arrangements. Irrigable lands under such schemes do not really belong to the farmers who are supposed to cultivate them, thus attachment and sense of ownership are lacking. Earlier studies have shown that feelings of insecurity of tenure, interference in the selection of crops and conventional agricultural practices (Plamer-Jones, 1991) dislocation of family life and distance involved from their new homes to their actual farms have placed immense stress on the activities of the farmers (Voh, 1977). Raza and Abdullahi (1979) also reported that socio-political aspect of re-settlements were not very pleasant and largely disastrous for smooth running and success of large scale irrigation projects. Thus, much efforts and motivations are therefore required on the part of the executing agency to meaningfully involve farmers in their irrigation schemes. This aspect is non-existent in small scale irrigation scheme. For the transition from subsistence rainfed agriculture to small scale irrigated cropping does not involve dislocation of family life, original dwelling place and social set-up and therefore it is more natural and readily acceptable to the farmers.

2.3.3 Labour Supply

Being labour intensive, irrigation agriculture is further dependent on the supply of labour. Baba, (1981) reported that modern irrigation has increased labour input by over 47% and 128% for irrigated wheat and tomatoes respectively. Similarly the private small scale irrigation and to some extent government aided small scale efforts has well expanded and flourished

depending on family and hired labour available (Maurya and Sachan, 1984). These small scale system expanded naturally and did not carry with them the effects of imposition from above which imposes considerable stress on the relation in the area. In the large scale system in Nigeria where land developed is allocated to private small holders, non-availability of hired labour in times of need is a serious problem. In such cases, labour requirement should be fairly and accurately planned, so that regular labour supply through this organized labour settlement is ensured.

2.3.4 Availability of Inputs

Irrigated agriculture is input intensive. That was why large scale irrigation scheme have their in-built stores with appropriate links in national and international input markets - to guarantee input supply for their farming activities. The private small scale holders on the other hand depended on publicly owned input supply agencies. These input agencies are in-efficient in their operations and timely supply of inputs cannot be assured from them. In such situation, the small scale irrigation schemes would suffer the problem of lack of availability of input at the right time, hence the output of farmers in the scheme will decline. Thus, for the success of small scale irrigation projects, additional government effort is necessary in this regard to arrange for timely supply at competitive prices.

2.3.5 *Credit Institution*

Farmers in newly developed irrigated areas require dependable credit institution in order to meet the increased operational cost. Large and small

scale governmental irrigation schemes normally have in-built credit system in this regard. However, the privately owned small scale irrigation schemes such as washbores owners require special effort on the part of financial institutions and government to ensure timely availability of the credit. It is pertinent to note that the establishment of the Nigerian Agricultural and Co-operative Bank and the Agricultural Credit Guarantee Schemes were all aimed at partly meeting this demand. Nevertheless, economist feels that there leaves much to be desired in this regard if irrigation schemes are to be successful, for majority of the farmers are inherently poor in capital formation (Erhabour, 1982).

2.3.6 Marketing system

As tonnage of the rainfed crops are increased and dry season irrigated crops join the public basket, the traditional marketing system tend to remain far-fetched from delivering the desired services to the producers. In small scale project areas, lack of good roads and transportation facilities are serious bottlenecks. For perishable commodities are sold at throw away prices or even got spoiled in transit. Therefore, the provision of good roads, short and long term cold storage facilities, price incentives, agro-processing industries and development of local, national and international markets for produce firms in those small holders areas is inevitably needed if gainful irrigated agriculture is to be sustained particularly small scale irrigation schemes. This may also require imaginative food import policies to protect the interest of these small farmers.

Chapter 3

METHODOLOGY

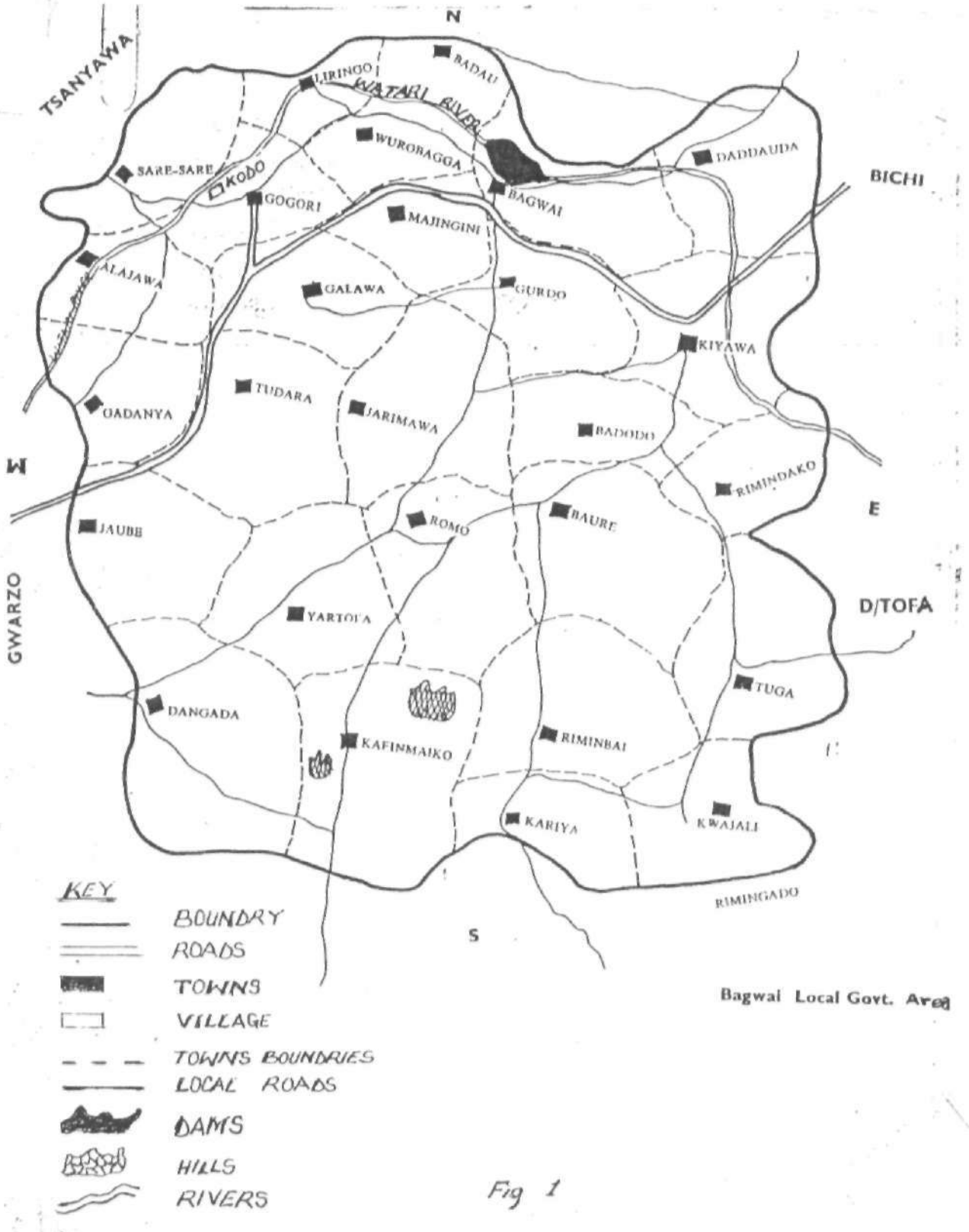
3.1 Introduction

The purpose of this chapter is to briefly describe the physical features and other demographic characteristics of the study area and provide a framework of analysis of the data collected from the field survey.

3.2 The Study Area

The study area Bagwai Local Government Area of Kano state was created in 1989 with a land mass of 45 square kilometre. The Local Government share boundaries with Bichi Local Government area to the North, Shanono Local Government Area to the West, Rimin Gado Local Government Area to the East. Nigeria population census conducted in 1991 put the population of the Local Government Area at 100,824 people. The Local Government is predominantly rural and socio-politically made up of a district, 10 constituencies and 27 villages. Among the villages situated along Watari River; Kodo area was selected for the study. A map of the study area is presented in figure 1.

