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ABSTRACT

ON FOOD SECURITY IN NIGER REPUBLIC: AN ECONOMIC ANALYSIS OF MILLET AND SORGHUM YIELD AND ACREAGE RESPONSES

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The most widely grown starchy staple food crops in Niger are millet and sorghum. Since the prolonged Sahelian drought (1968-73), which claimed thousands of human lives as well as decimating 35 to 50 percent of the livestock population, the output of these crops has dropped, seriously threatening most Sahelian countries' ability to feed themselves.

The Nigerien government, faced with an inadequate food supply, has stepped in the market by implementing policies aimed at insuring national food security. These policies include: (1) the creation of monopolies and/or monopsonies; (2) the outlawing of a trader category, perceived as the "villain" responsible for the scarcity; and (3) the licensing of a different trader group, giving them de facto monopoly power. Some of these measures clearly defeat the stated policy objectives.

This study conceptualizes the Nigerien food problems and provides descriptive and quantitative information emphasizing the determinants of the supply of these crops. Hopefully, this study will prove useful in guiding future policy decisions aimed at enhancing both the technical and distributional efficiency in the Nigerien millet/sorghum food subsector.

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To my dear father now gone. To my mother.

To Camille and Annie Pujol.

To my wife Marie Helene, our son Kiari, our daughters Estele and Nathalie I dedicate this work.

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CHAPTER I

INTRODUCTION

In Niger, the most serious famines in recent history occurred not because of general lack of food in the country as a whole, but rather because of geographical short supply areas.[1] Niger belongs to that strip of land south of the Sahara Desert,[2] internationally known as the Sahalian Region which comprises Niger, Chad, Upper Volta, Mali, Senegal, Mauritania, Gambia and the Cape Verde Islands. This area, little known to the rest of the world, suddenly came into nations' and peoples' awareness in 1968-73 when a disastrous famine swept into the region killing more than 100,000 people,[3] decimating 30 percent to more than 50 percent of the livestock[4] and leaving millions of human beings as permanent carriers of deep scares due to hunger and malnutrition.[5]

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[1] Djioulde Laya, Secheresse: Interview d'agriculteurs et d'eleveurs, IRSH Niamey, 1973.

[2] This definition of the Sahel as being the southern shore of the Sahara Desert can be misleading, given that many of the countries which belong to the zone have 50 to 77 percent of their land area in the Sahara Desert.

[3] David C. Wilcock, "The Political Economy of Grain Marketing and Storage in the Sahel," Ph.D. Dissertation, Michigan State University, 1978, p. 3.

[4] C.R.E.D., Marketing, Price Policy and Storage of Food Grain in the Sahel, The University of Michigan, 1977.

[5] In this study, famine will be referred to as global starvation of a mass of people in a given area of various size, due whether to natural disaster or man-induced calamity. Hunger will refer to the individual or group lacking "adequate" calory intake, be it due to a lack of endowment or to a failure of the entitlement mapping. Malnutrition will be referred to as a qualitative measure of the nutritional state of the individual or group across and within region, across and within households.

When the region was hit by the drought in 1968-73 (drought which turned into an overwhelming disaster) the international relief help which gathered momentum in 1972 and 1973[6] could not reach the real needy or when it did it was at high transportation costs. These costs included such things as air-lifted grain and air-lifted four-wheel trucks to distribute grains in the remote and highly inaccessible areas.[7] Since the drought, the Nigerien[8] government, as all governments in the Sahel Region, has adopted food self-sufficiency[9] as a policy goal.

From a vertually food self-reliant nation, up to the late 1960s, Niger's ability to feed itself has become increasingly difficult. Table 1.1 shows Niger's food production failing to keep pace with population increases. This has been magnified during the five consecutive drought years (1968-73). In 1973, per capita food production fell 40 percent compared to predrought 1968 levels according to Indices[a] CILSS. However dramatic this table may show the discouraging trend, one should be very cautious interpreting these numbers since their accuracy is not that

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[6]United Nations, Drought in the Sahel: International Relief Operations (1973-75), a report by the Food and Agricultural Organization (FAO), 1975.

[7]Tom Reed, A Report on International Food Distribution Within Niger, FAO/OSRO, UNDP Niamey, 1974.

[8]Throughout this study the term Nigerien (which is not NIGERIAN, spelled wrong), will be used to qualify things, facts and people of the Niger Republic, as opposed to Nigerian, which applies to Nigeria.

[9]The title of this study on food security should not be confused with autarky, as a policy goal to achieve food self-sufficiency, for autarky imposes short-term efficiency loss, and thus, cannot be a viable goal. More on the topic will be developed, in the following pages.

Table 1.1

Food Production Indices Per Inhabitant (1966-1977)

Year	Indicies[a]	Indicies[b]
1966	109	100
1967	116	92
1968	100	89
1969	111	106
1970	96	98
1971	93	96
1972	86	96
1973	63	91
1974	74	95
1975	68	77
1976	90	103
1977	82	93

[a]Source: C.I.L.S.S. Club du Sahel, "Cereal Policy in Sahelian Countries," Noua Kéhott Collogue, July 1979 (from the FAO Production Yearbook, Vol. 31), 1969-71 = base year.

[b]Source: Indices of Agricultural Production, USDA Statistical Bulletins 544 (for data through 1973) and 637 (for data from 1974-77), 1961-65 = base year.

well established throughout the literature.[10] The indices a and b below indicate such inaccuracy and disparity among sources of information.

Table 1.2 is another indicator of the adequateness of the Nigerien food situation. Here again, as magnified by Table 1.2, it can be seen that Niger's food availability[11] was adequate until the late 1960s. From 1970 to 1975, Niger had to import grains, either through commercial or concessional imports. The grain deficit reached 32 percent in 1973, the peak of the drought period.

Given that millet and sorghum are exclusively grown under rainfed contitions, the production of these crops has been profoundly influenced by the prolonged drought. In Figure 1.1, rainfall figures and millet and sorghum output are plotted against time. This figure clearly demonstrates how these variables move together. Given the high variability of rainfall in this sub-Saharian area, grain supply is highly unreliable. The steady increase of the population in rural areas, coupled with rapidly growing urban population, have put additional stress on the already weak grain supply.

Confronted with the above situation, the government of Niger has created a food marketing board with granted monopoly and monopsony power to set prices in selling and buying food products and complementary inputs. In addition, government regulations outlaw the small "traditional

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[10] For instance, even though the discrepancy between the two series in Table 1.1 can be explained by the differential in the base year, the USDA Statistical Bulletin No. 637, which covers 1970-79, and Bulletin No. 544, which covers 1965-74, do not match.

[11] Though food availability is a good indicator of a nation's ability to feed itself, availability alone is not sufficient to access the nutritional state of the population; access conditions, distribution across and within households are important.

Table 1.2

Millet and Sorghum Self-Sufficiency Ratio (Niger, 1961-1979)

Year	Production of Millet and Sorghum[a] (000) m.t.	Population[b] in (000) Inhabitants	Requirement[c] (000) m.t.	Self-Sufficiency Ratio[d]
1961-65	1,204	3,404	826	1.45
1962	1,249	NA	NA	NA
1963	1,330	NA	NA	NA
1964	1,329	3,393	848	1.57
1965	1,055	3,486	872	1.20
1966	1,119	3,588	897	1.25
1967	1,342	3,691	923	1.45
1968	948	3,800	950	0.99
1969	1,385	3,912	978	1.42
1970	1,101	4,031	1,008	1.09
1971	1,225	4,153	1,038	1.18
1972	1,118	4,279	1,070	1.06
1973	753	4,411	1,103	0.68
1974	1,102	4,477	1,119	0.98
1975	835	4,599	1,150	0.73
1976	1,265	4,725	1,181	1.07
1977	1,472	4,850	1,213	1.21
1978	1,494	4,979	1,245	1.20
1979	1,606	5,105	1,276	1.26

[a]Source: Nigerien Agricultural Statistical Surveys (various years). (Rapport Annual du Service de l'Agriculture I II).

[b]Source: USDA, Statistical Bulletins 365 (for data from 1964-73) and 637 (for data from 1970-79) as from one bulletin to the other the population figures for the same base years (1961-65) changed; the highest figure which is closest to the national figures has been selected.

[c]This column is obtained by multiplying the population figure by 250 kg. which is the national standard of per capita food requirement.

[d]This column is obtained by dividing column (a) by (c). (a/c).

