# EVALUATION OF COTRIBUTIONS OF IRRIGATION SCHEMES TO GRAIN PRODUCTION IN SELECTED LOCAL GOVERNMENTS OF NIGER STATE

BY

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2004/18447EA

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A PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING.

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## DECLARATION

I hereby declared that this project work is a record of a research that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

Sadiq Hassan Otuoze | 7-02-10
Date

## ACKNOWLEDGEMENT

I humbly thank almighty Allah, who sustained me throughout this noble program.

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## ABSTRACT

This project presents a report of the research on Evaluation of Contribution of Some Irrigation Schemes in Selected Local Government in Niger State to Rice Production. Four (4) irrigation schemes were visited which include: Agaei, Badagi, Zara, Lioji. In each of the irrigation schemes, ten (10) questionnaires were administered. Base on my interview with the famers, it was made known that about sixteen (16) bags of rice is expected per hectare. combined effect of almost continuous crop water demand and natural precipitations, which are irregularly distributed both in space and time, makes irrigation essential in order to increase and stabilize agricultural production in Niger state and Nigeria at large. In the state, the prospect of expanding the gross irrigated area is limited by the dwindling number of economically buoyant individual for large irrigation projects. Therefore, the required increase in agricultural production will necessarily rely, largely, on the government participating and supporting the interested individual so as to be more accurate in the estimation of crop water requirements and also improvements in the operation, management and performance of existing irrigation and drainage systems.

The irrigation practice is expected to bring forth clear benefits in environmental and economic terms, a more sustainable use of land and water resources in irrigated agriculture and higher yields and incomes.

# CHAPTER ONE

## INTRODUCTION

### 1.0 The Meaning of Irrigation

Irrigation has been defined by Cavazza (2000), as the artificial application of water to the soil for the purpose of crop production. He further stated that irrigation water is applied to supplement the water available from rainfall and contribution of soil moisture from ground water. Also irrigation is described as the application of water to the land for the purpose of supplying the moisture essential for the development and growth of plants (Israel, 2000). Irrigation engineering is an applied science dealing with investigation, planning, execution, controls, and serving of irrigation and allied works. It is an inter disciplinary area in which irrigation engineers have to interact with agricultural and soil scientist, hydrologist and meteorologist, administrators and planners and above all, farmers are whose well being. The various projects are planed and established Chisci (1998).

In operational terms, irrigation covers the task of finding, developing and distributing suitable water supplies to the soil to supplement the natural resource of water for crop productions. In Nigeria because of economic constrains and topography, most irrigation system in the developed inland valley swamps are of the diversion type. The first irrigation scheme in Nigeria was built around shella stream in 1929, but was later washed off by floods in 1946 (Wrachinien 1979). In 1949 the Northern regional Government established the first irrigation Division in Nigeria in the Ministry of Agriculture with responsibilities for developing small scale irrigation schemes. At that time (and up till now) the Niger province (Niger state) was the largest producer of rice in the federation.

Therefore in order to take the advantage of the potential for rice cultivation and other crops, a number of medium and small-scale irrigation scheme were initiated in 1970's

Irrigation provides crop insurance against short duration of droughts. It washes out or deletes silt in the soil. It also cools the soil and the atmosphere thereby making environment more favorable for the plant growth. It reduces the hazard of soil piping and soften soil especially hearten area (Chisci, 2002).

Irrigation is normally carried out under the following conditions:

(a) When the total amount of rainfall is less than the amount required by the plants.

(b) When the rainfall is sufficient but the distribution does not coincide with schedule of supply required by the plants Handy (2001)

## 1.2 Statement of Problems

Niger state was created in 1976, blessed with abundant land, water and human resources but still have a serious crisis of food insufficiency due to increasing cost of purchasing food from the neighboring states and lack of adequate internal food production. There is an urgent need for Agricultural mechanization to meet the need of increasing population. Irrigation is therefore paramount, in the process of adopting Agricultural mechanization.

Generally, most water from lakes, rivers, ground water, and stream are good for irrigation, though above 300µs/cm in salinity. But some care need be taken particularly with over head sprinkler system, which may cause leaf scorch on some salt sensitive plants. Therefore when used for irrigation requires special management including suitable soil, good drainage and consideration of salt tolerance of plants where as the sea and ocean water which has higher salinity levels up to 50,000µs/cm are not suitable for crop growth.

## 1.3 Objective of the Project

1. To make a clear evaluation of the contributions of irrigation scheme to food production.
2. To make useful Recommendations that are related to the problems encountered in the process of evaluations.
3. To access the problem affecting optimum irrigation contribution.

CHAPTER TWO

## 2.0 LITERATURE REVIEW

Over the last few years high level gatherings of the World's leaders and their advisors have repeatedly agreed that addressing the multiple needs for water for two billions or more people if the forecast population increase by 2001 is of high priority. The challenge is to achieve a balance between using water for food while also meeting expanding domestic and industrial needs for water. Opinions differ among the experts regarding some of the issues. However, the consensus reached was that the contribution of irrigation to incremental food production should be substantial.

Different scenarios (options) have been examined to explore a number of issues, such as the expansion of irrigated agriculture, the increase in food production from rain-fed areas and the public acceptance of genetically modified crops. On the one hand there is the business as usual scenario a continuation of current trends in production and policy leading to regional water shortages and possibly a global water crisis; and on the other hand there is a policy of major investment rapidly increasing agricultural research and development of irrigation and drainage.

Some analysts believe that what is needed is a new and greener revolution to once again increase productivity and boost production. However, the challenges are far more complex than simply producing more food because global conditions are different from what they were at the time of the 'Green Revolution. Meeting the present challenges is even more difficult because so few opinion leaders appear to be aware that the world may face urgent food and agricultural problems. The abundance of grain produced in the world, and the fact that 840 million hungry people apparently remain invisible, also obscures the challenges

(Cavazza, 2000). Severe droughts and sharply rising food prices spurred national governments and international agencies to address the food crisis of the 1960s and 1970s. The Green Revolution consisting of crop variety improvements, increased use of fertilizers and expansion of irrigation schemes avert the projected shortages in food production. According to some experts, another food crisis predicted by advocates of a new boom in investment for irrigation is not yet in view. Food grain prices have remained stable for the last 15 years. There is hunger in the world, but that is because the hungry cannot translate their needs into demand or civil disorders disrupt food flows. However, according to the authoritative consultative Group on International Agricultural Research (CGIAR), the world is entering the 21st century on the brink of a new world food crisis that is as dangerous and far more complicated than the threats it faced in the 1960s (Shah rking improvement are examines

Much could be said on the role of demographic and economic factors, such as world trade, price commodities and agricultural subsidies to farmers in meeting the challenge. However, the purpose of this project is not to contribute more to the debate between experts on food security. It is to examine the probable consequences of the business-as-usual scenario that has been the prevailing model for the development of irrigated agriculture, particularly of the large-scale irrigation systems, in many countries. It also projects the likely benefits of increased investment in irrigation and advocates a new approach to design and management of irrigation systems in association with institutional and policy reforms.