MAP OF THE STUDY AREA



Bagwai Local Govt. Area

Fig 1

3.2.1 Climate and Vegetation

The climate in the area is characterized by the occurrence of wet season mainly from June to September and a dry season from October to May. Rainfall is received from June to September with an average annual rainfall of 870.20 mm (Kowal and Knabe, 1972).

The dry season can be further divided into a cool, dry season referred to as the "Harmattan" period from October to February and a hot, dry season from March to May (Fatokin, 1975). The average minimum temperatures of 11.4^0C - 14.6^0C occur between December and January while the maximum temperatures between 35.6^0C - 42.7^0C have been recorded in the months of March/April. The maximum mean relative humidity of 63 - 78 per cent have been recorded between the months of May and September, while a rapid drop occurs in October. Until April, the average figures remain between 30 - 40 per cent.

Typically, the Sudan Savanna zone is characterized by five - leaved Acacia spp and their associates including Balanites aegyptiaca, Commiphora africana, etc. Tress and shrubs which are commonly found include Adansonia digitata, Anogeissus leiocarpus among others. Most of the trees found are fire-tolerant perhaps because of the intense human activity in the area - particularly with regards to cultivation and the use of fire (Wall, 1979).

3.2.2 Topography and Soils

The geomorphology of the area is greatly undulating plains with an active flood plain and recent alluvium associated with the Gongola river

systems. The soil in this area is mostly hydromorphic in nature, having very high clay content with residual moisture especially at the lowland during the dry season.

3.2.3 Farming Characteristics

Agriculture indeed forms the main occupation of the people in this area. The predominantly rural population consists of the nomadic pastoral Fulani and the primarily crop farming population of both Fulani and Hausa origin. Only a small minority of the people is engaged in paid (government) work and even then almost all of them supplement their income with earnings from farming.

Crops grown in the Fadama areas include: rice, groundnut, maize, sugarcane, tomato, leafy vegetables, etc. The scope for extensive cultivation was larger under rainfed area than irrigation. The production of crops is carried out by peasant farmers on fragmented plots using basically simple implements as hoes, matchets and an insignificant number of the farmers are using animal traction.

The Fadama crops are grown on residual moisure supplemented with irrigation. The methods of irrigation employed in the study area involve either the use of pump/washbore or shadoof system of irrigation.

The shadoof (Jigo in Hausa) is a simple device for lifting water using the principle of lever. A pole with the aid of counter-weight at the opposite end of the pole and fulcrum, water is lifted from a source such as stream or well. The shadoof system is mostly used in the Fadama. During the dry

season intensive vegetable production is common on the Fadama land and the crops irrigated by shadoof system. The main advantage of shadoof system include low capital and low level of technology. However, the area that can be irrigated is small; likewise the discharge rate is low, but labour requirement is high. Due to the low pumping head, the shadoof system is usually limited to farms adjacent to water source. The water application rate and the total applied water are necessarily low. Although there are so many farmers using this technique of irrigation, most prefer to use the pump/washbore technique (about 1 out of 5 farmers employ the shadoof technique).

For those using washbore, pumps are used to suck up water, the pump water is conducted with the aid of long flexible hoses on the irrigated field through a series of built-in channels to the individual plots and water inflows were controlled by opening and closing of channels to distribute water to individual basin within the plots. Although, levels of investment, cost and technology are high, the larger area that can be irrigated, greater discharge, reduced human energy and the fact that the land irrigated does not have to be adjacent to the water source are probably the motivating factors for farmers preference for this technique.

3.3 ***Sampling Procedure***

The farmers used for this study were selected from Kodo area. The criteria used for selecting the area are guided by dominant characteristics such as rainfall, soil types, size of land holding, proximity and the

concentration of the farmers using the two techniques of irrigation in the area and Fadama Project. The farmers were selected from a list obtained from KNARDA Fadama irrigation programme, while a purposive sampling technique was used in choosing the farmers with respect to the type of irrigation technique used.

One hundred and fifty (150) farmers were involved in the dry season tomato production for 1996/97 farming season. Each farmer grew mainly tomato in the small plot. From the 150 farmers, a random sample of seventy farmers were taken for the study; thirty-five farmers each for those using pump/washbore and shadoof technique of irrigation. The sample was limited to seventy because of financial constraint.

3.3.1 Method Of Data Collection

Structured questionnaires were developed and used for data collection. The 70 farmers selected for the study were interviewed on a weekly basis throughout the survey period, which lasted from October, 1996 to March, 1997. The information collected includes, the quantity and price of each input used, type and duration of labour, crop yield, duration of irrigation and problems faced by the farmers.

3.4 Framework of Analysis

The purpose of this section is to provide the theoretical and analytical sframework for the analysis of data collected. In order to achieve the objectives of this study certain economic tools of analysis will be used,

namely;

Production Function analysis based on least square technique of estimating Production Function that best describe the input-output relationship in the production process; and

(ii) Net Farm Income (NFI) model for the purpose of computing the profitability of the tomato enterprise.

3.4.1 Multiple Regression Analysis

Regression model was used in this study to satisfy objective 2. The purpose was to identify the input-output relationship existing in the production process and to determine the relative influence of variables that have contributed to the present level of output and consequent supply of farm produce. This model was employed to analyse the underlying production function.

3.4.2 The Farm Production Model

A production function displays the technical relationship between resource inputs and product output (Upton, 1973). The production function provides us with a comprehensive information on productivities of resources, efficiency of resource used, elasticities of production and return to scale. The data collected from the study area were fitted to several algebraic forms of the production function, such as the linear model, the Cobb-Douglas, the quadratic and the square root, as represented in equations 3.1, 3.2, 3.3 and 3.4 respectively.

Linear Equation

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.1)$$

where,

Y is the quantity of output;

$X_1X_2X_3X_4$ are quantities of variable inputs, and $b_1b_2b_3b_4$ are coefficient to be estimated. The linear function is based on the assumption that the inputs and outputs are all related by straight lines. This implies that the marginal product with respect to each input and rate of technical substitution among the inputs is constant. Hence, there is no diminishing marginal rate of return and economic optimum.

Cobb-Douglass (Power) Function

$$Y = aX_1^{b1}\, X_2b^{b2}\, X_3^{b3}\, X_4^{b4}\, e \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

The Logarithmic transformation of which is as follows:

$$\text{Log } Y = \text{Log}a + b_1\text{Log}X_1 + b_2\text{Log}X_2 + b_3\text{Log}X_3 + b_4\text{Log}X_4 + \text{Log } e \quad \ldots.. \quad (3.2.1)$$

The Cobb-Douglas Function has been extensively used in farm survey studies because of its convenience in interpreting elasticities of production and estimation of parameters involving fewer degree of freedom (Heady and Dillon, 1969). The function allows either constant, increasing or decreasing marginal products.

Quadratic Function

$$Y = a + b_1X_2 + b_5X_2^2 + b_6X_2^2 + b_3X_3 + b_4X_4b_8X_4^2 +$$

$$b_9X_1X_2b_{10}X_1X_3 + b_{11}X_3 + b_{12}X_1X_2X_3X_4 + e \quad \ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

This function allows for both diminishing and negative marginal productivity, but not both decreasing and increasing marginal products. The elasticity of production is not constant but declines with input magnitude. The function may however give negative total products for very high or very low level of input and is cumbersome when many variable inputs are included.