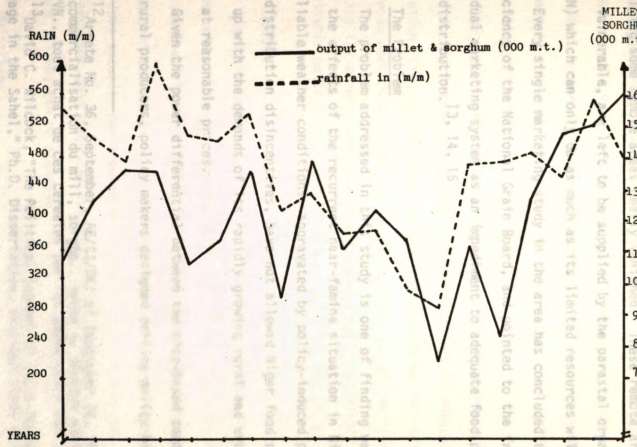

Figure 1.1 Rainfall and Millet and Sorghum Output as a Function of Time

traders"[12] as they are perceived to be responsible for the scarcity situation.

As might be expected, black-market developed. Due to control over price, any incentive to engage in taking the risk of storing grain and supplying some remote areas nearly vanished. These remote areas, the most vulnerable, are left to be supplied by the parastal organization (OPVN) which can only do as much as its limited resources will allow.

Every single marketing study in the area has concluded the lack of efficiency of the National Grain Board, and pointed to the fragmented and dual marketing system as an impediment to adequate food production and distribution.[13, 14, 15]

1.1 The Problem

The problem addressed in this study is one of finding ways to minimize the effects of the recurrent near-famine situation in Niger. Highly unreliable weather conditions, aggravated by policy-induced production and distribution disincentives, have not allowed Niger food supplies to keep up with the demands of its rapidly growing rural and urban population at reasonable prices.

Given the power differential between the city-based consumers and the rural producers, policy makers designed pricing policy biased toward

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[12] Arrete No. 36, September, AE/CI/DCI of September 24, 1975 states: "la commercialisation du mill, sorgho...reste du domaine exclusif de l'OPVN...tout achat de ces cereales per les commercants est interdit...."

[13] David C. Wilcock, "The Political Economy of Grain Marketing and Storage in the Sahel," Ph.D. Dissertation, Michigan State University, 1978.

[14] Bonnie Ann Stewart, "The Impact of Marketing Institutions Serving the Agricultural Sector in Zinder, Niger," Ph.D. Dissertation, Department of Oriental Studies, University of Arizona, 1978.

[15] University of Michigan: Marketing, Price Policy and Storage of Food Grains in the Sahel, 1977.

urban consumers. Since the drought (1968-73), the government, on the assumption that private "traders" were responsible for the scarcity situation, carried out policies which outlawed certain categories of traders. This de facto gave monopoly power to few merchants who naturally exploited their granted power, to earn profit at the expense of both producers and consumers. Uniform price setting and the creation of government monopolies and/or monopsonies, which instead of helping the farmers to get an equitable share of their labor, were rather surplus extracting institutions.

The uniform pricing policy which ignored real market opportunities, the dual and fragmented marketing system, the lack of adequate transportation, storage and communication infrastructures and the lack of rigorous marketing norms are increasing the cost of the system and are forcing the already weak and lagging grain supply into inefficient and unreliable paths.

1.2 Purpose

Given the importance of millet and sorghum in the diet of more than 95 percent of the Nigerien population, the main purpose of this study is to: evaluate the major institutional, environmental and economic determinants of the supply of millet and sorghum in Niger, so that to examine the food security position of the country and to investigate whether or not abundant food supply at reasonable prices for consumers and producers, alike, can be achieved.

1.3 Objectives

The overall objective of the study is to investigate the nature of the Nigerien food system with emphasis upon the staple food crop

subsector. From this investigation alternative policies to accomplish food security, one of the overriding priorities of the Nigerien people and government facing recurrent food shortages, will be suggested.

To accomplish this major objective, the following more specific objectives are set forth.

(1) As a subset of the Sahelian food problem, analyze the Nigerien food situation through a worldwide perspective on the food issues.

(2) Provide a descriptive analysis of the Nigerien food crop subsector in order to assess any potential inefficiency in the system.

(3) Analyze the price responsiveness of millet/sorghum yields and acreage to assess the overall supply response.

(4) Identify and quantify the effect of the major determinants of millet and sorghum supply.

(5) Examine the food self-sufficiency position of the Nigerien population through projection of grain supply and demand through the year 1990.

5.4 The Data

The data used in this study are secondary source, time-series of price, output of millet and sorghum, acreage, yields and weather variables from 1961-1979.

The main sources consulted are as follows:

- the Nigerien's Agricultural Statistics Bureau (Rapport annuel du service de l'Agriculture Tome II statistiques;
- the University of Michigan, "Marketing and Price Policy in the Sahel";
- John A. Becker, "Analysis of Cereal Availability in the Sahelian Entente States of West Africa" (Appendix 1-3-13);

- Marches tropicaux et Medeterraneens, 1980, Special Issue on Niger;
- World Bank Development Reports;
- FAO and USDA publications.

Given that it has been customary to hear so many authors complaining about the quality of the data and their lack of accuracy, the data has not been transformed by using some weighting schemes given the unknown bias already contained. However, price series from 1970 to 1979 have been weighed.

The rainfall figures are national averages. The average has been computed on the basis of a proposively chosen sample of locations. Given the nonrandom choice of these locations, one should not expect the computed mean to collapse into its true population mean value, even when the sample is large.

The stations are chosen on the following criteria:

(1) Fair representativeness of the millet and sorghum growing area in the state.

(2) Availability of continuous time series data. The selectivity of this second criteria is obvious that certain regions will have more stations than they would otherwise.

The 11 stations are as follows: Tillabery, Birningaoure, Doutchi, Dosso, Konni, Fillingue, Goure, Dakoro, Zinder, Nagaria and Maine-Soroa (see Appendix Figure C.1).

Some indexes have been computed:

(1) The area and yield indexes uses 1960 = 100 as the base year.

(2) The rainfall index is computed using the mean of the 19 years = 100 as base.

1.5 Plan of Study

In Chapter I a statement of the problem was provided together with the rationale for carrying out this research, the purpose and the objectives of the study.

In Chapter II a discussion of the Nigerien food situation, as a subset of the Sahelian food situation, will be made through a review of the literature on the world food issues.

In Chapter III an investigation of the Nigerien food crop subsector will be made to delineate the millet and sorghum marketing channels and to describe the channels' participants behavioral responses to the constraints of their environment. This chapter will also set out to show the relationship between the actors' behavior and the problematic situation described in Chapters I and II.

In Chapter IV the methodological approach to the millet and sorghum yield and acreage responses will be given.

In Chapter V a discussion of the empirical results will be provided.

Finally, in Chapter VI the conclusions and the policy implications of the study results will be given, as well as suggestions for further research.

CHAPTER II

THE NIGERIEN FOOD SITUATION THROUGH A REVIEW OF THE LITERATURE ON THE WORLD FOOD ISSUES

2.1 Introduction

The Nigerien food situation is best understood only when looked at through a worldwide perspective on the food issues.

Food security and food self-sufficiency presently seem to be one of the most popular subjects of concern for many leaders in the developed (DCs) and underdeveloped (LDCs) countries. While in the DCs agriculture is being overpriced with consequent shift of productive resources and excess supply, in the LDCs agriculture is being underpriced with subsequent shortages.[1] Given the sociopolitical and biological role of food, both sets of policies serve to restore sociopolitical equilibrium. However, they often generate other sources of disequilibria.

In this chapter the following literature will be reviewed:

(1) The global perspective and issues of the world food problems.

(2) A general appraisal of actions taken to insure food security at national and international levels.

(3) The impact and "raison detre" of food aid.

Before examining each of these points the domain of food self-sufficiency and food security will be defined. In this study food security will refer to the ability of a nation, region, or household to adequately feed

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[1] T.W. Schultz, In Distortion of Agricultural Incentives, Indiana University Press, 1978.

itself (quantitatively and qualitatively) through improving the productive capacity of their agriculture and/or taking advantage of trade opportunities. Food self-sufficiency will refer to the ability to produce all its food needs.

For a land-locked country such as Niger which lacks transportation and adequate communication systems, the two terms (food security and self-sufficiency) can be synonimous, by restricting food to food grains.