According to the International Water Management Institute (IWMI) reliable and timely delivery is the exception, not the rule, in most developing country irrigation systems. Typically farmers in the more favored parts of irrigation systems receive an adequate supply, while those at the tail end can face ruin. Poor management directly aggravates existing inequities within the farming community. Many farmers, frustrated by unreliable water deliveries, have opted to install tube-wells. Consequently, groundwater use is exploding in many surface systems to compensate for the unreliable service from canal systems. Perhaps it will require a shock such as occurred in the 1960s and 1970s to awaken policy makers and the public at large to take the necessary actions to improve the irrigation systems.

## 2.1 Irrigation Development in Nigeria

In Nigeria especially Northern part country, irrigation was introduced since 1959 at Yau along the Yobe River. The irrigation division in Nigeria was established in 1949 by the ministry of Agriculture of the Northern Nigeria region. The activities of this division were confined to small scale irrigation scheme. Hamdy A and De wranchien. (2001)

Since the advent of modern practice in Nigeria, irrigation has had an enduring uniqueness. It has transformed hostile natural environment into dependable sustained productivity and wealth. That is, it is friendly to man, to his living national economic needs.

In the historical and current development of irrigation in Nigeria, it is noted that in 1963 O.F.N embarked on the study of land and water resources of Sokoto Rima Basin. This and other similar studies led in subsequent years of formal establishment of two River Basin Development Authorities; namely Sokoto Rima and Chad Basin in 1973. In 1979, the current eleven River Basin Development Authorities (RBDAs) covering the entire nations were established (Sanda, 2000). Irrigation in Nigeria covers about 2.8% annual crops. The total irrigation potential is estimated at 2-2.5 million hectares capable of producing 24-40% of the total current annual crop production. This therefore emphasizes the need for continued irrigation agricultural practice.

## 2.2 Extent of Irrigation

Irrigation is meant for improving the total volume or reliability of agricultural production by managing water for crops. It is estimated about 13% of the world's arable land are under irrigation, and they use about 1,400 billion cubic meters per annum. The irrigated areas in development countries are estimated to increase to about 2.9% per annum.

Report presented at the 1974 world food conference suggested a desirable target up to 1985 to be the improvement some 50million hectares of existing irrigation.

According to F.A.O's indication, world plan 60% of the crops of middle East region are produced on irrigated land which comprised only 36% of the total cultivated land.

## 2.3 Public Spending on Nigerian Agricultural Sector

Public spending on Nigerian agricultural sector is exceedingly low. Less than 2 percent of total federal expenditure was allotted to agriculture during 2001 to 2005, far lower than spending in other key sectors such as education, health, and water. This spending contrasts dramatically with the sector's importance in the Nigerian economy and the policy emphasis on diversifying away from oil, and falls well below the 10 percent goal set by African leaders in the 2003 Maputo agreement. Nigeria also falls far behind in agricultural expenditure by international standards, even when accounting for the relationship between agricultural expenditures and national income. The spending that is extant is highly concentrated in a few areas. Three out of 179 programs account for more than 81 percent of federal capital spending, of which nearly three-quarters go to government purchase of agricultural inputs and agricultural outputs alone. The analysis finds that many of the Presidential Initiatives which differ greatly in target crops, technologies, research, seed multiplication, and distribution have identical budgetary provisions. This pattern suggests that the needs assessment and costing for these initiatives may have been inadequate, and that decisions may have been based on political considerations rather than economic assessment. Budget execution is also poor. The Public Expenditure and Financial Accountability (PEFA) best practice standard for budget execution is no more than 3 percent discrepancy between budgeted and actual expenditures. In contrast, during the period covered by the study, the Nigerian federal budget execution averaged below 79 percent, meaning more than 21 percent of the approved budget was never spent. Budget execution at the state and local levels was even less impressive, ranging from 71 percent to 44 percent. However, other sectors showed similar low levels of budget execution, suggesting that the problem is a general one going beyond agriculture.

There is an urgent need to improve internal systems for tracking, recording, and disseminating information about public spending in the agricultural sector. Consolidated and up-to-date expenditure data are not available within the Ministry of Agriculture, not even for its own use. Without this information, authorities cannot undertake empirically-based policy analysis, program planning, and impact assessment.

There is also a need for clarification of the roles of the three tiers of government in agricultural services delivery. This is important to reduce overlaps and gaps in agricultural interventions and improve efficiency and effectiveness of public investments and service delivery in the sector. Finally, applied research is needed to address critical knowledge gaps in several areas.

(i) Spending on fertilizer programs makes up a sizeable portion of overall agricultural spending in Nigeria, yet very little is known about the impact of this spending.

(ii) To date, only a small portion of the national grain storage system has been constructed, but if the entire network is completed as planned, the cost will be enormous.

Supporting even the current modest level of grain marketing activities is consuming significant amounts of public resources. Is an investment on this order of magnitude desirable? What has been the impact of these investments?

(iii) There is a need for an analytical study focusing on the economics of the National Special Program for Food Security (NSPFS). The total cost of NSPFS should be estimated by a constituted committee.

Detailed financial information about the NSPFS should be publicly available, so as to make it less difficult to assess whether the considerable investment in NSPFS generated attractive returns, and whether NSPFS merits support as currently designed. A rigorous external evaluation is needed to assess the performance of NPSFS and generate information that could be used to make design adjustments (Chisci. and Morgan, (2002)

## 2.4 Land and Water Resources in Nigeria

Land and water resources development is concerned with the planning, use and management of natural resources, primarily for agricultural purposes. To this end, the combined effect of almost continuous crop water demand and rainfall irregularly distributed over space and time, make irrigation essential for increasing and stabilizing agricultural production in arid, as well as semi-arid and semi-humid regions. Due to the limited, and in many cases the depletion and deteriorating quality of water resources, the need to assure an adequate and stable crop production has led to a more efficient and rational use of irrigation water.