Square root function

$$Y = a + b_1X_1 + b_5X_1^{0.5} + b_2X_2 + b_6X_2^{0.5} + b_3X_3 + b_7X_3^{0.5} + b_4X_4 + b_8X_4^{0.5} + b_9X_1^{0.5}X_2^{0.5}X_2^{0.5}X_2^{0.5} + b_{10}X_1^{0.5}X_3^{0.5}X_3^{0.5}X_3^{0.5} + b_{11}X_1^{0.5}X_4^{0.5} X_4^{0.5}X_4^{0.5} + b_{12}X_1^{0.5}X_2^{0.5}X_3^{0.5}X_4^{0.5} + e \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.4)$$

The function exhibits diminishing total and marginal product, but like the quadratic function it has disadvantage of being an inefficient utilizer of degree of freedom.

The analysis of efficiency of resource allocation can be accomplished by estimating production functions of various forms, although none of the functional forms discussed above can be used to characterize a particular agricultural production system. This is because the algebraic form of the function will vary with climate, soil and the variety of crops and livestock involved in the production process. What this means therefore is that for each study, the functional form chosen is one that provides "best fit" consistent with a prior knowledge and sample observations.

3.4.3 Specification of Model used in the Production Function Analysis

The input-output data obtained from the field were fitted into various production functions already discussed in section 3.5.1. Two different regression analyses were run; one for farmers using shadoof for growing tomato and the other for farmers using pump for growing tomato.

The model in its implicit form was:

$Y = f(X_1, X_2, X_3, X_4, E)$, where

Y = Output of tomato in kg

X_1 = Area of plots devoted to tomato production in hectare

X_2 = Quantity of fertilizer in kg

X_3 = Irrigation labour in (man-hour)

X_4 = All labour less irrigation labour (man-hour)

E = Error or disturbance term is included to capture the effects of endogenous variables not included in this model.

3.4.4 Estimation of Productivity and Resource Use Efficiency

The production function is used in determining the efficiency of resource use and patterns of output (Heady and Dillon, 1969). For example, for the Cobb-Douglass function as expressed in equation (3.2), the b_i's, that is, the regression coefficients, provide measures of the marginal physical product associated with each input. Thus, for instance;

$$b_i = \frac{dy}{dX_i} = MPPX_{i,y}.$$

Multiplying the MPP by the unit product price, Py, yield the marginal value product (MVP) which can be equated to the marginal factor cost (MFC) to determine the point of economic efficiency in production. With the Cobb-Douglas functional form the b_i's are also the production elasticities associated with the individual inputs employed. If the value of elasticity is less than unity, there is decreasing returns to the input, if it is equal to unity, there is constant returns, while a value greater than one indicates increasing returns. The returns to scale measures the percentage change in the units of all resources employed.

3.4.5 Variables Selected in the Analysis of the Model

Primary data for the purpose of estimating input-output relationships were collected on the following specific variables:

(a) Farm size (X_1): It is expected that output of tomato would vary in the same direction as farm size. Assuming uniform quality, increase in farm size would result in increase in output. Unit of measurement; hectare.

(b) Quantity of fertilizer (X_2): This is also included in the model so as to quantify variation of output to changes in quantity of fertilizer used in kilogram. Increasing quantity of fertilizer use is expected to result in increased output up to a maximum point.

(c) Irrigation Labour (man-hours) (X_3): This is included in the model in order to determine its influence on tomato yield.

(d) All labour less irrigation labour (X_4): The total labour employed (both

family and hired) is expected to vary with output realisable. Similarly diminishing returns would be expected in a situation where the optimum level of labour employment is exceeded. Units: man-hour. Adegeye and Dittoh (1985) conventional conversion rates would be used to standardize labour use among various classes of labour.

(e) Output: This refers to tomato (in kg) harvested from various sampled fields.

(f) Other factors known or unknown, non-quantifiable or otherwise not included in the model like time of planting, quality of inputs and so forth are represented by the error term (e). It is expected to capture all the unaccountable variations arising from such factors: endogenous to the production process.

3.4.6 Information Expected from Production Function Analysis

(i) Physical quantities involved in the transformation process could be ascertained by estimating coefficients b_i - which are unknown parameters. The estimates of b_i estimated gives an insight into the direction and magnitudes of change when an input is changed by one unit. The level of output when input is zero is a_0, the constant factor.

(ii) Marginal Value Product (MVP) calculated from production function will give an insight into efficient use of resources when compared with their respective factor prices.

(iii) The coefficient of multiple determination (R^2) will be obtained. It measures the degree of fitness of the regression line. It is defined as

the percentage of the total variation that can be explained by variation in independent variables. The equation with higher R^2 value explains the variation well and is regarded as a better fit than one with lower R^2 if other conditions are met (Heady et al, 1969).

(iv) Finally to settle on which inputs are most important in the production of output, the regression coefficients in respect of various inputs used are tested using the students t-test. The t-values of inputs significant at levels of 10% or less are considered significant in this analysis.

3.5 Cost and Return Analysis

The Net Farm Income (NFI) model has often been used in analysing the profitability of farm production practices. Dillon (1968); Orewa (1978); and Ofojekwu (1982), have used the model in several crop enterprise studies. This is used to achieve objective 3 of the study. Basically, it is used in determining the difference between total revenue realisable from the crop enterprise and the total cost of production (both fixed and variable). The model is popularly stated as:

Net Farm Income (NFI) = Total Revenue (TR) Less Total Cost (TC)

$$NFI = TR - (TVC + TFC)$$

(i) Total Revenue (TR): Is the naira value of the total output accruing from the production process including whatever by-products sold from each farm-firm. If all units of output (Q) are sold at same price (Py), then TR = PyQ; and

(ii) Total Cost: Refers to both Total Fixed and Total Variable Costs

(a) Variable Costs: are costs that are incurred directly during the production process. They vary with the scale of production over the period of production. They include the cost of the current supplies such as seeds, fertilizer, irrigation water, hired labour, hired machinery services, etc.

(b) Fixed Costs - are those costs that do not vary with output but must be incurred whether production occur or not. Fixed costs in tomato production are limited to depreciation of durable tomato production equipment such as hoes, matchet, shadoof components, pump and washbores. Depreciation of such durables is calculated using the straight line depreciation method.

Depreciation by this method involves finding the difference between the purchase price (P) and the Salvage Value (S) and dividing by the number of years of life of the asset (L). That is, annual depreciation is:

$$\left[\frac{P - S}{L}\right]$$

3.5.1 Variable Cost Analysis

Labour Cost: This is specifically tied to hired labour used for the various operations. The wages paid by farmers during the study period is used in this analysis. It is expressed in Naira/Man-hour and varies with the type of operation.

Family Labour: Family labour is valued using the economic opportunity cost principle. It is assumed that family labour attracts

equal pay as the average wage payable in the area for such an operation.

Non-Durable Goods: For inputs like seeds and fertilizer, inputed cost (based on market cost of acquisition) were used if farmer used own stock, otherwise the actual cost of purchase from respective sources is taken into account (as stated by the farmer).

3.5.2 Test of Hypothesis

Two Net Farm Income (NFI) position of the farmers were calculated. One for farmers using pump/washbore and the other for farmers using shadoof technique of irrigation. The two means (NFI) for the farmer were subjected to t-test using the formular below:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\hat{\sigma}_{\bar{x}_1 - \bar{x}_2}}$$

where $\hat{\sigma}_{\bar{x}_1 - \bar{x}_2} = \hat{\sigma} \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}$

with $N_1 + N_2 - 2$ degree of freedom where X_1 and X_2 are two sample means and N_1N_2 and σ are sample sizes and estimated standard deviation drawn from normal population respectively.

Chapter 4

PRESENTATION AND DISCUSSION OF RESULTS

This chapter presents the nature of resource use among sample farmers input-output relationship and costs and returns in tomato production under the project in Bagwai Local Government Area of Kano state.

4.1 Resource Use Among Sampled Farmers

4.1.1 Land

Land is one of the most important resources readily available for production in developing countries. The mode of acquisition of land in Kodo area is by traditional inheritance.