In the political sphere the emphasis is put on food self-sufficiency, at any cost. This statement would seem to be a valid and legitimate political goal. However, international trade theory suggests that there are mutual benefits to be captured through "free trade" and that a country would be better off by letting others produce those commodities for which it has the least comparative advantage and engage in trade to acquire them under certain assumptions. Most of these assumptions do not stand the empirical test, (i.e., zero transportation costs, nonmobility of capital and labor across nations, uncoerced choices, money does not matter, absence of barrier, etc.). On economic grounds, pursuing self-sufficiency goals without exploiting existing mutual benefits which could be captured through trade, would result in short-term efficiency loss. Yet, given uncertainty, rising world food prices, and rising concentration in the world food market, many writers have advocated that each country should become self-sufficient for its food requirements through building its own national food security.

In support of this view, discussion has emphasized the unreliability of external supply. As the developing countries are concerned, there are two main sources of external supply: concessional and commercial. Concessional sources of supply such as through "PL 480" or other programs,

are highly unreliable, given their political ties and the fact that their volume is highly determined by the level of effective demand. This viewpoint is summarized by Alberto Valdes, et. al.[2] in the following terms.

> Food aid was cut in 1973-74 and relying on such a source of supply remains highly risky. Commercial supplies may or may not be reliable depending on the commodity. The rice market, for example, is a "thin market," subject to sudden interruptions and shifts in trade channels.

In any event, for Niger to rely on external sources for its food needs would involve tremendous monetary and social costs due to high transportation costs, delays, and rising world food prices. Thus, this study suggests that Niger achieve self-sufficiency in food grain short of self-sufficiency in all food items.

Next, a review of the literature on the world food issues and how they relate to this study is made.

2.2 Global Perspectives

The discussions of food availability often center on food insecurity. Food insecurity can be defined as the probability that food grain consumption falls below a desired level due to a fixed upper limit of the food import bill and an unfavorable combination of poor harvests and world food grain prices. Food security would be when that probability equals or approaches zero. It is expressed as a probability to indicate that a host of factors are operating. Some of these important components are domestic production (and fluctuations), world grain prices, prices of inputs, domestic consumption, and the distribution of wealth. These

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[2]Ammar Siamwalla and Alberto Valdes, "Food Security in Developing Countries," Report from Food Policy, Vol. 5, No. 4, 1980, p. 261.

components are of such a nature that food insecurity must be addressed with both a macro (global) and a micro (national) approach. In most of the literature and in the world Food and Agricultural Organization (FAO) the emphasis is put on the notion of global food availability and famines are characterized by the decline of such availability (FAD).

Amartya Sen[3] analyzed the relevance of the FAD argument and challenged it by developing the theory of "entitlement failure." Based on empirical evidence, Sen showed that the first Bengal famine of 1943, the Bangladesh famine, the Ethopian famine of the Wollo Region, did not occur because there were not any significant declines in food availability since, in most of these regions, food was being exported although millions of people were dying in the streets. He suggests to look for the causes in most modern famines at the institutional, political, and economic structures which define property rights, jurisdictional boundaries, and set the rules of the "game."

Broadly defined, Sen's entitlement approach is the failure on the part of a group of people to establish entitlement over a definite amount of food, either by loss of direct entitlement or endowment, or by the failure of the "exchange entitlement mapping."

The entitlement approach can explain the Sahelian famine in two steps: First, Franke[4] explains that the colonial system through heavy taxation induced the peasants of the West African colonies to grow more

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[3]Amartya Sen, "Famines," World Development Report, Vol. 8, 1980, pp. 613-621.

[4]Richard W. Franke and Barbara H. Chasin, Seeds of Famine, "Ecological Destruction and the Development Dilemma in West African Sahel," Allanheld, Osmun and Company Publishing, Inc., Montclair, New Jersey, 1980.

and more peanuts on marginal lands pushing further north the herders on the desertic fringe where the ecosystem in transient equilibrium could not support the overgrazing. Second, as a result of the overgrazing when rainfall in 1968 was below normal, the herders lost their animals (their only source of income and claim of their entitlement to food). They then migrated in large numbers and many of them died in the process (mainly old people, pregnant women, young people, etc.). This is particularly true in the Nigerien and Malian Sahelian regions. Sen gave another example of the power of the entitlement approach to explain much of today's famine. That is, during the Irish famine of 1846 people were starving while the market and stores were well supplied (p. 617).

Akhter Hameed Khan[5] in his history of the food problem shares Sen's view when analyzing the "Great Bengal Famine." He came to the conclusion of a "man-made" disaster.

In addition to these methodological problems in approaching food problems, the parameters that enter the food equation have been manipulated and are confusing. This view is summarized by Thomas T. Poleman in the following terms:

> The public has every reason to be confused about the food situation. Conflicting pronouncements abound. Depending on where counsel is sought, it is possible to be informed that mankind has been led into a nutritional cul-de-sac from which there may be no escape, or that world resources ...could feed at maximum (American) standards, 47 billion people.[6]

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[5]Akhter Hameed Khan, "A History of the Food Problem," Agricultural Development Council, 530 5th Avenue, New York, New York, 10020.

[6]Thomas T. Poleman, "World Food Myths and Realities," World Development, 1977, Vol. 5, No. 5-7, pp. 383-394.

In this article, Poleman spelled out three of the common myths that surround the world food situation: (1) the myth of eminent global starvation; (2) the myth of the "tragedy of the common;" and (3) the myth of food-population race. He sees the essence of the problem in terms of income and economic participation dilemmas by concluding that:

> The quandry faced by LDCs is best visualized not as the doomsayers have it, in the sterile terms of race in which food and population push relentlessly toward some hypothetical saturation point. Rather, it is a very maleable competition between population growth and economic participation on the one hand and between economic participation and food on the other hand.

Until the purchasing power of the poor is increased through on-farm or off-farm employment, effective solutions to the world food problem would be difficult to find.

Some of the long-term trends that are important here are the rates of growth of agricultural production, population, and domestic demand. Prior to World War II, most LDC regions were exporters of food products. The situation changed after the war even though food production in the LDCs during the 50s was growing as rapidly as in the developed countries and faster than the population. By the middle of the 1960s, food production in the LDCs had fallen behind population growth. The situation became exacerbated in the 1970s when stocks plunged to a recent all time low and several regions suffered a two to three year series of crop failures.

The implications of these general trends are that the LDCs changed from self-sufficiency in food supplies during the 1950s to a situation where they imported between 15 and 20 million tons of grain in 1970 with half of it being in the form of food aid.

World food production declined modestly in 1972--only 1.6 percent at the world level--but the impact of this decline on some countries,

commodities, trade patterns, prices, and per capita food production levels was serious. The crop shortfalls were particularly unsettling because they broke the growing confidence about overcoming the world food problem that had emerged in the period after 1966, the period of the "Green Revolution." However, sharp declines occurred in many LDCs, especially in South Asia. In parts of Africa, where production was already precariously low due to a prolonged drought, production suffered further setbacks. Production also declined in Canada, Australia, and the USSR. The USSR, customarily a net grain exporter, became the world's largest importer of grain; importing a net total of 30 million tons in 1972 and 1973 (compared with total net exports of 6.8 million tons in the previous two years).

The impact of curtailed supplies was more severely felt by the poorer segments of the population, particularly the unemployed, especially during the lean periods between harvests. Thus, the problem of uneven sharing was magnified internally in many countries.

Food insecurity can then be considered as being composed of a short-term disaster/famine component, highly related to production fluctuations and longer-term phenomenon of persistent and chronic malnutrition.

2.3 International Measures to Achieve Food Security

For 35 years, international organizations have tried to stabilize grain supply. In 1946, Sir John Boyd Orr, General Director of the FAO, proposed a world grain reserve. Despite rhetorical support, no grain reserve has been established. Dr. Boerma, the following Director of the FAO, suggested that buffer stocks be established in each country. The Directors of FAO passed and many solutions and recommendations of

agencies of the United Nations (U.N.) have died short of being followed. Yet, these proposals and other continued to be the focal point of the discussion concerning food security.

Grain reserves can exist in different forms depending on who initiates the reserve, who has control, and who has access to that reserve. The issues surrounding the formation of grain reserves are terribly complex because they involve a compendium of not easily resolvable domestic and international considerations. The decisions regarding the size, location, operation, control, etc., of grain reserves revolve around the competing values of interest groups and these decisions are infused with serious political and economic overtones. It remains to be seen how compatible are these competing political interests and to what extent localized political objectives can and will be sacrificed to the necessary extent to provide food security worldwide.