To achieve these goals massive investments have been made over the last few decades by governments and individuals as well as a concerted effort by the international community. Different scenarios have been developed to explore a number of issues, such as the expansion of irrigated agriculture, massive increases in food production from rain fed lands, water productivity trends and public acceptance of genetically modified crops. Opinions differ among the experts as to some of the above issues. However, there is broad consensus that irrigation can contribute substantially to increasing food production. At the 1996 World Food Summit it was estimated that 60% of future food needs would have to be met by irrigated agriculture. The International Commission on Irrigation and Drainage (ICID) forecasts that present food production will double within the next 25 years (Plusquellec, 2002).

The prospect of expanding the gross irrigated area is limited by the dwindling number of economically attractive sites for new large irrigation and drainage projects. Therefore, the increase in irrigated agriculture will have to come for a substantial part, on the one hand from a more accurate estimation of crop water requirements and, on the other from substantial improvements in the operation, management and control of the existing systems.

The key reason for the failure of the present schemes and the inability to sustainable exploit soil and water resources is poor planning, design, system management and development. This can be attributed partly to the incapability of planners, engineers and managers to adequately quantify the effects of their interventions in soil and water resource systems and to incorporate them into guidelines for improving technology and design and enhancing management.

To fully exploit the benefits of investments made in irrigated agriculture a major effort is needed to develop appropriate technology for improving the use and management of soil and water and for maintaining biodiversity, while conserving and protecting the environment.

In this regard, a new integrated and holistic approach to irrigation and drainage management and monitoring is needed, to increase food production, to conserve water, to prevent soil

Stalinizations and water-logging and to protect the environment and ecology. All this requires enhanced research, technological innovation and a large variety of tools, such as automated equipment for water control and regulation, sensors, remote sensing, geographic information systems, decision support systems and models, as well as field surveys and evaluation procedures.

With regard to the above issues, the on-going GRUSI (Italian Irrigation Research Group) project, which commenced in the 1950's and involves the Italian scientific and professional community, can be considered an important step towards launching an internationally supported program for enhancing R&D in irrigation science and technology in the Mediterranean region ( Wrachien et al., 2002).

With regard to the above issues, the paper first describes the salient aspects of irrigated agriculture in the Mediterranean region. Then the main results of the GRUSI project are outlined. Finally, the importance of institutional strengthening, sound financial and managerial frameworks, availability of human resources involved, research thrust, technology transfer and networking improvement are examine.

## 2.5 Irrigation in the Context of Water Resources Management

In recent years, water issues have been the focus of increasing international concern and debate. More than two thirds of the water withdrawn from the earth's rivers is used for irrigated agriculture; in developing countries the proportion is even higher - more than 80 percent. But agriculture is a relatively low-value and often highly subsidized water user. Competition for water with other sectors is already constraining economic development in many countries; as populations expand and economies grow this competition will intensify.

as will conflicts between water users, or between countries where such competition transcends international borders.

Cities and industries can afford to pay more for, and earn a higher economic rate of return from, a unit of water than agriculture. Hence governments and financing institutions are being forced to reconsider the economic, social and environmental implications of investment in irrigation. As a result, it is likely that in future the water sector will be less dominated by irrigation, and in some countries water formerly used for agriculture is already being reallocated for higher-value uses.

The 1993 World Bank policy paper water resources management crystallized much of the thinking of governments and financing institutions with regard to the overall management of water resources. It called for new approaches, including demand management. - that is to say the use of economic, legal, institutional and other policy interventions to influence the demand for water in order to improve the efficiency of its use. In countries with significant water management problems, the international financing institutions increasingly require the preparation of inter-sectorial water resources management strategies to guide the lending programmer in the water sector, as a precondition to lending for irrigation. The implication is that loans for irrigation development will not be made where this will prejudice other more profitable or socially desirable uses of water.

These Guidelines, however, start from the assumption that water policy reviews have indicated that irrigation is a justifiable option within the context of a country's overall water resources management strategy, and that investment finance could be made available for its development. The Guidelines therefore do not address the principles and processes involved in water resources management strategy formulation, which are well covered else where. The need for project planning to be in strict conformity with such strategies nevertheless cannot be overemphasized.

## 2.6 Irrigation Effects on Water Quality

In arid and semi arid areas irrigation is necessary for crop production, however, this leads to water degradation and salinity problems (Hoffman, 1990). Surface runoff may contain chemical fertilizers, or pesticides. In addition, some chemicals are injected into the irrigation water for application to the field and carried in the runoff. Most irrigation waters contain in dissolved salts which remain in the soil after water use by evapotranspiration. These salts must be removed to maintain crop production and natural or artificial drainage systems needed to remove excess water and associated salts from the plants root zone. This water is obviously of lower quality than the applied water and is frequently returned to a stream or underground water supply, degrading the quality.

The adverse effects of salinity and nitrogen have long been known. Only recently, however, has the potential impact of trace elements been recognized. These trace elements including arsenic, boron, Cadmium, Chromium, Lead, Molybdenum and Selenium, originate mainly in the geological material on site instead of the irrigation water. This impact adds a new dimension to irrigation and drainage management since both salinity and toxic trace elements must be considered when planning the disposal system and selenium is a prime example.

## 2.7 Rain-Fed Production of Food as an Alternative to Irrigation

Although between 30 and 40 percent of the world's food at present comes from the irrigated 20 percent of total cultivated land, before contemplating further irrigation development the potential for increased food output from rainfed areas should be considered. There may be prospects for obtaining sustainable production increases under rainfed conditions through relatively simple low cost technologies: for example improved in situ water conservation techniques and the adoption of integrated pest management and integrated plant nutrient management strategies. However where land resources are scarce, further area expansion of rainfed food production could increasingly involve more marginal areas, with a risk of increased deforestation, soil erosion and general land degradation. In the less well-endowed areas particularly, the potential for stabilization or intensification of existing rainfed production by increased use of agrochemical inputs is also technically limited: either the possible gains have already been achieved, or they are unlikely to be achieved because of aversion by farmers to the known risks of investing in improved inputs in marginal rainfall areas. Hence, even though irrigation development cannot, and perhaps should not, be relied upon to meet the entire future increase in demand for food, supply can be expected to depend to an even larger extent on irrigation in the next century than it has in this.