The total land area cultivated by the respondents for the survey area was 12.68 ha. Out of this 8.63 ha was used for irrigated tomato production with an average plot of 0.123 hectares.

However, more land was cultivated under pump (7.28 ha) than shadoof (1.35 ha). Some of the farmers in the study reported having plots at different locations. The land is fragmented into small plots ranging from less than 0.07 ha to 1.7 ha. Fragmentation of farm into small units affects productivity because it does not permit optimal use of resources including labour, fertilizer and spraying of chemicals.

Table 4.1: Land Use Among Sampled Farmers

Size of Farm	Pump/Washbore			Shadoof		
Size of Farm	No	Farm Size	%	No	Farm Size	%
< 0.09	-	-	-	4	0.154	11.41
0.1 - 0.9	29	6.032	82.86	31	1.196	88.59
1.0 - 1.9	6	1.248	17.14	-	-	-

Source: Field Survey, 1997

4.1.2 Labour

In this study three types of labour use were distinguished; the labour of farm operator, the labour of farmer's children and hired labour which the farmer rewarded in cash or kind. About 94.24 per cent of the total farm labour was contributed by family members. The total labour in man-hours was found by summing up labour use by operation and class of labour using Adegeye and Dittoh (1985) conversion rates. Out of this, 50.70 per cent was from those using pump/washbore and 36.44 per cent from those farmers using shadoof while hired labour accounted for only 5.86 per cent of the total labour used for irrigating their plots. This further confirms the predominance of family labour in small scale farming.

4.1.3 Water

This is one of the most important resources in dry season cropping. Without assured and adequate water supply, tomato yield will be adversely

affected (Orewa, 1978).

In Kodo area, two sources of water were used for irrigating tomato crop. These were the pump/washbore and shadoof. Irrigation time ranges from half an hour per hectare per week to 4.8 hours per hectare per week for those using pump/washbore and 1.21 hours per week to 5.86 hours per hectare per week for those using shadoof.

4.1.4 Seeds/Seedlings

Most of the farmers preferred to buy seedlings from other farmers than raise seedlings themselves. The reasons given by farmers for this were:

(a) time constraints

(b) high cost and non-availability of quality seeds.

Table 4.2: Sources of Seeds by Farmers

Source	Number	Percentage
a. Purchased:		
(i) KASCO	13	18.57
(ii) Market	19	27.14
b. Previous stock	30	42.86
c. Gift	8	11.43

Source: Field Survey, 1997

Some of the farmers purchase their seeds from Kano state Agricultural Supply Company (KASCO) while others got theirs from the open

market. Some farmers used seeds from the crop of previous season. However, prices paid for seed/seedlings by the farmer varied greatly with the source.

4.1.5 Fertilizer

The type of fertilizer used is compound NPK. Some of the farmers used manure on their plot.

A total of 90.09 bags, were used by all tomato farmers interviewed given an average of 169.78 kg/ha and 70.78 kg per farmer.

Farmers using pump used 70.80 bags with an average of 157.80 kg/ha while those using shadoof used 25.20 bags with an average of 232.26 kg/ha.

Most of the farmers, complained of the high cost of fertilizer (sometimes up to ₦1,200:00 per 50 kg - bag). The increase in price and non-availability of fertilizer constituted a major source of concern to the farmers because in a country like Nigeria where the investment capabilities of farmers is very low, changes in prices of inputs such as fertilizer can affect their level of usage and this could affect agricultural production adversely (Sintiki, 1990).

4.2 Sequence of Operation on the Irrigated Plots

In the 1996/97 growing period, plots earlier cultivated for sorghum, maize and rice after harvest were smoothened up with hand hoes to make the soil loose. Hoes were also used in tilling on the farm. This operation is

done by the use of family and hired labour in October.

Prior to this operation, seedlings are normally raised in nurseries in October and later transplanted after the farm bed preparation. Seeds used in raising the nursery beds consist of good quality seeds of Roma VHF and local tomato known as Bagobiri (in Hausa) preserved from previous harvest. The moisure content of each farm bed is met by the water from the dug well by those farmers using shadoof and others by the use of pump.

Transplanting of tomato seedling started in November and ended in December 1996. This is an activity that takes place in the early morning or evenings. This is with a view to retaining the moisture content of the seedlings before transplanting. Normally, farm beds are irrigated with water before transplanting.

Farmers in Kodo area used NPK fertilizer as well as cattle, sheep and goat droppings. Price per bag of NPK from the open market ranges between ₦830 to ₦1,200.00. The application of fertilizer started during transplanting amongst the respondent and the amount varied. It was observed that most farmers did not actually implement the recommended rate of 300 kg/ha applied in two split doses (A.E.R.L.S., 1985).

Water application started in many farms either before or during transplanting. It is expected that farmers using pump could irrigate his farm at least once a week. The frequency is more for those using shadoof method of irrigation.

Weeding operation started barely three weeks after transplanting and the activities continued at an average rate of once a month. Hand pulling

and hoe weeding were practiced.

The harvesting started in February, 1997 and stretched into March, 1997. During this period, the number of farm visits was increased to enable accurate record of yields and quantity sold. Yield of each respondent was recorded on a daily basis and it was observed that a basket size of 23 kg capacity was used in selling the tomatoes on the farms and for evacuation.

Farmers in the study area generally harvested their tomato and sold them immediately at the nearest market. The prices of tomato varied considerably within a season, rising just before harvest and then falling after harvest. The method involved in pricing involves higgling and haggling. For example, at the beginning of harvest, the price of 23 kg basket at farm gate ranges between ₦140.00/basket during the first week ₦95.00/basket at mid season and ₦80.00/basket towards the end of the season.

A large proportion of tomato harvested was sold at farm gate (93%) while an insignificant number was given out as gift (4%) and about (3%) was consumed.

Tomatoes not sold at farm gate were sold at Gogori, Gwarzo, Badume and Bichi markets. It was noted that the cost of transporting tomato to Gogori was ₦ 5.00/basket and the loss due to transit is minimal. Pick-up vans were used for transporting tomato from Gogori to other markets such as Gwarzo, Badume and Bichi markets. It costs between ₦12.00 and ₦15.00 to transport each basket to those markets. The prices obtained for the sale of a medium size basket of tomato in those markets ranged between ₦130.00 and ₦ 140.00/ basket.

4.3 Results of the Production Function Estimates

In determining the nature of the relationship between the inputs and outputs, multiple regression techniques using the Least-square method (LSM) were used. Linear, Square root, Quadratic and Cobb-Douglas production function were fitted to the same pool of input-output data. The Cobb-Douglas production function was however selected as the equation of best fit based on the magnitude of the co-efficient of multiple determination, R^2; significance of t-value; the overall significance of F-value and the correct signs of the parameters.

The results of the estimated Cobb-Douglas production function for farmer using pump/washbore and shadoof method of irrigation are presented in table 4.3 and 4.4 respectively.

Table 4.3: Regression Coefficient and Standard Error for tomato Production Function for Farmers using pump

Variable	Regression Coefficient b_i	Standard Error of b_i	t-ratio
Constant term (a)	5.9319	1.6355	3.627
Land (X_1)	0.3933	0.1926	1.344*
Fertilizer (X_2)	0.2699	0.0718	2.749***
Irrigation labour (X_3)	0.3300	0.1834	$0.130^{n.s}$
All Labour Less Irrigation Labour (X_4)	0.3801	0.1539	2.699***
Sum of Regression coefficient	1.37	-	-

R^2 = 0.869; $\bar{R}^2$ = 0.852

F - ratio = 50.07 significant at 1 per cent level

* = significant at 10 per cent level

** = significant at 5 per cent level

*** = significant at 1 per cent level

n. s = Not significant

Source: Computed from Field Survey Data, 1997

From Table 4.3 the coefficient of determination R^2, for the Cobb-Douglas Function was 86.9 per cent. This implies that 86.9 per cent of the total variation in the dependent variable (Gross Output) was explained by variation in the independent variable included in the model. This also indicates a positive and high degree of association between the independent and dependent variables. The F-ratio was 50.07 which is significant at one per cent level, suggests that the independent variables included in the model, collectively were important in explaining variation in the dependent variable.