The physical existence of a stock is but one necessary condition for assuring that grain will be available to a target population. Other necessary conditions include: (1) that a reserve is not destroyed by fungal or rodent infestation; (2) that the target user groups own, can purchase, barter for, or in some other way gain access to the grain; and (3) that a transportation and distribution network exists to move the grain to the users. These considerations are especially important in considering the formation of any type of reserve, whether it be a national or international one.

There are many types of grain reserves which have been recently discussed in the literature. These reserves can be categorized in four groups: (1) a marketing reserve in which grain after harvest is stored as a working stock for a gradual use over the remainder of the growing

cycle; (2) a buffer reserve in which surplus grain is saved in a year of excellent harvests for the use in another year plagued by poor production; (3) a food aid reserve in which grain is set aside even during a year of productive shortfall for distribution for domestic or foreign persons defined as "needy;" and finally (4) an emergency food reserve in which grain is accumulated to disburse to areas which experience production shortfall or some other natural disasters. After all the proposals for a grain reserve have failed to materialize, another agency of the U.N. was created: the World Food Program.

In 1973, a FAO conference proposed an international undertaking on world food security. That was followed by the creation in 1974 of the World Food Council.

The 1973 FAO Conference pointed out the following elements:

(1) A statement that world food security is a common responsibility of all governments and that conservation is more than ever needed to mitigate acute food shortages in the face of the world.

(2) An improved global early warning system.

(3) Governments consultations under FAO coordination.

(4) Guidelines for national stock policy and earmarked stocks or funds readily available to face any emergency situation.

(5) Special assistance for LDCs to increase their food production, improve their transportation network, and their storage facilities. Some of these are gathering momentum in the Sahelian region through the CILSS.

The 1974 World Food Conference. The major recommendation of that conference was: the global information and early warning system and the

creation of a reserve of 10 million tons of grain as the minimum requirement for worldwide food aid.

The Global Information and Early Warning System on Food and Agriculture was established to: (1) identify countries and regions where acute food shortages and malnutrition problems are thought to be imminent; (2) monitor world food supply-demand conditions so as to enable governments to take timely and appropriate measures; and (3) contribute to the effective functioning of the International Undertaking on World Food Security. The system was created primarily to assist those areas most severely affected by food shortages in obtaining comprehensive and timely flows of information and forecasts on the situation and prospects for agricultural production as well as import requirement, export availability, livestock situation, etc. How far these proposals have been pushed is not known. Yet, one can imagine the political difficulties for sovereign countries in an "era of uncertainty" to publicize such data that are vital to their political, economical, and strategical survival.

FAO conferences succeed one another without getting much done and the U.N. created another body, the World Food Council (WFC), which was entrusted with the follow-up and the coordination of the policies concerning food production, nutrition, food security, and food aid. The WFC, at its first meeting in Rome in 1975 and at its second meeting in 1976, seems to be still discussing where the reserves should be located, who should pay for the storage, ect., and not much has changed in the news of food security, despite all the rhetoric and numerous organizations.

2.4 On the Impact of Food Aid

The impact and consequences of food aid has already been touched in the literature reviewed in the preceding sections. In this part, a summary of that body of the literature will be made.

There is a significant body of literature which supports food aid as instrumental to growth and development and another which sees food aid as an impediment to growth and development and/or a pure exercise of dumping unwanted surplus through expansion of demand.

Despite the disagreement, there seems to be a growing concensus on the following two points among the pros and cons:

(1) Food aid is a real transfer of resources from the donors to the recipient countries.

(2) Food aid as a temporary relief operation is a "good," viable solution.

The major argument of the proponents goes as follows. They see food aid to serve at least four major purposes.

(1) Food aid provides food to the hungry, through direct subsidized distrubiton, often centered on the most nutritionally vulnerable group. This helps contain price increases which otherwise would hit hardest those groups, given the price inelasticity of demand and also the fact that food represents a high proportion of their expenditures.

(2) Provides financing for specific projects for the government (through food for work, etc.)

(3) Can be used to build up food reserves which would reduce price fluctuations.

(4) Is expected to reduce major constraints on growth and employment.

K.D. Roger,[7] et. al., argues that the fall in Indian production was only 3 percent, contrary to what some authors have believed to be 30 percent. These authors further argue that the subsidized distribution of food by the government increased food grain demands.

M. Lipton[8] did not consider food aid as the cause of the Indian agricultural setback, but rather points to the inadequateness of the planning mechanism which somehow neglected agriculture.

I.L. Mason,[9] in the case of Pakistan, argued that food aid provided a margin of safety which allowed the introduction of technology to stimulate production. However, Mason did not deny the disincentive effects of food aid.

The "cons" argument goes as follows:

L. Dudley and R.J. Sandilands,[10] looking at Columbian subsidized wheat imports, showed that internal wheat production fell nearly 30 percent during the same period. Not all agree on the point that the shortfall should be attributed in full to the subsidized imports.

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[7]K.D. Roger, et. al., "Modified Price, Production and Income Impacts of Food Aid Under Market Differentiated Distribution," American Journal of Farm Economics, Vol. 54, May 1972.

[8]M. Lipton, Strategy for Agriculture: Urban Bias and Rural Planning in the Crisis of Indian Planning, edited by P. Streeten and M. Lipton, London: Oxford University Press, 1968.

[9]Islam L. Mason, "Foreign Assistance and Economic Development: The Case of Pakistan," Economics Journal, Vol. 82, March 1972.

[10]L. Dudley and R.J. Sandilands, "The Side Effects of Foreign Aid: The Case of P.L. 480 Wheat in Columbia," Economic Development and Cultural Change, Vol. 24, January 1975.

K. Griffin[11] pointed to the role of U.S. food aid as the second explanation of the retarded growth of agriculture in Taiwan.

B.R. Shenoy[12] points out the worsening of food supply in India despite increased food aid (India is by far the largest recipient of U.S. food aid). At this point, proponents of the food aid point out that the situation could well be worse in the absence of such aid.

T.W. Schultz set out 20 years ago to show the major economic disincentive effects of food aid by stating, "In all of the hearings before the U.S. congressional committees and statements and reports of executive branches I have found no serious consideration of the disincentive effect of American food aid." (P.L. 480)[13]

The list on both sides can be extended; yet, finding no point in doing so. I shall conclude this section with a quote in a more recent article from T.W. Schultz:

> The economics of being poor makes it exceedingly difficult for rich people to comprehend the preferences and resource constraints that determine the choices that poor people in low income countries make...dumping surplus and tying aid if it can help the donor countries to dispose of their own burdensome surplus, will depress supply in the recipient countries...."[14]

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[11] K. Griffin, "An Assessment of Development in Taiwan," World Development, June 1973

[12] B.R. Shenoy, P.L. 480 Aid and India's Food Problem, New Delphi: East-West Press, Ltd., 1974.

[13] T.W. Schultz, "Value of U.S. Farm Surplus to Underdeveloped Countries," Journal of Farm Economics, Vol. 42, December 1960.

[14] _____, "Economic Distortions by the Donor Community," Agricultural Economic Paper No. 81-8, World Bank Symposium, Washington, D.C., January 1981.

It would seem that a unifying statement on this issue would read as follows:

> "Limited food aid adequately isolated from the market channels of the receiving countries in periods of crisis is a positive form of aid."

CHAPTER III

THE NIGERIEN MILLET AND SORGHUM MARKETING SYSTEM

3.1 Conceptual Framework

In this chapter the millet and sorghum marketing system will be described to assess any potential inefficiency that may exist in the system. A systems approach to marketing will be used in the description. This will avoid the seemingly confusing marketing and production dichotomy, since production neither starts nor ends at the farm gate. The input delivery sequence and the product distribution sequence are both production activities that belong to the horizontal and vertical sequences of an integrated system. The system channels will be described and factors conducive to less than desired and achievable performance will be spelled out and policy recommendations made.

This study will attempt to go beyond the narrow conceptual framework of structure, conduct and performance (s-c-p) of the industrial organization (IO) paradigm. Within this paradigm, market structure variables such as number and size distribution of firms, entry conditions, the extent of product differentiation, determine the market participants' conduct in terms of their pricing strategy and how they view their competitors' actions. This, in turn, determines market performance in terms of the allocative and distributive efficiencies of the system. However, this study will make use of the (IO, s-c-p) paradigm and expand it by looking more closely at the internal decision making

behavior of the individual firms facing a constantly changing and uncertain environment.