## 2.8 New Irrigation Development

Increased production through new irrigation development is nevertheless increasingly difficult to justify economically for the production of basic foods, because of the decline in world market prices for these crops and typically high per hectare capital costs (see Box 1-2, also Annex 2 of Investment Centre Technical Paper. The situation may change in the longer term if, as world population grows, the demand for food begins to outstrip supply. In this case prices might reasonably be expected to approach the marginal cost of irrigated production, and the use of current World Bank price projections for project analyses may be inappropriate. Indeed, should world market prices for basic food crops show signs of recovery which could significantly alter the profitability of production of such crops under irrigation nevertheless, for the foreseeable future any expansion of irrigation for the production of basic foods will only be possible if substantial reductions in per hectare capital cost of new development can be achieved?

In many countries, however, the better irrigation sites are already developed, and hence new projects could be expected to cost even more per hectare than those developed in the past. New irrigation development in these countries may therefore increasingly be justified only for the production of relatively high value crops - for which markets and marketing are often constraints - rather than for basic foods. In this situation markets, as much as the availability of suitable sites, will determine the pace of investment in new irrigation, unless lower cost technologies can be devised and introduced. This is today's challenge to irrigation engineers.

### 2.9 Evaluation of Existing Systems of Irrigation

Although the design of new irrigation systems constitutes important engineering activities, it should be noted that even greater opportunities are often available in the evaluation and improvement of existing systems. Many of these older systems were designed before much was known about intake rates and water holding capacities of soils, and when water supplies were not fields that do not receive enough water have limited production potentials and nutrients, and may cause drainage problems.

Evaluation of existing systems can be approached in a number of ways. A simple method of determining under irrigation is by use of the soil auger or tube samples. Observation of the opportunity time for infiltration in various parts of the field may be helpful. More sophisticated methods involve application of such equipment as portable flumes, meters, and infitrometers in carefully conducted diagnostic procedures, such as described by Marion and Keller (1978)

### 2.10 The Situation of Irrigation Today

Social research and experience have shown that irrigation projects in some developing countries provide irrigation engineers and other operational personnel with opportunities to raise significant amounts of illicit revenue from the distribution of water and contracts, some of which may be redistributed to superior officers and politicians. Thus, in return for financial inducements, irrigation engineers will award contracts to high-priced or unqualified, incompetent contractors, and "turn a blind eye" to substandard work that saves costs for the contractor and increases his profit. The results of such corruption are not usually immediately apparent, but substandard work obviously has a detrimental impact on subsequent maintenance requirements and costs, contributes to the vicious circle of poor maintenance-poor cost recovery-poor maintenance, and hence has an obvious bearing on sustainability. Financial inducements may also be used to bribe ditch-riders and other operational personnel to enhance water supplies to one farmer, or a group of farmers, at the expense of others, usually the poorest and least powerful, which often means tail-enders.

Corruption of this kind is considered to be one of the most important supply-side factors in the poor performance of public irrigation. It has been very difficult to control in the past because of lack of financial discipline and accountability within irrigation bureaucracies.

### 2.11 Infiltration Process

The precipitation which reaches the soil surface is directed along one of two routes: it's either drains into the soil or enters the soil moisture, or it remains on the surface and contributes to surface storage and flow. The relative proportions of precipitation following each of these routes depend to a large extent upon the infiltration capacity of the soil. In general, only that portion of the rain fall not able to enter the soil through infiltration remains at the surface.

though some of the water held in surface depressions may infiltrate later. As a consequence of control on surface routing of water, however, exerts a fundamental influence on hydrological processes, and agricultural affection infiltration assume considerable importance.

Infiltration involves the movement of water across the air-soil interface into the pore spaces of the soil. The ability of the soil to absorb water in this way is known as its infiltration capacity .This depends in part upon relatively permanent properties of the soil, such as the texture, and structure which affect the poor volume of the soil, and in general it is seen that light texture i.e sandy or well structured soils have higher infiltration capacity than heavy or poorly structured soils. During an intense storm, however, the infiltration capacity tends to decline as the surface layer of the soil become saturated; water can then infiltrate only as the surface pores empty by drainage to depth. The rate at which drainage occurs is largely a function of poor diameter, connectivity and tortuous, and these factors determine the longer- time, saturated infiltration capacity of the soil. In addition, however, infiltration may decline during rainfall due both to expansion of clay particles as they absorb water and also to clogging of soil pores by slaking of particles from aggregates. Thus the infiltration capacity is not constant for any single soil type and may vary according to storm characteristics such as rainfall intensity and duration. For the same reason, marked spatial variation are seen in infiltration rates during a storm on fool slope, for example, infiltrations are often limited by the saturation of the soil due to down slope movement of water in the soil. This results in the preferential development surface storage and runoff in the areas, while upslope of the soil is still able to accept rainfall.

### 2.12 The Soil Moisture Budget

The soil presents an important storage component in the hydrological cycle, often retaining water for long periods and releasing it gradually to streams and ground waters. As such, soil moisture storage has marked influence on both stream discharge and on water quality. Moreover, because antecedent soil moisture conditions influence the infiltration capacity, water retention may affect the amount of rainfall entering the soil erosion.

In general terms, the amount of moisture stored in the soil can be expressed as a water balance equation: $S = R + L_i - E - P - L_o + S_o$

Where S is the soil moisture content at the time under consideration

R is effective rainfall (rainfall- interception)

$L_i$ is the lateral flow of water into the soil

E is evapotranspiration

P is deep percolation

$L_o$ is the lateral outflow

$S_o$ is the original soil moisture content.

All these factors are affected by soil and vegetation conditions and are thus influenced by agricultural practices. Agricultural drainage and tillage, for example, speed up losses by deep percolation; crop removal increases the amount of rainfall reaching the soil and reduces evapotranspiration; changes in soil structure due to tillage, residue management, crop rotation or use of FYM affect rates of percolation, evapotranspiration and lateral flow. Several studies have illustrated these effects, although it is apparent that, because of the temporal and spatial variability of all the factors involved, it is not easy to quantify the overall impact of agriculture on the soil moisture budget.

One of the main controls is exerted by crop cover, for this influences both inputs to and losses from soil moisture store. Russel (1973) quotes early work by R.K. Schfield showing that after a prolonged drought fallow soils retain more water all depths than does land carrying barley –a reflection of the effect of crop transpiration.