The estimated regression coefficient (b_i) are the production elasticities of the resources used. In the specified equation, all the elasticities of production with respect to individual inputs were each less than unity.

They all had positive elasticities of production indicating that when other inputs are held constant, varying the level of usage of any of them will increase output by the corresponding percentage of the elasticity of production of the input. For instance, a 1 per cent increase in land holding,

all other inputs constant would result in 0.39 per cent increase in output.

Similarly, the regression coefficients or elasticities of production showed that fertilizer and farm labour input were significant at 1 per cent level; land at 10 per cent indicating that they are the most important factors explaining the variation in output. Irrigation labour, though not significant, had positive elasticity of production thus influences output.

Table 4.4: Regression Coefficient and Standard Error for tomato production Function for Farmers using Shadoof

Variable	Regression Coefficient b_i	Standard Error of b_i	t-ratio
Constant term (a)	4.1507	1.0370	4.002
Land (X_1)	0.4271	0.8857	3.183***
Fertilizer (X_2)	0.2831	0.2866	3.891***
Irrigation labour (X_3)	0.3322	0.1148	2.389***
All Labour Less Irrigation Labour (X_4)	0.2100	0.1653	2.680***
Sum of Regression coefficient	1.25	-	-

$R^2 = 0.846$; $\bar{R}^2 = 0.825$

F - ratio = 41.19***

Source: Computed from Field Survey Data, 1997

Table 4.4 shows the regression coefficients with respect to each of the explanatory variables and their t-values. The value of multiple regression coefficient; R^2, for the Cobb-Douglas Production Function is 84.6 per cent. This implies that 84.6 per cent of the total variation in the dependent

variable (Gross Output) is explained by variation in the explanatory variables included in the model. The F-ratio is 41.19 and is significant at 1 per cent, implying that the variables significantly explained variation in gross output. The regression coefficients with respect to Land (X_1), Fertilizer (X_2), Irrigation labour (X_3) and All Labour Less Irrigation Labour (X_4) are positive, indicating that an increase in any of the variables, holding others constant, will lead to an increase in the gross output. For instance, a 1 per cent increase in the amount of fertilizer used, all other inputs constant, would result in 0.28 per cent increase in output.

Similarly, the regression coefficients or elasticities of production showed that all the input are significant at 1 per cent level indicating that they are all important factors in explaining the variation in output.

4.3.1 Returns to Scale

The sum of elasticities of production generally indicate the nature of scale associated with the production system. From tables 4.3 and 4.4, the sum of elasticities was found to be 1.37 and 1.25 respectively. This implies that production is characterized by increasing return to scale. The economic implication is that if all inputs included in the model for farmers using pump are increased by 1 per cent, output will increase by 1.37 per cent and for farmers using shadoof, an increase in all inputs by 1 per cent will result in output increase by 1.25 per cent.

4.3.2 **Marginal Value Productivity**

A resource or input is considered to be used most efficiently if its marginal value product is just sufficient to offset its cost. Thus, for efficiency in resource use, the basic condition is equality between the marginal value product and the marginal factor cost. Marginal value product of an input is given by the following equation.

$$MVP = b_I \frac{Y_i}{X_i}. P_y$$

where: MVP = Marginal value product of each resources

b_I = the elasticity of production of each resources (i.e the regression coefficient)

Y_i = the geometric means of tomato yield (Y_i)

X_I = the geometric means of resource (X_i)

Py = unit price of output

According to Heady and Dillon (1969), the most reliable and perhaps the most useful estimate of marginal productivity is obtained by taking x_1 at its geometric mean, i.e. Y should be the estimated level of output when each input is held at its geometric mean. When Marginal Value Product (MVP) and the price of the input are approximately equal, the profit is maximized. Table 4.5 and 4.6 presents Marginal Value Product (MVP), their arithmetic means Marginal Factor Cost (MFC) or price of each input. Y and X are values of Log Y and Log X when they assumed their arithmetic means. The

last column gives the ratio of MVP to price of each input. The larger the ratio the greater the scope for further employment of the factor. A negative ratio suggests the need to reduce the employment of the factor in question.

To determine the efficiency of resource use, it is necessary to compare the Marginal Product (MP) of the inputs and their respective market prices as shown in table 4.5 and 4.6

Table 4.5: Marginal Value Product of Inputs, their arithmetic means and Prices for Farmers using Pump

Variable	Y	X	b_i	MVP	MFC	Ratio MVP/P
Land	7633	0.669	0.3933	2008.37	N.A.	-
Fertilizer	7633	105.57	0.2699	19.51	18.00	1.08
Irrigation Labour	7633	863.428	0.3300	2.91	21.50	0.13
All Labour Less Irrigation Labour	7633	321.02	0.3801	12.55	15.00	0.83

Source: Field Survey, 1977

Table 4.6: Marginal Value Product of Inputs, their arithmetic means and Prices for Farmers using Shadoof

Variable	Y	X	b_i	MVP	MFC	Ratio MVP/P
Land	2616	0.155	0.427	7208.34	N.A.	-
Fertilizer	2616	36.00	0.2831	20.57	18.00	1.11
Irrigation Labour	2616	411.457	0.3322	2.11	21.50	0.10
All Labour Less Irrigation Labour	2616	145.527	0.2100	3.77	15.00	0.25

Source: Field Survey, 1997

The average price of a bag of fertilizer at the time of study was ₦900.00. By dividing 900 by 50 kg (weight of fertilizer bag) the price per kilogram was computed. The prevailing average charge per day work for irrigation labour was ₦150.00. Dividing this by 7 hours (equivalent a man-day work) gave a unit price of ₦21.50 per man-hour while other farm labour input was ₦15.00 per man-hour. It was not possible to get the value of land since the farmers do not actually pay for the land. Hence, it was not possible to determine how efficiently land was used.

For farmers using pump, fertilizer input have marginal value product of 19.51. This means that if other inputs were held constant, increasing fertilizer input by 1 kg would increase the total value product of 19.51. The marginal product of fertilizer (19.51) was higher than the unit price of ₦18.00 per kg. The farmer would increase profit by increasing the use of fertilizer until the marginal value product equal its price per unit.

Irrigation labour had a marginal value product of 2.91. The marginal factor cost was ₦21.50 per man-hour. This implies that irrigation labour is over-utilized, further increase in labour input will result in diminishing total profit.

For all labour less irrigation labour, the marginal value product for labour was found to be ₦12.55. This is lower than the unit price of farm labour which is ₦15.00. This indicates that labour is over-utilized. Farmers using pump in the cultivation of tomato were employing excessive labour in the study area.

For farmers using shadoof, the marginal value product for fertilizer was ₦20.57 which is higher than the marginal factor cost of ₦18.00 implying that farmers would increase profit by using more fertilizer.

Irrigation labour for farmers using shadoof had a marginal value product of ₦2.11 which is lower than the marginal factor cost of ₦21.50 implying that irrigation labour is over-utilized, beyond its economic optimum. Farmers will be better off reducing use of labour.

All labour less irrigation labour by farmers using shadoof had a marginal value of 3.77 as compared to the marginal factor cost of ₦15.00 per man-hour. This indicates that farm labour is over-utilized. Additional naira spent on labour will increase output by less than 3.77. The implication in the region of production is that as successive quantities of labour and fertilizer are increased, output is increased up to a point where the average physical product is equal to marginal physical product. At this point irrigation labour must have been stretched beyond its limit. Additional increase in irrigation labour and farm labour input produce no yield advantage. Hence, profit maximization is not attained beyond this region. Therefore, it does not make sense to keep adding more labour inputs. The tendency is to move to the region of higher profitability. The quantity of irrigation labour and farm labour input has to be decreased in order to achieve economic efficiency. Higher output can be achieved by a decrease in the use of irrigation labour and farm labour input.