Number and size alone are not sufficient as criteria to delineate the extent of market structure and the resulting conduct of the actors and the outcomes of the system. When taking a narrow neoclassical economist's look at most LDCs village lenders and traders, the following classical image is perceived:

- numerous;
- small with little capital;
- virtually no barriers to entry;
- high turnover;
- sell homogenous, small quantities of the same output;
- none can influence the market, etc. One thus sees a purely competitive model, each of the actors being price taker, given enough information the system would be perfectly competitive. In the long-run, they will equate MR = MC = LAVC. No excess profit and that resources would be allocated efficiently (first best pareto-model). This view is not widely shared, however. The argument goes as follows:

Mellor[1] on the question of the seasonal price variation using India's data rejects the hypothesis that the middleman profits greatly at the farmers' expense and qualified the claim as a common stereotype. The following quote is from the third meeting of the "Club des Amis du Sahel" team on marketing and price policy.[2]

[1] John Mellor, The Economics of Agricultural Development, Cornell University Press, Ithaca, New York, 1966.

[2] C.I.L.S.S., Brussels meeting on grain marketing and price policy team, March 16-18, 1977.

> The Quasi-unanimous opinion of the group members is radically opposed to this proposition.

(The proposition of legalizing and encouraging private traders.) Elliott Berg was the lone dissenter.

Barbara Harris,[3] through a quite extensive literature review and substantial time spent in the rural Sahelian regions, argued on the adequateness of the performance measures used by those who concluded on the efficiency and lack of collusion among private traders. She also pointed to the danger of overgeneralizing study results for what is true for India may have no relevance for Mali, and that what is true for Southeast Nigeria may not apply for the whole country. She also pointed to numerous studies that found evidence of monopolistic or oligopolistic behavior on the part of traditional traders.

Noncompetitive pricing behavior on the part of the traditional traders is not a simple matter or rhetoric. There exists a strong body of empirical facts in addition to those mentioned above.

Frank Ellis[4] reported grain price fluctuations ranging anywhere from 8 CFA/kg. at harvest to 40 CFA/kg. during the "soudure" period, or 500 percent increase which can hardly be attributed to storage, transportation costs and normal profit alone.

Weitz-Hettelsater's[5] study found 800 percent to 1,000 percent price differential between harvest and the soudure period, and that 300 percent to 400 percent differentials are not the exception, but rather the rule.

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[3]Barbara Harris, "Going Against the Grain," Workshop on Socioeconomic Constraints to Development of Semi-Arid Tropical Agriculture, I.C.R.I.S.A.T., February 19-23, 1979.

[4]Frank Ellis, "Report of the West Africa Grain Stabilization Project," USAID, mimeo, May 1972. University of Michigan marketing study, 1977, p. 146.

[5]Weitz-Hettelsater, Engineer, "A Grain Stabilization Study of the Entente States and Ghana," Entente Council Fund, March 1969.

The CRED study of 1977, though recognizing the likelihood of finding large price differentials due to large distance, inadequate transportation and lack of information, reported that the price variation remains within a 20 percent average, reflecting transportation storage costs and "normal" profit. They pointed out, however, the questionable procedure which, in their own words, was hypothetical (Volume II, p. 52, Niger).

David C. Wilcock (1978) reported Nigerien traders buying grain from farmers at 12-15 CFA when the official price was 25 CFA and reselling it to OPVN, realizing a substantial profit of 700 million CFA.

When one looks conceptually at the environment in which the "traditional traders" operate, it appears clear that they do indeed enjoy some noncompetitive priveleges.

Typically, grain markets are very thin, given that farmers market only a small proportion of their output. Due to the high cost of assembling such small quantities throughout a highly dispersed geographical area, there are not sufficient buyers. The local buyer himself may be very poorly informed on city wholesale situations. However, the city-based wholesalers or large collectors are usually more informed. This category of participants are usually involved in the transportation industry, owning one or several trucks taking consumer goods to the countryside and hauling back grain and other commodities. The city-based retailer and/or wholesale-assemblers, in addition to their information scale economy, have access to formal sources of credit.

The approach in this study as mentioned will be the extended (s-c-p) framework of a system driven by a three-term sequence of environment (E), behavior (B) and performance (P), or E-B-P.[6]

Here, environment (E) will be thought of as the aggregate physiological, biological, political, social, economic and transcendental overlapping opportunity set that is the outer and inner "boundaries of the possible payoff matrix for the society as a whole." Given his social and/or political clout and know-how, each individual will articulate his preferences and reach his goals through market, social and political transactions. This behavior is contingent upon the environment response in a previous situation, in terms of rewards and punishments. The structure of reward and punishment or, in other words, the structure of the incentives, is the driving force behind the individual behavior; the outcome of which is the performance of the system. (More on the conceptual framework of this paradigm can be found in A. Allan Schmid,[7] 1978; and J.D. Shaffer[8]).

The central role of marketing in the development process has not been recognized until recently.[9,10] There seems to be a growing concensus within and outside the profession of Agricultural Economics that

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[6]J.D. Shaffer, Food System Organization and Performance Toward a Conceptual Framework, AAEA Meetings, Atlanta, Georgia, December 1979.

[7]A. Allan Schmid, Property, Power, and Public Choice: An Inquiry Into Law and Economics, P. Publishers, Inc., New York, 1978.

[8]J.D. Shaffer, "Observations on the Political Economies of Regulations," Journal of Agricultural Economics, Vol. 61, No. 4, Part 2, November 1979.

[9]Uma Lele, "The Design of Rural Development Lessons From Africa," World Bank Research Publication, Johns Hopkins University Press, 1975.

[10]Harold M. Riley and Michael T. Weber, "Marketing in Developing Countries," Working Paper No. 6, MSU Rural Development Series, 1979.

marketing should be regarded as a dynamic dimension in the development process.

Increased output can certainly be achieved through increased use of "high payoff technologies" to boost production. Undoubtedly, if there exists some inefficiency in changing the form of the product and in transferring ownership in temporal and spatial dimensions, the amount of losses could be as high as 30 percent (J. Mellor, 1966, p. 328). While increasing the production of any given crop in any given year by 10 percent can be regarded as an unbearable task; losses of that magnitude can occur in any given year with the failure of the marketing system.

In addition to expanding the availability of the output through the reduction of losses, improved marketing raises the economic value of the output through increasing consumer satisfaction by making it available in the form, place and time most agreeable to consumers.

Furthermore, improved marketing through increasing both the farm level demand and the effective retail level demand is expected to give enough incentives to producers to respond positively to price increase. Lower marketing costs, if passed on to consumers, given the relatively high price and income elasticity of food demand in most developing countries,[11] will increase demand with subsequent increases in output and in the price received by farmers.

As development proceeds, marketing service demand in terms of creating time, place, form and ownership utilities, is expected to

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[11] John W. Mellor, The Economics of Agricultural Development, Cornell University Press, Ithaca, New York, 1966.

_____, The New Economics of Growth, Cornell University Press, Ithaca and London, 1976.

increase due to the necessary division of labor, rising income and increasing urbanization, and the steady rural-urban migration.[12]

Whether or not the supply side will be adequate will largely depend on a host of factors centered around the actors' perceptions of their payoff matrix.

According to Adam Smith:

> And thus...the certainty of being able to exchange all that surplus part of the product of his own labor which is over and above his own consumption, for such part of the product of other mens' labour as he may have occasion for, encourage every man to apply himself to a particular occupation and to cultivate and bring to perfection whatever talent or genius he may possess for that particular species of business.

(The Wealth of Nations, Book I, Chapter III, p. 21.) This concept on the determinant of the division of labor is central to the incentive and power structure conducive to increase in wealth and development of individuals and nations.

While growth is often considered as an increase in the aggregate output of goods and services in an economy, with no mention about their distribution, this study will attempt to define development as a sustained increase of the per capita production and consumption of goods and services in an economy.

These goods and services will encompass such items as: food, health, services, clothing, education and leisure. The definition of development used here will include both an increase in the aggregate size of these goods and services as well as their size distribution. In other words, who produces what? Who gets what? How much of it, at what cost? Etc. Thus, the concern here will be with efficiency as well as the equity dimension of the development equation.

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[12] H. Mittendorf, "The Challenge of Organizing City Food Marketing Systems in Developing Countries," Zeitschrift fur Austandisehe Landwitztschaft, 17 Jahrgong, Heft 4 October-December 1978.