## 2.13 Evapotranspiration

Evapotranspiration is a combination of two words; evaporation and transpiration. Evaporation is the process by which liquid water is converted to water vapour while transpiration is loss of water through the stomata of plant. Soil evaporation (E) and plant transpiration (T) are usually combined into one term evapotranspiration (ET) as it is difficult to separate them in a cropped field. ET may be expressed in mm\day or any other desired duration such as one season or one year. ET losses depend on climate and soil moisture supply. As the soil moisture in the root zone is depleted, ET losses decrease

## 2.14 Evaporation losses

In sprinkler application of irrigation water, evaporation occurs from the spray and from the wet surfaces. Cavazza (2002) developed relationships between spray losses and atmospheric parameters. He has compared the evapotranspiration rates of the same foliage as it is being wetted by sprinkler water. It was found that the evaporation from wet foliage was essentially the same as for dry foliage. In those situations where wet-leaf loss, energy available for evaporation of water was not reaching the wet leaves at the rate which it reached the dry leaves. The energy difference was absorbed by the spray.

## 2.15 Evaporation Suppression

Reduction of evaporation from free-water surfaces is an important water conservation measure. Two broad approaches are employed: reduction of the free–water surface area and protection of free water surfaces.

Reduction of free- water surface is accomplished by minimizing the surface area to volume ratio of reservoirs. Storage of water in natural ground water reservoirs rather than surface reservoirs also reduces evaporation losses.

Protection of free- water surfaces has been uneconomical except in special situations. Some attention has been given to application of monomolecular firms for evaporation suppression. The film inhibits the escape of water molecules, but must be continuously supplied because of break up by wind action and deterioration by biological processes. Evaporation reductions in excess of 25 percent have been achieved.

## 2.16 Crop Water Requirements

To make maximum use of available water supplies, the irrigator must have knowledge of total seasonal water requirements of crops and how water use varies during the growing season. The seasonal requirement is necessary to select crops and area that match the available water supply. Knowledge of the variation during the season aids in scheduling irrigations. It should be noted that expected effective rainfall is considered in determining the field irrigation requirements. The duration and length periods of inadequate precipitation during the growing season in humid and sub-humid regions largely determine the economic feasibility of irrigation. In the northern Hemisphere water deficiency during the month of July and August is more serious than in earlier or later month

Estimates of evapotranspiration must be known when planning an irrigation system. Evapotranspiration may be determined by field measurements of soil water content as in fairly short season crop in this region, has the lowest seasonal use of 655mm, with the high water requirement occurring during March, December and January.

## 2.17 Effective Rainfall

Rainfall must be considered when determining the crop water needs that must be supplied by irrigation. Not all rainfall is effective, but only the portion that contributes to evapotranspiration. Rainfall on a wet soil profile is ineffective in meeting evapotranspiration but may contribute to the leaching requirement. Rainfall that produces run off has reduced effectiveness.

A method commonly use for estimating effective rainfall was developed by the SCS (1999). The method bases effective rainfall on monthly evapotranspiration, monthly rainfall, and the soil water deficit, which also may be the net irrigation depth.

## 2.18 Water Quality

Agricultural impacts upon water quality are possibly the most serious of the hydrological effect of farming. In recent years, agro- chemicals have been implicated in the pollution both surface and ground waters, and in some cases it has been claimed as the direct threats to humans health have and been created as a consequences. Pollutants include inorganic fertilizers (especially Nitrogen and Phosphorous compounds), organic manures, livestock wastes and pesticides. In addition, soil erosion may cause pollution of water courses and reservoirs by sediment.

# CHAPTER THREE

## 3.0 METHODOLOGY

The method used for the accomplishment of the objectives of this project was Investigative Survey Research Approach (ISRA). The concept involves the collection, collation and analysis of the data obtained from the questionnaire. The respondents were accorded an opportunity to comment on several issues relating to the irrigation schemes, and problems encountered on the field during operation. The questionnaires were administered by personal contact with farmers in the areas visited.

### 3.1 Investigative Survey

The data used for this project were obtained from four irrigation schemes where irrigation is being practiced within Niger state metropolis. The complete data were obtained from the following Local Government areas within the state. Agaie, Katcha, Kontagora and Rafi.

In all, forty questionnaires were printed out for administering, the mode of distribution seems to be simple but lot of difficulties during the collection and collation of the completed samples. This was largely due to language barriers between the farmers and I. Also, all required information was not made available to me at the time of this exercise. Some of the information supplied was contradictory while some were not complete or irrelevant to this research. Hence the processing of these data by computer as initially envisage was practically unrealistic, since the four irrigation schemes visited are no longer under the management of the state government instead the land have been apportioned to individual farmers who have to produce their individual data which require certain amount of interpretations.

## 3.2 Brief History on the Irrigation Schemes

Operationally, irrigation covers the task of finding, developing and distributing suitable water supplies to the soil in addition to the natural sources of water for crop production. In Nigeria however, because of economic constrain and topography, most irrigation systems in developed inland valley swamps are of the diversion type.

The first irrigation scheme in Nigeria was built around shella stream in 1946. In 1949, the Northern regional government established the first irrigation Division in Nigeria in the ministry of agriculture with responsibilities for developing small-scale irrigation schemes. Therefore, in order to take the advantage of the potential for rice cultivation and other crops, a number of medium and small scale irrigation schemes were initiated in 1970's Niger state is a predominant agricultural state and due to many tributaries of river Niger which passes through the state, the government intention for initiating these schemes was that double of rice production and dry season farming of sugar cane and other crops would be encouraged.

## 3.3 Available Data

The sample of the questionnaire is shown in appendix, with all the relevant information that are required to evaluate the contributions of some irrigation schemes to grain production in selected local Governments of Niger state to rice production. Also, photograph of some facilities used as well as rice growing on the field are shown.