The results of study indicate excessive use of irrigation labour. The estimates of the marginal value productivities point clearly to the non-optimal

combination of inputs among small scale farmers and hence the need for resource adjustment.

The results of labour utilization indicated some improvement over low labour productivity of traditional small scale farmers in most literatures. This improvement is due to the use of herbicides, water pumps, farm tools and techniques which could do effective work and so boost labour productivity. The man-hours devoted to the various operations previously are reduced because of the intensification of labour-saving devices in small scale irrigation.

The results also indicate that the marginal value of fertilizer was positive and higher than the acquisition price implying that income from tomato could be increased by increasing level of fertilizer use.

The two production function are similar. From the estimated regression equations, the bulk of the independent variable coefficients for the two techniques of production were found to be significant, even at the 0.10 level of probability. The non-significance of the coefficient for irrigation labour for pump farmers imply that less reliance should be placed on the value, though the sign of the coefficient is quite indicative of the type of contribution it made towards the variation in the output of tomato. Nevertheless, land, fertilizer and all other labour less irrigation labour play major role in explaining the variation in tomato output between the two techniques of production.

In both cases, they made positive contribution to tomato output but the positive signs infers that they have not been used to their optimal levels.

One of the hypotheses of this study is to determine whether there is any significant difference between the resource productivity of farmers using pump/washbore and farmers using shadoof system of irrigation. Using the student's t as the test statistics we assume that:

$$t = \frac{\text{MVP (Pump) - MVP (Shadoof)}}{\text{Standard Error/MVP (Pump) - MVP (Shadoof)}}$$

is approximately distributed as student's t (Ladipo, 1975).

Table 4.7: Estimated Sample t value of Paired Marginal Value Product

	Land	**Fertilizer**	**Irrigation Labour**	**All Labour Less Irrigation Labour**
Sample Mean	5199	1.06	0.8	8.74
Standard Error	0.6931	0.2418	0.0686	0.0114
T-Value	7502.49	4.93	11.66	766.66

N:B: Tabulated Student's t at 5 per cent level of significance is equal to 1.98

The computed t-value for tomato output was found to be greater than the tabulated student's t at 5 per cent level of significance. The conclusion was to reject H_0; this implies that there is a significant difference between MVP of resources used by pump farmers and MVP of resources used by Shadoof farmers.

4.4 Factors Affecting Cost

The labour profile as presented in the table 4.8 shows differences in labour requirements for each operations.

Table 4.8: Labour Input Operation per hectare

Operation	Man-Hour		Percentage Contribution	
	Pump	Shadoof	Pump	Shadoof
Land clearing and tilling	160.28	225.25	9.4	6.31
Basin making	103.14	260.64	6.08	7.80
Transplanting of seedlings	7.73	20.46	0.46	0.57
Weeding	63.38	94.14	3.84	2.64
Fertilizer Allocation	23.27	78.89	1.47	2.71
Irrigation Labour	1290.62	2654.56	76.25	74.32
Harvesting	40.35	193.91	2.41	5.56
Moulding	0.55	3.31	0.03	0.09
Total Input	1689.32	3531.32		

Source: Field Survey, 1997

Land preparation, basin making, weeding and irrigation were dominant in the use of labour. These operations took 9.46 per cent, 6.08 per cent, 3.84 per cent and 76.25 per cent respectively for farmers using pump while those using shadoof took 6.31 per cent, 7.80 per cent, 2.64 per cent and 74.32 per cent respectively. The high labour for land preparation was due to the fact that land preparation was carried out manually. Studies have shown that the use of tractor for land preparation reduces the man-hours by

four to five hours per hectare (Ofojekwu, 1982).

Irrigation is yet another labour consuming operation in tomato production. An average value of 2654.56 man-hours per hectare is required for the shadoof irrigation system as opposed to 1290.62 man-hours required for pump-irrigation system per hectare of tomato farm cultivated. The disparity in labour man-hours required for the two irrigation techniques suggests that one way of reducing labour input in shadoof irrigated farm is by employing the use of pump/washbore.

For the weeding operation, labour input was generally high for farmers using pump/washbore and shadoof since hand-hoeing was the only method adopted for weeding. The role played by weeding is justified because it prevents tomato on the farm from competition for light, water and nutrient in the soil.

Fertilizer application contributed 1.47 per cent of the total labour for farmers using pump/washbore and 2.71 per cent for farmers using shadoof of the man-hours for the production of tomato in Kodo area. The study revealed that fertilizer has been expensive at the time of study. The use of fertilizer in substantial amount by the farmers influenced the total cost of production. Other labour contributed are transplanting 0.46 per cent, harvesting 2.41 per cent and mulching 0.03 per cent of the total labour input for the production of tomato by farmers using pump/washbore while farmers *using shadoof required 0.46 per cent for transplanting, 2.41 per cent for* harvesting and 0.09 per cent for mulching.

Other capital input like fuel, grease as well as depreciation on farm

equipment also accounted for a fraction of the total costs. The pump being powered by small petrol engine depreciated over a period of ten years; the washbore depreciated over a period of twelve years and three years for matchets and hoes. The shadoof materials depreciated over one year since the shadoof has to be rebuilt though not completely every year. The straight line depreciation method was used.

4.4.1 Factors Affecting Returns

The returns of tomato production showed disparities under the two irrigation techniques considered in this study. The average gross return per hectare vary from a rather high value of ₦32.020.67 under pump to a relatively low figure of ₦27.309.18 under shadoof farmers. Yield and price factors greatly determine this observed pattern of returns under the two techniques. The total yield of tomato by farmers using pump was found to be 11.41 tonnes per hectare while those using shadoof have an average yield of 16.88 tonnes per hectare.

With the underlying assumption of this study that the sampled area are equally endowed with natures resources (soil, climate, topography, etc) tomato yield per hectare is therefore dependent on quality and quantity of man-controlled inputs (e.g. fertilizer, irrigation, water) applied to the crop. For dry season crop production, irrigation water is a major input and its timely application is yet another major factor that influences tomato yield. It is noted in the study area that the high cost of pump, delay in the supply of new pump, inadequate provision for repairs and delay in drilling washbore have

adversely affected the operation of the farmers which in turn has affected the yield of the crop.

There is also delay in the application of fertilizer due to the fact that fertilizer from Kano State Agricultural Supply Company (KASCO) do not get to the farmers, therefore they have to make their purchase in the open market. Most of the farmers could not afford to purchase fertilizer in bags (50 kg) especially farmers using shadoof. They had to resort to small denominational purchase (in mudus) in the local markets around Gogori. The purchasing again are subject to the availability of fertilizer in these local markets. In general, tomato yield like most other crops is highly dependent on the timely and the fully application of the essential farm inputs that go along with the improved technology.

Table 4.9: Average Prices of Medium Size Basket of Tomato in the Survey Area

Months	Farm Gate Price (₦)	Market Price (₦)
October, 1996	70.00	120.00
November, 1996	80.00	140.00
December, 1996	85.00	138.00
January, 1997	75.00	105.00
February, 1997	50.00	80.00
March, 1997	55.00	70.00

Source: Field Survey, 1997

Prices is another major factor affecting the level of returns from tomato production. It was observed that prices of tomato varied depending

on the time and locality where it is sold. Farm gate prices is not uniform or constant (Table 4.9). This is so because at the onset of harvesting, prices of tomato were higher than mid season.

Table 4.10: Average Retail market Price in Distant Markets

Location	Price per Basket (₦)
Gwarzo	130.00
Badume	140.00
Gogori	105.00
Bichi	140.00

Source: Field Survey, 1997

Respondents who sold at Gogori, Gwarzo, Badume and Bichi markets sold at higher price (Table 4.10). The pricing system is not standardized. It featured a prominence of higgling and haggling, consequently, farmers sold their products after reaching a compromise with the would-be customers.