It may not be redundant to recall here that whatever the state-of-the-art may be, regardless of the social and political system, increased and sustained physical and biological capacity of the agricultural sector and its output have historically been the cornerstone of any "successful" development.

Early development economists in the mid 1950s[13,14] operated on the assumption of disguised unemployment in agriculture (zero if not negative marginal product of labor in agriculture) and advocated urban industrial led growth models. To their deception, there was not any significant surplus labor force that could be captured (at least in some period of the year).

The importance of agriculture and marketing is so manifest that even these authors recognized that if industry could be the engine of growth, sustained agricultural output is a necessary precondition which will provide the "chassis and the tires" to support the engine in a smooth run. These authors saw the "chassis and tires" in terms of cheap food from the rural area to the city-based industrial workers so that the output of the industrial sector could expand at low costs.

While the industrial sector's role in development has not yet gathered momentum in most of the LDCs including Niger, a cheap food strategy did more harm than good to the welfare state and growth in these countries through distortion of incentives and city-biased

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[13] Fei, J.C.H. and Ranis, Development of the Labor Surplus Economy, R.D. Irwin Publishing Company, Homewood, Illinois, 1964.

[14] W.A. Lewis, Economic Development with Unlimited Supplies of Labor, The Manchester School, XXII, May 1954.

_____, Unlimited Labor, Further Notes, The Manchester School, XXVI, January 1958.

development strategies linkages (T.W. Schultz,[15] J. Mellor,[16] Uma Lele[17] and C.K. Eicher,[18] etc.)

Thus, incentives established through "correct price signals" seem to have historically helped to build up a powerful agricultural system capable of sustained increase in output.[19]

The biological nature of the food system in developing countries (LDCs) is highly risky and "trapped at low-level equilibrium traps."[20]

Institutional externalities and market inefficiencies (especially in Niger and the Sahelian Nations) cloud the message carrying capacity of prices through the long tunnels of a highly fragmented marketing channel.

From the classical to the neoclassical economists, there is a steady growing concensus that the structure of incentives is central in

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[15] T.W. Schultz, On Economics and Politics of Agriculture in Distortion of Agriculture Incentives, Indiana Press; and Transforming Traditional Agriculture, New Haven, Connecticut: Yale University Press, 1964.

[16] J. Mellor, Facing the Food Challenge in Sub-Saharian Africa, Statement to the I.F.R.I. Board of Trustees Meeting at the University of Ibadan, Nigeria, 1981.

[17] Uma Lele and Wilfred Candler, "Food Security: Some East African Considerations," in: Food Security for Developing Countries (edited by Alberto Valdes), Westview Press, Boulder, Colorado, 1981.

[18] Carl K. Eicher, et al., Employment Generation in African Agriculture, Draft, Michigan State University, March 17, 1970.

[19] T.W. Schultz, "On Economics and Politics of Agriculture," in: Distortion of Agriculture Incentives.

[20] The term was first used by T.W. Schultz to describe the fact that in "traditional agriculture" the level of technology is low and remained unchanged for long periods of time so that the law of diminishing return sets in early in the production process.

encouraging every man in any society to apply himself in the perfection of whatever talent he may possess.

However, central to the wealth and well-being of individual and society market incentives alone may not lead to a pareto optimal welfare state in the society, given many of the assumptions of the first best pareto allocation, do not stand the empirical test. For example, there is differential endowment among individuals, and furthermore, rather than being given the endowment is endogenous to the system. Individuals are not all as well informed; market mechanisms alone would only distribute that information according to the individual's real income. The interdependence of utility among individuals and the ubiquitouness of risk and uncertainty calls for the need of allowing nonmarket forces to play as countervailing power[21] in the preference articulation.

The need of incentive and a danger of letting the market forces to play undisturbed is dramatized by this quote from Wassily Leontief, 1974,[22] "The profit motive is the wind that fills and propels the vessel." Milton Friedman repeats again and again that "the profit motive is the powerful driving force of the economy...." He also insists that we should abandon the vessel to the whims of the winds and let it go the direction in which the wind happens to be blowing.... "Follow this advise and the ship will quickly land on the rocks...."

In the next section, performance, dimensions, marketing channels and the actors' behavior of the Nigerien food crop subsector will be presented.

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[21] J.K. Galbraith, The New Industrial State, Houghton-Miflin Company, Boston, Massachusetts, 1967.

[22] Wassily Leontief, "What an Economic Planning Board Should Do," Challenge, July-August 1974, pp. 35-40.

3.2 Performance Dimensions

The system would be labeled as an improvement relative to the existing conditions, if it helped to meet some desired societal goals or objectives. Notwithstanding that goals and/or objectives have to be defined politically, a necessary normative approach is adopted here to give a general set of goals conducive to an improved food production and distribution system in the Nigerien context.

Food security has different meanings for the different participants of the system:

(1) For the city-based consumers, food security means abundant supply of food at low and stable prices.[23] However, city-based consumers often occupy a privileged position in the system due to their power in influencing the political preference articulation in favor of their vested interest.

(2) For the farmers (the overwhelming majority of the Nigerien population) low stable food price, in a world of skyrocketing inflation, would mean a serious deterioration of their purchasing power and the fall in their real income would mean food and nutrition insecurity in general. This group, being at the periphery of the system, lacks the political clout and interest needed to influence the system through voice articulation. Yet, they do have the exit option which does not help as a recuperation mechanism of the deteriorating food situation. (Albert O. Hirschman, 1970[24])

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[23]Ammar Siamwalla and Alberto Valdes, "Food Insecurity in Developing Countries," Food Policy, Vol. 5, No. 4, November 1980, p. 262.

[24]Albert O. Hirschman, Exit, Voice, and Loyalty, Harvard University Press, Cambridge, Massachusetts, 1970.

The exit option takes the form of producing for their own subsistance, taking only fewer and fewer quantities of their output into the marketplace, and hence, does not contribute to satisfying the urban food demand which seemingly is the overriding concern of the public sector. This last point is exemplified in the following quote from Alberto Valdes and Ammar Siamwalla (1980):

> Most governments seem helpless in dealing with the complexities of food insecurity in the rural areas. The complexity arises not only from difficulty of transportation and other physical constraints, but also from the more difficult economic problem of providing affected households with adequate purchasing power at times of crop failure. It is partly for this reason that government action on food security has historically concentrated on meeting urban demands.

Despite the complexity of the problem and conflicting interests, the following objectives could provide a unifying strategy in meeting the stated desired goals:

(1) Provide an abundant and reliable supply of food at economically affordable price to the consumer, so as to meet their physical, psychic and biological food requirements.

(2) Provide enough incentive to the different agents involved in the production and distribution of food through "correct price signals," i.e., reflecting the relative costs of production.

(3) Reduce market uncertainty through an adequate information system, grading and standards, and an official recognition of the activity of the different participants.

(4) Help create an environment which would enhance the peasant risk taking ability such as adoption of new "unproven" technology through risk pooling structure.

(5) Help create more employment in the rural area so that to reduce sensibly the rural urban migration pattern.

(6) Encourage the sense of belonging among the actors in the system so that private interest can less sharply oppose social interest.

3.3 The Nigerien's Millet and Sorghum Marketing Channels

Figure 3.1 shows the participants of the Nigerien's millet and sorghum marketing system and the functions they perform. The figure is drawn such to show distinctively the separations between the private sector marketing system and the public sector with its parastatal monopsony and monopoly. The section from the middle top right to the middle bottom right is the private sector loop. The middle top left to the middle bottom left is the public and/or parastatal sector. The continuous lines represent the flow of the output of millet and sorghum; the thickness of these lines represents the relative size of the flow. The broken lines are input flows; their thickness here again represents the relative importance of the flow.

A description of the channel actors and their functions from the bottom to the top follows.

3.3.1 Millet and Sorghum Growers

By and large, farmers are the largest body of participants in the system. They are numerous, representing over 80 percent of the total population. They are quasi-illiterate, live in small villages, on small and highly scattered farms, with average farm size varying from three to five ha. (7-12 acres). These farmers live in a near subsistance economy, depending on where they are located relative to large cities and the main roads.