## 3.4 Mode of Cultivation

Usually the land for rice cultivation is cleared manually or with the use chemical (herbicides) ınd thereafter, tilling will follow. After tilling some of the farmers use broadcasting method ›f planting

# CHAPTER FOUR

## 4.0 Results and Discussions

### 4.1 Socio- economic Characteristics of the Farmers in the Areas

Table 4.1 composition of the irrigation schemes visited

| IRRIGATION SCHEMES | | NO OF RESPONDENTS |
|---|---|---|
| 1. | AGAIE | 10 |
| 2. | KATCHA | 10 |
| 3. | LIOJI | 10 |
| 4. | ZAR | 10 |
| | Total | 40 |

Source, The results of some irrigation schemes visited December, 2009

Table 4.3 Distribution of farmers by sex

| Sex | Numbers Respondents | percentage |
|---|---|---|
| Male | 38 | 95 |
| Female | 2 | 5 |
| Total | 40 | 100.0 |

From table 4.3. above, it could be seen that of all the farmers interviewed, 95 percent were males and only 5 percent were females. This indicates that most of the farmers that engage in rice production were males.

**Table 4.4 Distributions of Farmers by Age.**

| AGE | Number of Respondents | percentage |
|---|---|---|
| 18-35 | 12 | 30 |
| 36-45 | 25 | 62.5 |
| 46-55 | 3 | 7.5 |
| Total | 40 | 100 |

Table 4.4 shows that the highest, percentage of farmers were in the age group of 36-45 years and about 30 percent of farmers interviewed falls into age group of 18-35 years, while 7.5 percent of the farmers were between the age of 46-55 years. It therefore indicates that rice production is done by the strong and able farmers. The low percentage of farmers between 46-55 years could be attributed to the fact that they have less strength to engage in rice production while people at the age group of 18-35 are not interested in farming. Most of them usually prefer to look for other greener pastures apart from farming.

**Table 4.5 Distribution of Farmers by Years of Farmers Experience**

| Year of experience | Number of years | percentage |
|---|---|---|
| 10-15 | 13 | 32.5 |
| 16-21 | 16 | 40 |
| 22- 27 | 11 | 27.5 |
| Total | 40 | 100.0 |

Table 4.5, shows that farmers with 16-21 years of experience has the highest percentage of 40 while those between 10-15 years of farming experience represents 32.5 percent of the total farmers and those between 22-27 has 27.5 percent.

It could therefore be said that all the respondents are fairly experienced in the rice production.

**Table 4.6 Distribution of Farmers by Size of Land Owned for rice Production**

| Hectare | Number of farmers | percentage |
|---|---|---|
| 3-6 | 11 | 27.5 |
| 7-10 | 24 | 60 |
| 11-14 | 5 | 12.5 |
| Total | 40 | 100.0 |

Table 4.6 shows that 60 percent of the farmers cultivated 7-10 hectares of land for rice, 27.5 percent cultivated 3-6 hectares of land while 12.5 percent cultivated 11-14 hectares of land.

This shows that most farmers interviewed were medium scale farmers.

**Table 4.7 Distribution of Farmers by their Levels of Educations.**

| Level of education | Number of respondent | percentage |
|---|---|---|
| No formal education | 22 | 55.0 |
| Primary education | 13 | 32.5 |
| Secondary school | 4 | 10 |
| Tertiary education | 1 | 2.5 |
| Total | 40 | 100.0 |

Table 4.7 shows that most farmers are not formally educated. This indicates that not all the farmers can read and write. 55 percent of the farmers had no formal education. 32.5 percent had primary school education while 10 percent of the farmers interviewed had secondary school education and only one among all possessed tertiary education

**Table 4.8 Distribution of Farmers by Source of Credit**

| Source of credit | Number of respondents | percentage |
|---|---|---|
| Personal savings | 22 | 55.0 |
| Friends | 5 | 12.5 |
| Cooperation loan | 13 | 32.5 |
| Total | 40 | 100.0 |

Table 4.8 shows that 55.0 percent of farmers interviewed source their credits through personal savings which presents the highest credit source. Cooperative loan accounts for 32.5 percent of credits sourced by rice farmers were from cooperative while 12.5 were from friends. None of the farmers could get credit from commercial banks

**Table 4.9 Distributions of farmers base on access to the use of Tractors**

| Farmers access | Number of respondent | percentage |
|---|---|---|
| No accessibility | 34 | 85.0 |
| Accessibility | 6 | 15.00 |
| Total | 40 | 100.0 |

Tables 4.9, shows that 85 percent of farmers growing rice have no access to tractor use while only 15 percent has access to tractor. It could be seen that most farmers employed

the use of hired labour to do most of their farming operations hence their cultivation potentials

**Production Potential of the Irrigation Schemes Visited**

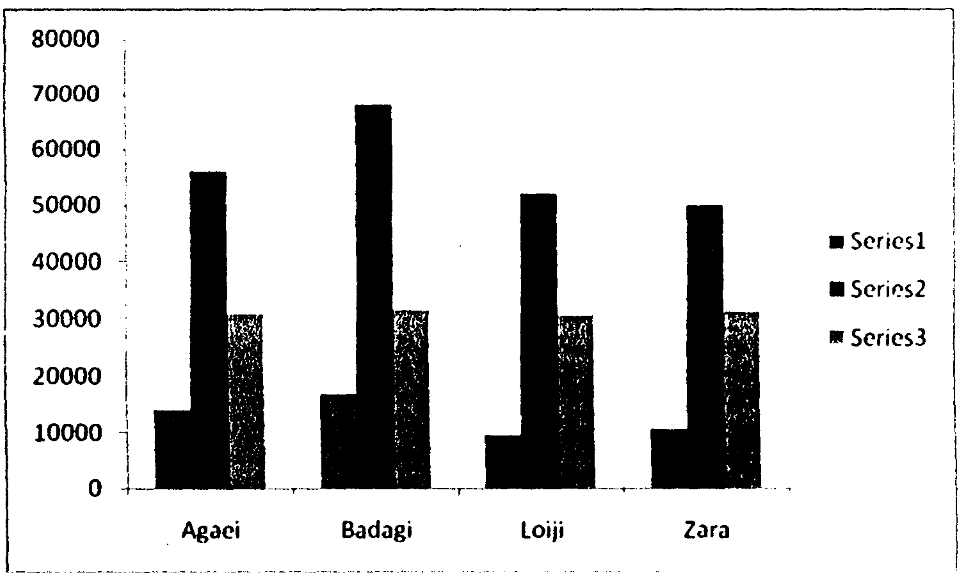
4.9 Distribution of irrigation schemes based on rainy season rice production.

| Irrigation Scheme | Local Government | Total production (Bags) | Average area cultivated (ha) | Average cost involved (₦) |
|---|---|---|---|---|
| AGAEI | AGAEI | 13,895 | 56 | 30,750,000 |
| BADAGI | KATCHA | 16,767 | 68 | 31,500,000 |
| LIOJI | KONTAGORA | 9,300 | 52 | 30,490,000 |
| ZARA | RAFI | 10,450 | 50 | 31,150,000 |

Table 4.10 shows that virtually all the irrigation schemes visited are producing rice but Badagi irrigation scheme is the heist producer of rice when compared others. Also more hectares of land are being put into irrigation in Badegi. The cost of involved in the rice production varied in accordance to certain factors such as cost of labor and materials needed.