4.5 Budgeting Analysis

The farm budget model was employed to estimate the cost, returns and net farm income (NFI) of the farmers in the study area.

4.5.1 Cost of Production

The total cost of production incurred by sampled farmers using pump and shadoof irrigation technique is ₦16071.02 and ₦15088.50 respectively.

The total cost included expenditures on seeds, fertilizer, insecticides, labour and operating expenses on pumps; while fixed costs included depreciation on pumps, shadoof components, cutlasses and hoes. The variable cost constituted 85.76 per cent of total costs of production, with human labour accounting for 41.58 per cent and purchased inputs 44.52 per cent (Table 4.11).

This indicates that purchased inputs have assumed greater importance in the production process of the small farmers with the adoption of new technologies.

The costs and returns from the production of tomatoes by farmers using pump and shadoof in the study area are presented on table 4.11. The costs and returns of farmers using pump were higher than those for farmers using shadoof. The total variable costs for the production of tomato was 88.50 per cent of the total cost for farmers using pump and 86.03 per cent of the total cost for shadoof farmers. This was due to the substantial expenditures on seeds/seedlings, fertilizer, organic manure, operating cost of pump, pump maintenance, marketing and labour inputs. The inputed cost of family labour was 24 per cent for pump farmer and 56 per cent for shadoof farmers relative to their total cost of production respectively. The result highlighted the fact that labour is the most important input in the production of crops among small-scale farmers. The proportion of family labour in pump irrigated farms relative to shadoof irrigated farms was very high because shadoof requires extra labour for irrigation.

Table 4.11: *Cost and Returns per Hectare from the Production of tomato with different irrigation techniques Year, 1997*

Item	Pump (₦)	Shadoof (₦)
Output (Average Yield in metric tonnes)	11.41	16.88
Returns (N)		
Gross Returns	48,091.69	42.397.68
Variable Cost:		
a. Labour		
Family	4,043.08	8,451.06
Hire	564.09	95.05
b. *Material Cost*		
Tomato Seeds/Seedlings	456.13	695.57
Fertilizer	3,264.93	2,461.81
Organic fertilizer	987.75	451.81
Irrigation water	668.13	338.54
Insecticides	784.13	16.59
Marketing Cost	614.79	470.76
Operating Cost of Pump	1,252.11	-
Pump Maintenance	1,105.63	-
T.V.C.	13,740.76	12,980.92
Fixed Cost		
a. Depreciation on pumps, washbore and accessories/ depreciation on shadoof *components*	2,148.92	1,936.85
b. Depreciation on other farm tools	181.34	170.73
T.F.C.	2,330.26	2,107.58
Total cost	16,071.02	15,088.50
Net Farm Income	32,020.67	27,309.18

Source: Field Survey, 1997

The Net Farm Income for farmers using pump/washbore is ₦32,020.67 while those using shadoof is ₦27.309.18 which gave a difference of ₦4,711.49 (17.25 per cent) in net farm income. All the farmers produced at a profit. The

profit margin for pump irrigated farms per hectare was considerable higher than that for shadoof irrigated farms. The general conclusion which emerges from this analysis is that tomato production with the pump system is more profitable to the farmers. This corroborated Orewa (1978) findings which showed that the size of farm from which farmers can derive the highest net income is greater in pump irrigated farms than in shadoof-irrigated farms.

4.5.2 The Net Farm Income Statistical Test for Significance

The net farm income data was statistically tested for significance using t-test for comparing two-sample arithmetic means between farming using pump and shadoof method of irrigation is shown in table 4.12.

Table 4.12: Means and Standard Deviation of Net Farm Income for farmers using Pump and Shadoof Irrigation Techniques

Farmers Group	N	Mean	SD	t-value
With pump	35	17536.36	8279.30	4.88***
With Shadoof	35	6033.21	1699.22	

*** Significant at P = 0.01 in favour of pump farmers

The t-value obtained was 4.88, the $t\alpha/2$ 68 degree of freedom was checked from the table. The t-value of 4.88 is highly significant at 1 per cent level of significance. This means that the null hypothesis (H_0) should be rejected which states that: There is no significant difference in the mean net farm income of farmers using pump/washbore and those using shadoof. The alternate hypothesis is then accepted which says that there is significant

difference in the mean net farm income of farmers using pump and those using shadoof method of irrigation which is in support of the net farm income of the farmers, that is, ₦32,020.67 for farmers using pump and ₦27,309.18 for farmers using shadoof.

4.6 Constraint to Increased Tomato Production Under the Project

During the survey, farmer were asked to rank the most important problems/factors limiting tomato production under the project. Table 4.13 summarizes the responses of the farmers.

Table 4.13: Farmers' Assessment of Constraint to the Cultivation of Irrigated Tomato

Problems	Percentage of Respondents				Order of Importance
	Not Important	Less Important	Important	Very Important	
Fertilizer	-	-	22	78	1
Water Availability	-	-	27	73	2
Capital	-	9	33	57	3
Land preparation	-	14	43	43	4
High cost of Pump	-	16	57	27	5
Seeds	-	12	69	19	6
Insecticides	6	22	61	11	7
Marketing and Price	7	29	57	7	8

Source: Field Survey, 1997

Non-availability of fertilizer, inadequate water supply, capital and land preparation ranked in decreasing order of importance constitutes farmers constraints. Also observed was the high cost of water pumps, spare parts

and repairs/servicing as well as marketing and price.

Farmers in the study area were aware of how these problems affected their farming business. The farmers identified the fact that these problems often caused delays in their work, which resulted in late planting, low yields and consequently low returns. Farmers were then asked what ways they thought government (or its agencies, e.g. KNARDA or local government), could do to improve irrigation farming.

The suggestions were as follows:

(a) government/KNARDA should ensure availability of fertilizer to farmers at reasonable prices, rather than buying from the market at high cost;

(b) financial assistance to be made available to help solve the problem of farm inputs; and more washbores should be drilled to help solve the problem of inadequate water supply.

However, project officials were of the view that farm inputs was in short supply from Kano State Agricultural Supply Company (KASCO) which confirms the farmers' view in this respect. Extension services were hampered by non-availability of means of mobility (e.g. motorcycle) that could ensure speedy dissemination of information to farmers. In addition, they observed bureaucratic bottlenecks which often resulted to delay in drilling of wells. Provision of means of mobility, increase supply as well as timely drilling of wells by KNARDA were suggested by the project officials.

Chapter 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Major Findings of the Study

The study described tomato production using two techniques of irrigation in the study area. Descriptive statistics were employed mainly to describe the farming characteristics under irrigated agriculture. The study showed that most of the farmers were involved in intensive vegetable cultivation; especially tomato, which involves intensive cultural practices and plants are given attention by the farmers. Farm sizes varied from 0.07 to 1.7 hectares and were normally managed by individuals or household. Land are often owned according to the local laws or customs. The most popular water lifting devices are shadoof and 2 or 3 in centrifugal pump powered by a small petrol engine and washbore. The average cost of pump was ₦28.000.00. The price was considered too high by most farmers. In 1985, the price of pump was between ₦760.00 - ₦950.00 and farmers as individuals or informal group were able to purchase one and could cover their costs in a year, but due to inflation and withdrawal of subsidy the situation is now different.

About 94.24 per cent of the total labour was contributed by family labour and the remaining 5.86 per cent being accounted for by non-family labour. All respondents indicated using fertilizers. The total quantity of fertilizer used on the farms by the respondents was 4505.5 kg giving an

average of 169.78 kg/ha and 64.35 kg per farmer. Farmers using pump used 3690 kg with an average of 157.80 kg/ha while those using shadoof used 1260 kg with an average of 232.26 kg/ha. The farmers purchased either seeds or seedlings. The seeds were bought from the Kano state Agricultural Supply company or the open market. Some farmers used seeds from the previous season.