Given the ubiquitous risk factor that surrounds their environment, they have developed some strategic responses over time as reinforcement

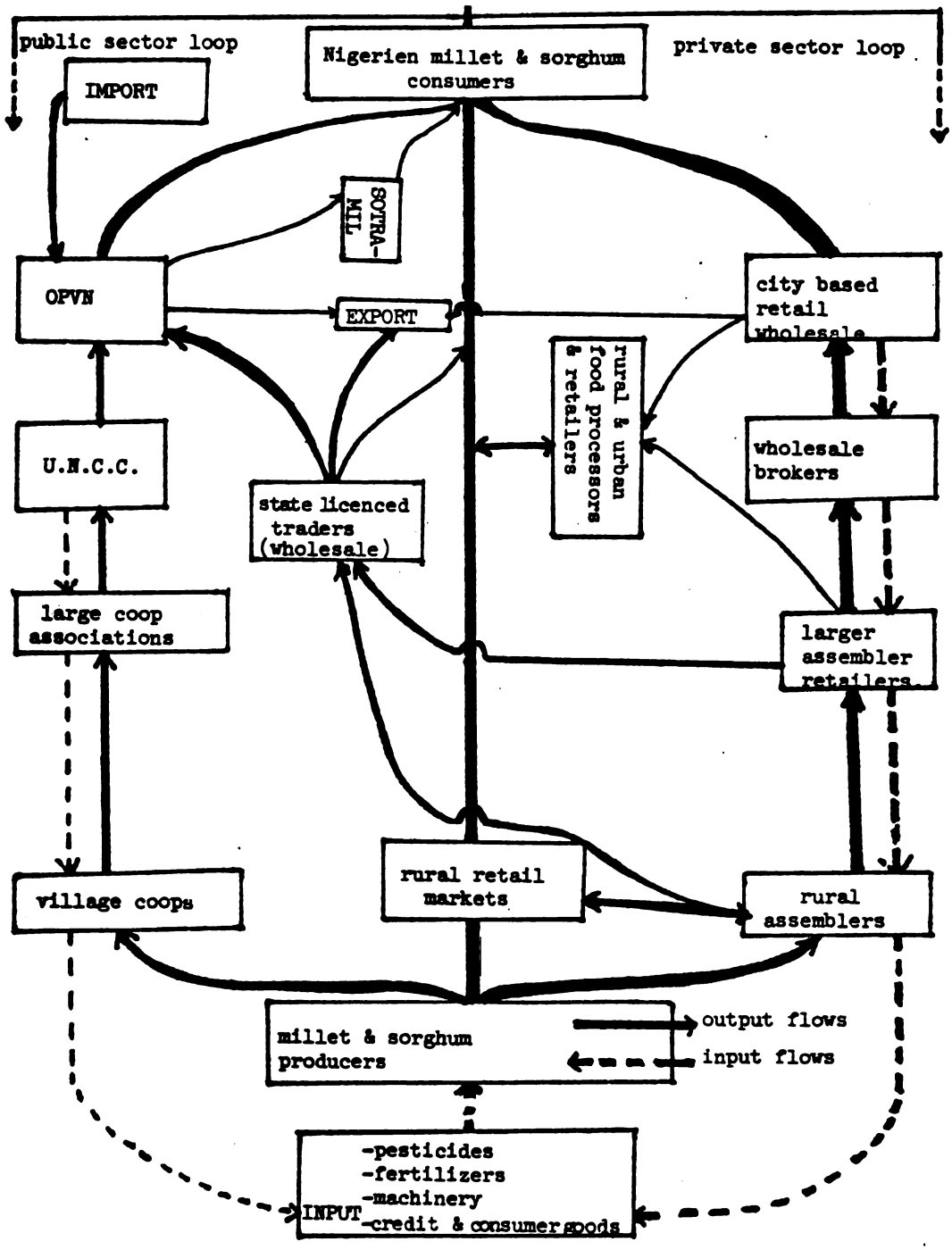

Figure 3.1

The Nigerien Millet and Sorghum Marketing System

of the contingencies[25] for survival in their environment. The following are some of their characteristic attitudinal responses.

(1) Storage of their food in their own field or house.

(2) Mixed farming, to minimize the risk of crop failure and/or large price variations, and also as a labor saving device. (Labor which is their single most important factor of production is "over" demanded in certain periods of the year.)

(3) Take only small quantities of their marketable output into the marketplace in order to get cash for basic transactions (consumer goods, taxes and other cash requirements).

(4) Reluctance to adopt new technology, given their limited leverage, the "margin of error is reduced as the ratio of purchased inputs to output increases."

(5) Reliance on the village community rules and sharing arrangements, which often times do not involve monetary transactions, yet governed by mutual respect and reciprocity, which are central to the incentive system.

(6) Repetition over time of the positive reinforcers that shaped their last successful performance in whatever transaction they may have been involved. That contingency of the reinforcement in Skinnerian[26] terms is a strong barrier when it comes to trying to change their behavior from the outside (i.e., adoption of new untried technology). This resistance to change, which certain authors qualified as signs of laziness and/or of irrationality may actually stem from sound economic and

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[25]In J. Platt terminology, pleasure and pain are important because they are involved in the process of shaping behavior through reinforcement, not as the motivation of the behavior. Through control and response, to the shaping of forces, contingencies of reinforcement are designed.

[26]J. Platt, The Skinnerian Revolution, in Beyond the Punitive Society (ed. by Harvey Wheeler), W.H. Freeman and Co., San Francisco, 1973.

social rationality, as put by the late Professor John M. Brewster,[27] given the realities they face in their environment.

(7) Reliance on the village money lender. Formal agricultural credit sources, be they from the local governments or from outside sources, due to their fungibility seem not to have reached the target population despite their lower costs.[28, 29] In addition to the fact that these sources of credit are denied to farmers, the farmers do not rely heavily on them even if credit was readily available. For example, in its report, the MSU team[30] reported that more than four-fifths of the credit readily available at 5.5 percent interest has not been taken by the farmers. They noted that during the same period, in the same area, "traditional" lenders were charging interests as high as 140 percent.

Looking more closely at this situation which may apparently be regarded as irrational, actually stems from sound economic sense. The village money lender is not prescriptive when solicited for a loan. Neither would ask, nor does he prescribe, the use in which that money ought to be put. Thus, the money can be used for a second or third marriage, for the wedding expenses of the son or the daughter or other social expenses that rank high on the utility surface of the borrower.

The money lender will give the loan as long as he judges repayments highly probable without tying the loan to the purchase of some

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[27]John M. Brewster, Traditional Social Structure as Barriers to Changes, Chapter 3, p. 67.

[28]Dale W. Adams and J.D. vonPischke, "Fungibility and the Design and Evaluation of Agricultural Rural Credit Projects," American Journal of Agricultural Economics, Vol. 62, No. 4, November 1980.

[29]Claudio Gonzalez-Vega, "Interest Rate Restriction and Income Distribution," American Journal of Agricultural Economics, Vol. 59, No. 5, December 1977.

[30]Thomas Stickley, "An Analysis of the Agricultural Credit System of the Eastern ORD of Upper Volta," Final Report, MSU/AID/Afr. C-1314 Contract, August 1980.

agricultural inputs (seed, fertilizers, pesticides, oxen and materials, etc.). The reliability and discretion of the traditional source creates long-lived relationships between the lender and the borrower, complexities and mutual trust that gives rise to loyalty. Thus, under such conditions it is not at all surprising that peasants are reluctant to turn down their loyal, reliable, reachable source of supply, to turn toward another low-cost, but selective and hardly reliable source of supply.

The MSU team also reported high loan repayment delinquencies (48 percent of the borrowers were delinquent). This empirical evidence shows what kind of risks the traditional money lender is taking in providing his service. The team also reported the eventual intervention of government agencies to enforce loan collection. A peasant who may fail due to illness or bad harvest may find himself struggling with government collection agents and that to the borrower may mean disgrace in the village community with no where to go, having cut relationship arrangements with the high cost and reliable and "unconditional" village lender. (By unconditional it is not meant that the village trader lends out to anyone.) Thus, this attitude of the peasant can be explained on the grounds of his bounded economic rationality of "satisfying rather than maximizing behavior." There, the peasants instead of maximizing short-term low cost loans, have preferred to minimize the uncertainty of long-run supply.

The same is true for grain and other deals between peasants and the village traders. The peasants don't trust those sitting in air-conditioned offices who make policy decisions with sometime no means of enforcing them and who sometimes never show up to buy the commodity for

which they set a high price, thus leaving the peasant with his product and his cash and other financial needs not met. Thus, farmers prefer to sell to the village trader who buys in any given year, however, at low prices even in the most remote area.

These examples show how farmers' risk management strategy, linked with their loyalty to their own institutions, can be a serious problem in trying to induce change in the peasant life.