Table 4.11 Production of rice in rainy season (rainy season farming)

| Irrigation Scheme | Rice produced (Bags) | Average area cultivated (ha) | Gross profit (₦) | Cost involved | Net profit (₦) | Percentage gain (₦) |
|---|---|---|---|---|---|---|
| BADEGI | 16767 | 68 | 58,684,500 | 31,500,00 | 27,184,500 | 46.32 |
| AGAEI | 13,895 | 56 | 48,632,500 | 30,750,000 | 17,882500 | 36.76 |
| ZARA | 10,450 | 50 | 36,575,000 | 30,150,000 | 6,425,000 | 17.57 |
| LIOJI | 9,300 | 47 | 32,550,000 | 30,490,000 | 2,060,000 | 6.33 |



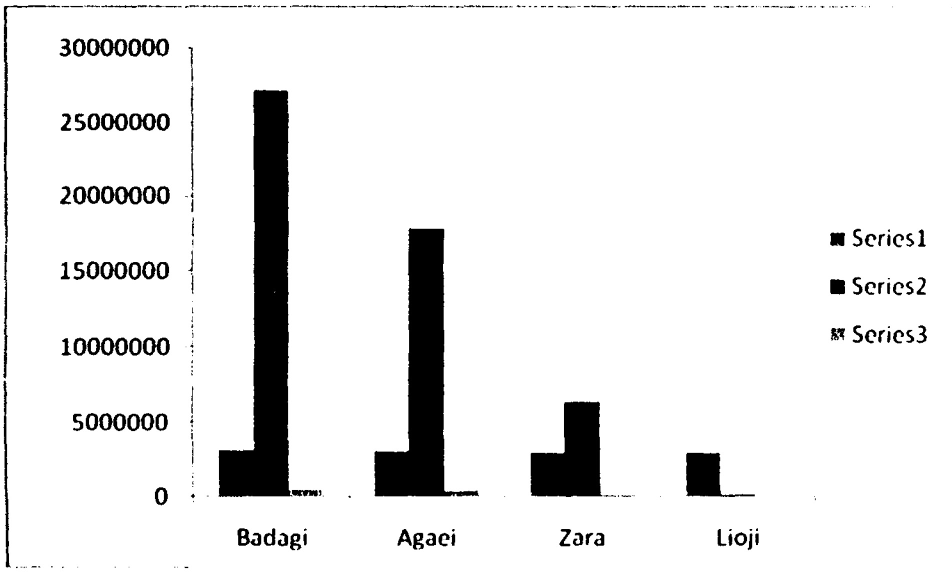

The graph above shows rice Production, Average Cultivated Area and Gross Profit

Series 1: Rice produced
Series 2: Average cultivated
Series 3: Gross profit

From the graph presented above, more of the arable land is put into maximum use in badagi and Agaie as compeered to Lioji and Zara. This is because rice produced more those areas than the others.

Table 4.13 Production of rice in dry season (Irrigated farming)

| Irrigation Scheme | Rice produce (Bags) | Average area cultivated | Gross profit (₦) | Cost involved | Net profit (₦) | Percentage gain (₦) |
|---|---|---|---|---|---|---|
| BADEGI | 18,479 | 68 | 66,524,400 | 35,100,000 | 31,424,400 | 47.24 |
| AGAEI | 15,724 | 56 | 56,606,400 | 35,000,000 | 21,606,400 | 38.17 |
| ZARA | 12,956 | 50 | 46,641,600 | 30,999,000 | 15,651,600 | 33.54 |
| LIOJI | 11,729 | 47 | 42,224,400 | 30,790,000 | 11,434,400 | 27.08 |




A Graph Showing Cost of Production, Net Profit and Percentage Gained.

Series 1: Cost of production

Series 2: Net profit
Series 3: Percentage gain

From the graph above Badagi has high cost of production followed Agaei. This may be due to the fact that more of rice is being produce in those areas and hence the labor and other materials necessary for the production of rice are also expensive.

Table 4.14 compares of rice production between rainy season farming and dry season (irrigated) farming

| Season | ∑ average rice produced (bags) | ∑ Net profit | ∑ average cost (₦) | Average cost per bag (₦) |
|---|---|---|---|---|
| Rainy (Not irrigated) | 50,412 | 53,552,000 | 122,890,000 | 3500 |
| Dry (irrigated) | 58,888 | 80,116,800 | 446,889,000 | 3,600 |

From the table presented above, it is clear that irrigated rice farming brought higher yields and productive values than the one grown in rainy season. This may be due to some factors such as flooding which can be controlled during irrigation than rainy season.

Economy of rice production in dry season for the various irrigation schemes. This was done by the ratio of gross profit versus cost involved in the production.

Economy of rice production in Agaei =56,606,400/35,000,000

=₦1.62

Economy of rice production in Katcher = 66,524,400/35,100,000

=₦1.88

Economy of rice production in Rafi = 46,641,600/30,999,000

=₦1.50

Economy of rice production in Kotangora = 42,224,400/30,790,000

=₦1.37

This shows that any single naira invested in rice production using irrigation for ten (10) years will yield a return of 1.62, 1.88, 1.50, and 1.37 in Agaei, Katcher, Rafi, and Kontangora respectively.