Water is one of the most important resources in dry season cropping. Two sources of water were used for irrigating tomato grown by farmers. These were pump and shadoof. The time spent on irrigation operation ranges from half an hour per hectare per week to 4.8 hours per hectare per week for those using pump and 1.21 hours per hectare per week to 5.86 hours per hectare per week for those using shadoof.

The problems facing the farmers include; non-availability, high cost and delays in the supply of farm inputs, inadequate supply of water, pump maintenance, financial constraints, lack of tractors to incidence of pest and diseases.

The Marginal Value Product (MVP) of fertilizer for farmers using pump was ₦19.51 which is higher than its unit price of ₦18.00/kg. Hence, there is room for expansion of its use. For farmers using shadoof, the MVP of ₦20.057 for fertilizer was higher than its unit price implying that farmers would increase profit by using more fertilizer.

The MVP for irrigation labour was ₦2.91 and ₦2.11 for farmers using pump and shadoof respectively. It is lower than the marginal factor cost of ₦21.50 per man-hour. This implies in both cases that irrigation labour are

over-utilized and further increases in labour input will result in diminishing total profit.

The MVP of other labour inputs was found to be ₦12.55 and ₦3.77 for pump and shadoof irrigated farm respectively. The MVP was positive but lower than the unit price; ₦15.00 for both techniques of irrigation. This indicates that labour is over-utilized. Hence, it is not economical to increase labour. Rather a reduction in labour input will be required until marginal value product equals its unit price. This study showed an improvement in labour productivity over inefficient use of labour (negative MVP) recorded by Makarfi (1985) and Kpotun (1989).

The sum of elasticities of production for pump and shadoof irrigated farms was found to be 1.37 and 1.25 respectively. Both techniques exhibited increasing returns to scale, this implies that if all inputs included in the model for farmers using pump are increased by 1 per cent, output will increase by 1.37 per cent and for farmers using shadoof, an increase in all inputs by 1 per cent will result in output increase by 1.25 per cent.

The MVP of resources used by farmers using pump is statistically different from the MVP of resources used by farmers using shadoof method of irrigation.

The results of the budgetary analysis revealed the total cost of production of sample farmers using pump and shadoof irrigation techniques to be ₦16,071.02 and ₦15,088.00 respectively. Variable costs accounted for a greater proportion (85.76 per cent); while fixed costs accounted for only 14.22 per cent of the total costs.

The net farm income per hectare for farmers using pump is ₦32,020.067 while those using shadoof is ₦27,309.18 which gave a difference of ₦4,711.49 (17.25 per cent) in net farm income. All the farmers produced at a profit. The result indicated that it is more profitable to grow tomato using pump method of irrigation which corroborated Orewa findings. There was however a very high variability in yield, prices, costs and returns among the respondents studies.

The test of significance of net farm income confirmed that there are significant difference in the mean net farm income between farmers using pump and those that are using shadoof.

5.2 Policy Implication of the Findings

One implication of these findings is the need for the farmers to employ the use of animal traction for the ploughing operations. This is important in order to reduce the man-hour needed for such operation since these operations were carried out manually. The government can intervene by making the necessary implements available for purchase to the farmers in Kodo area.

Another implication of the findings is the non-availability and increase in prices of fertilizer during the growing season. Where these inputs are available, farmers in the area complanied of getting such inputs as farm loans, fertilizer and insecticides late. It is therefore necessary for government to remove the institutional constraints affecting the supply of inputs in terms of method of distribution and timeliness in the supply of key

inputs and services. There is the need to expedite action on these constraints otherwise some farmers will have to go back to the old methods of production for example using shadoof instead of pump.

The third implication of this study is that farmers are now unable to either purchase new pumps or replace old ones without assistance. The effort of the Fadama Users Association (FUA's) is laudable in the provision of credits for the purpose of purchasing pumps and drilling washbore but there is the need to consolidate the efforts already made by the credit agencies so that more farmers can benefit from the available loan scheme.

Lack of good roads, transportation and marketing facilities in the rural areas are major bottlenecks. Perishable crops like tomato at the peak period of harvest are often sold at give-away prices or even allowed to rot because of the inability of the farmers to market them immediately. It could discourage the farmers from further production of the crop. Therefore, it will not help in stimulating production.

5.3 Conclusion

This study was designed to compare the profitability of tomato production using the pump and shadoof technique system of irrigation in Bagwai area. The emphasis was however on identification of quantities of production inputs used in tomato production under both techniques, as well as costs and returns with a view to identifying the causes for the low fresh tomato supply by the farmers. From the results obtained in the study, the following conclusion can be made:

(a) Farmers in the study area can easily obtain high tomato output which can earn them reasonable net incomes from either the shadoof or pump system.

(b) The most important factor affecting farmers was the supply of necessary inputs such as tractors, pumps, washbores, fertilizer, seeds, water and pump maintenance.

(c) The results indicated over-utilization of irrigation labour. Fertilizer and labour had positive marginal value products.

(d) The estimates of the marginal value productivities when compared to the acquisition cost indicate non-optimal combination of inputs among the farmers. Hence, a reduction in the use of irrigation labour and farm labour input will be required until marginal value product equal its unit price.

(e) The current high demand for pump in Kodo area among farmers indicated the confidence in the system.

Based on these results, we can only have sustained irrigation development in Nigeria, if small-scale farmers are given the necessary support most especially in terms of supply of inputs at the right time and right quantities.

5.4 Recommendations

(a) The labour devoted to land clearing and ploughing could be saved through a more efficient land preparation method by using the animal

traction. The supply of the implements can be incorporated into the Fadama programme.

(b) For the technical problems relating to spare parts, repairs and maintenance of pump which made farmers to travel to Kano to purchase spare parts or repair their pumps, it would be necessary to give training to village mechanics in pump maintenance and servicing. This could be done through the Zonal Agricultural Development Project at Gogori, a few kilometres to Kodo village.

(c) The development of rural roads and better market structures in the rural areas should continue to receive priority attention by the government while other long-term developments like cold storage facilities are necessary for sustained irrigation development among small-scale farmers in the area.

(d) It has been noted that the FUA in the study area are more concerned with the issue of pump. They should take a look at the co-operative marketing aspects as well. This will enable them to market their tomatoes in more distant but more profitable markets. It will also help them in getting the farm inputs easily from government agencies.

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APPENDIX 'A'

A t-test for comparing two sample arithmetic means

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\hat{\sigma}_{1+2}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$ (Frederick E.C. et al, 1988)

Where: $\bar{X}_1 = 17636.36$

$\bar{X}_2 = 6033.21$

$\hat{\sigma}1+2 = 9978.52$

$n_1 = 35$

$n_2 = 35$

$df = n_1 + n_2 - 2$

$= 35 + 35 - 2$

$df = 68$

$\hat{\sigma}_{1+2} = 8279.30 + 1699.22 = 9978.52$

$$= 9978.52 \sqrt{\frac{1}{35} + \frac{1}{35}}$$

$$= 9978.52 \sqrt{0.028 + 0.028}$$

$$= 9978.52 \sqrt{\frac{11503.15}{0.056}}$$

$$= \frac{11503.15}{9978.52 \times 0.236}$$

$$= \frac{11503.15}{2354.93}$$

$$= \underline{4.88}$$

Decision rule:

$t_c > t\,\alpha/2$ df.

Reject H_0 : otherwise do not reject H_0

H_0; $X_1 \neq X_2$

H_1; $X_1 \neq X_2$

$t\,\alpha/2$ 68 df. 5% LOS = 1.671

$t\,\alpha/2$ 68 df. 1% LOS = 2.390

Since $t_{4.88} > t_{1.671}$ or $t_{2.390}$ Reject H_0 and accept H_1

That there is a significant difference between the two means of Net Farm Income of those farmers using pump and those that are using shadoof technique of irrigation.