Economy of rice production in all the local government visited: This is done by the ratio of total gross profit versus total cost involved

Economy of rice production in the four local governments =211996800/131889000

= N 1.61

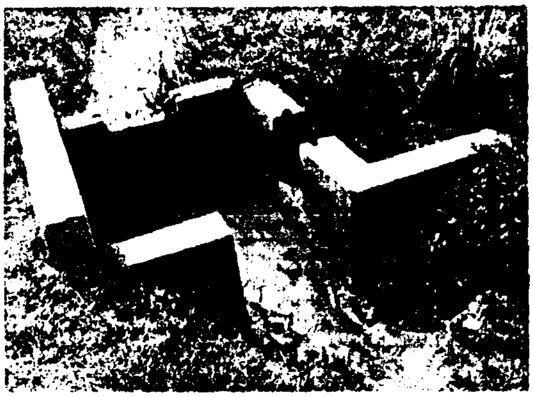


Plate 4.1: Main Canal

Plate 4.2: Badegi Dam

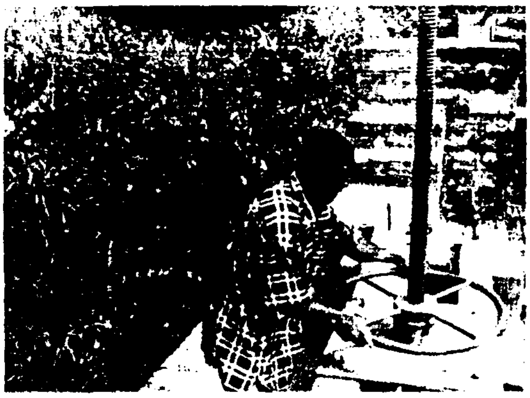


Plate 4.3: Agaei Dam

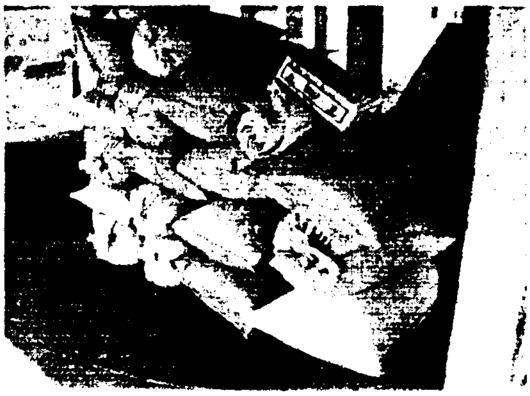


Plate 4.4 Processed Rice

# CHAPTER FIVE

## 5.0 CONCLUSION AND RECOMMENDATION

### 5.1 Conclusion

There is a serious need for government intervention in promoting agriculture and also to raise local awareness for a successful development of the irrigation schemes. Any state that fail to engage in mechanize agriculture will hardly feed her citizen properly. It is clear that many of the problems encountered by these irrigation schemes are mainly from negligence of the government. Hence, in order to increase the performance of the schemes, the following long and short term proffered recommendations must be employed.

### 5.2 Recommendations

Base on the research carried out, I therefore proffer the following recommendation:

(a) Repair of broken irrigation canals and continuous cleaning of the irrigation channels

(b) Provision of drainage of systems to reduce volume of water when necessary.

(c) Provision of unrestricted shallow drainage to enable cultivation of upland crops during the wet season.

(d) Provision of independent storage structures at the of laterals to extend growing season for diversification

(e) Provision of village associations to take greater responsibility in the management of the schemes

(f) Machinery stations are to be provided with tractor and implements or animal power needed to undertake timely land preparation for both upland and irrigated crops.

(g) Provision of credit facilities to support the purchase of farm input such as seeds, fertilizer, and other agro-chemicals.

The above recommendations must be accompanied by engineering works on land leveling, reconstruction of irrigation canals. However, as the main problems affecting the schemes visited within Niger state, it is suggested that the intervals between the application of the short and long terms recommended solutions, a comprehensive study of local situation in all schemes should be conducted. The analysis of the results will identify the point of intervention whether same solutions are applicable to all the schemes in the state or not.

1.

# FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
## DEPARTMENT OF AGRICULTURAL AND BIORESOUCES ENGINEERING
## QUESTIONNARE ON THE SURVEY OF IRRIGATION FARMS IN SOME SELECTED LOCAL GOVERNMENT AREA OF NIGER STATE.

Dear respondent;

The questionnaire is strictly for research purpose, whatever answers supplied shall be treated confidentially.

1. Name of the organization/farm ..............................................................

..............................................................................................................

2. Name of the farm Manager/Qualification

   ..............................................................................

3. Total number of employee ..............................................................
4. Location of the farm ..............................................................
5. What type of irrigation do you practice? ☐ Surface ☐ Drip ☐ Sprinkler
6. What is/are your major Source(s) of finance

   ☐ Government, ☐ Private, ☐ Partnership

7. Land mass/Hectares covered ..............................................................
8. What is the major source of water supply

   ☐ River, ☐ well, ☐ Dam, ☐ Lakes'

9. What is the major source power supply

   ☐ Solar energy, ☐ Manual, ☐ Electricity.

10. Periods of use of irrigation from .............................. to .......................

10. Period of peak consumptive use .......................... to ......................

11. What is the cost of establishing the irrigation scheme ................

12. Running / Maintenance cost ..................................................

13. The types of crops produced

☐ Cash crop, ☐ Food crops, ☐ Vegetables

14. Average annual income ..................................................

15. Types of irrigation facilities used ..................................................

..................................................................................

16. What are the problems encountered in using the facilities ....................

..................................................................................

17. How long does it take you to irrigate your farm at a time ................

..................................................................................

18. How many times do you irrigate ?

☐ a day, ☐ a week, ☐ a month

19. What are the food produce you engage in?..........................................

.......1..........................................................................

20. The significance of those food produce to the state? ......................

.......2..........................................................................

21. Do you produce in excess to supply the neighboring state(s)?

☐ Yes ☐ No

If yes, Please list the states. ..................................................

3

..................................................................................

22. Which year did you commence the irrigation project? ......................

23. Which of the season do you have more yield?

4

☐ Dry season, ☐ rainy season

| Year/Names of crops | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2000 | | | | | | | |
| 2001 | | | | | | | |
| 2002 | | | | | | | |
| 2003 | | | | | | | |
| 2004 | | | | | | | |
| 2005 | | | | | | | |
| 2006 | | | | | | | |
| 2007 | | | | | | | |
| 2008 | | | | | | | |
| 2009 | | | | | | | |

The yield of crops grown under natural rainfall

| Year/Names of crops | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2000 | | | | | | | |
| 2001 | | | | | | | |
| 2002 | | | | | | | |
| 2003 | | | | | | | |
| 2004 | | | | | | | |
| 2005 | | | | | | | |
| 2006 | | | | | | | |
| 2007 | | | | | | | |
| 2008 | | | | | | | |

The yield of cops grown under irrigation

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