In selling their product and buying consumer goods, the millet and sorghum producers face government and/or private monopsony or monopoly, respectively. Farmers seem to be powerless price takers and the most highly vulnerable body of the system participants.

3.3.2 The Village Traders

A body of industrious people living in rural communities make up village traders. There they try to maximize their profit in performing valuable functions such as buying and selling. In the rural communities these people lend money and usually claim loan repayment at high interest rates, repayment taking place during the low harvesttime price.

These traders provide consumer goods at a relatively lower cost had each single buyer had to go to the nearest city to supply himself. These "lower prices" remain, however, quite high compared to what they might be under alternative conditions.

In the absence of hard empirical facts it is not clear whether the aggregate social welfare is improved when one takes into account the different dimensions of the village traders' benefits and cost matrix and the societal costs and benefits, given the environmental constraints. A closer look at the middle-man technology (input/output ratio) may well show that these village traders are performing quite "efficiently" in

a static sense, but simply trapped at "low level technological traps." It would seem that there is room for improvement through modifying the structure, the institutional boundaries and institutional innovations which would induce responsive preference articulation by the actors, given a well-defined payoff matrix.

The village traders are often times linked to some powerful city-based wholesalers who provide them capital and logistic assistance (i.e., trucks to collect grains). These city-based wholesalers are, of course, linked in a dynamic sharing behavior with the city-based technostructure.

In aggregate, the traditional merchants are numerous. Yet, in most villages and large cities, they are few. In some remote villages the village trader is the only seller of certain consumer goods (salt, matches, soap, etc.). They are also the only or the one among a few providers of credit and buyers of the commodities farmers are willing to sell.

Given the time and space dimensions, in addition to some institutional realities such that the existence of hierarchy of roles in the society as defined by Castes, many of the village traders enjoy monopolistic and/or monopsonistic privileges.

The issue is not whether or not they are monopolistic and should or should not be abolished; the real problem is first to reorganize the nature of the invaluable services they render to the society and the need to improve the distributional efficiency of the functions they perform. On well-known general grounds, there seems to be no doubt as for their superior technical efficiency (in static terms) as compared to the parastatal organizations; for example, due to differential incentive structure, the attitude of the private sector traders and their public sector

counterpart is very different. While the private trader will react quickly to face the problem of a deteriorating stock of grain by selling it expediously at what the market bears at the time or engage in a timely remedial operation, the public sector, due partly to bureaucratic decision lag and some spurious motives beyond efficiency considerations, the stock will likely deteriorate and the report will mention it, leaving room for embezzlement. In the domain of transport, private trucks are better maintained and the managers are concerned about minimizing average transportation costs by seeking back hauling opportunity. In the public sector there is not such an incentive, given that the empty cargo space can be used by officials or the drivers for their own business.

In concluding this section it will be pointed out that the traditional traders do provide invaluable services to the community with some degree of technical efficiency, yet, there is room for improvement on both the grounds of technical and distributional efficiencies by removing or aleviating some of the environmental and institutional constraints that surround their business.

3.3.3 The Small Food Processing and Retailing Industry

Here the term industry may not technically be correct, given the differentiated nature of the commodities offered; product group may be more appropriate. Yet, in this study the two terms will be used interchangeably.

These participants of the system are engaged in milling, oil extracting and prepared foods of various types, of away-from-home feeding establishments. They are generally very small, operating on little capital, with mostly local technology, and seemingly with little help

from the institution as far as access to capital and new technology are concerned.

These participants are believed to perform quite efficiently, albeit the harsh environmental and institutional barriers they have to face.[31]

3.3.4 The Millet and Sorghum Consumers

The largest body of millet and sorghum consumers resides in the rural area. However, effective demand for these grains is mainly centered in the cities. As pointed out earlier, even though farmers do store most of the required grain, some of them may be buying grain in the local markets at high "soudure" prices because of short harvest, mistakes or obligations to have sold more than they should have at harvesttime.

3.3.5 OPVN (Office des Products Vivriers du Niger)

OPVN is the Nigerien parastatal food grain marketing board created by Law No. 70-17 of August 1970 and Decree No. 70-228/PRN/MER of October 1970, fixing it responsible for:[32]

(1) Organizing and improving the marketing of staple food crops (millet, sorghum, maize, wheat, cowpeas, etc.).

(2) Establishing annual estimates of both food resources and requirements on the basis of which storage, import and export operation will be monitored.

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[31]Enyinna Chuta and Carl Liedholm, "Rural Nonfarm Employment: A Review of the State-of-the-Art," MSU Rural Development Paper No. 4, 1979.

[32]The English translation of the Decree No. 70-228/PRN/MER of October 1970 is from the University of Michigan CRED Study, op. cit.

(3) Build regulatory stock for the purpose of: (a) stabilizing both producer and consumer prices; (b) insuring interregional equilibrium of food resources and requirements within Niger; and (c) participating in a multinational program of price stabilization and harmonization of trade.

(4) Make all useful propositions with an aim of organizing and controlling the markets of staple foods and their derived products.

(5) Create and guide the direction of enterprises involved in the processing of staple foods within the conditions defined by the government.

(6) Assume the preparation and execution of food aid programs established through national or external means.

(7) Foster or assist in the favorable development of the cooperative movement.

The "journey" for OPVN, as described by this decree, is not a short one indeed. The task is formidable for a single organization to carry out with any significant degree of efficiency. Since its creation, OPVN received assistance from several organizations, either directly from the government or through bilateral or multilateral agreements. The assistance came from: The United States Agency for International Development (USAID) through PL 480, The Canadian Agency for International Development (ACDI), West Germany and other European countries in the form of grants, including food, logistic means and also technical assistance.

Due to the already sketched reasons for nonefficiency maximizing behavior on the part of such a public organization and the failure of the institution to internalize the cost of the mistake to the actors,

OPVN's performance has left much to be desired. An assessment of that organization's performance can be found in some detail in CRED Study, 1977; and David Wilcock, 1978.

OPVN gets its supply from UNCC's cooperatives, state-licensed traders and, as already stated, from grants and government subsidies. Among all of its tasks as set by the decree, attempts to stabilize the price of grain has been the major concern of OPVN. Given its narrow market share, OPVN price stabilization attempts have not had any significant impact on the price of grains.

Its emergency stock operation may have worked quite satisfactorily in larger cities and where the road network is good. Its impact on price and food availability in more remote areas is not well-established. The monopoly power granted to OPVN and government regulations which force OPVN to sell grain nationwide at the same price, make it likely that OPVN can only survive through grants and subsidies with subsequent incidences on other sectors of the economy.

3.3.6 SOTRAMIL

SOTRAMIL is another parastatal enterprise involved in the processing of millet and sorghum into flour, biscuits, noodles, etc. In addition to the government of Niger, shareholders include: The Nigerien Peanut Marketing Board (SONARA), The Nigerien Organization of Commerce and Production (COPRO-NIGER), The Nigerien Development Bank (BDRN) and other private companies.

Given its small size, only one single small factory, its lack of qualified personnel and some consumers' preference-related problems[33]

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[33]Bonnie Ann Stewart, op. cit.

and outside competition, SOTRAMIL's impact would seem to be quite marginal in influencing the Nigerien millet and sorghum subsector at any level.

As noted by Bonnie Ann Stewart (p. 121), even the target of processing 2,000 MT of flour in its 1977-78 objectives will not likely be met. Even if the 2,400 MT required to process the 2000 MT of flour were bought, this would be only a negligible portion of the marketed millet and sorghum output which in 1977-78 was more than 176,600 MT (assuming 12 percent of the year's output has been marketed). SOTRAMIL received its supply of grains from OPVN, UNCC cooperatives and traders in the local markets. As for the other parastatal organizations, SOTRAMIL enjoys access to formal credit and other tax alleviations for its import of raw material.

3.3.7 UNCC and the Village Cooperatives

Founded in 1962 and reorganized in 1966, the Nigerien Union of Credit and Cooperatives (UNCC) is another parastatal organization with granted monopoly power in providing inputs such as fertilizers, pesticides, machinery and credit to the rural community of Nigerien farmers.

As defined by the law of 1967, the UNCC functions are as follows:

(1) Promote the creation and help implement the management of cooperatives in areas where they still do not exist.

(2) Assist member cooperatives in the marketing of their products.

(3) Supply member cooperatives with the necessary agricultural inputs and the necessary technical assistance.

(4) Manage irrigation "perimeters" and other government projects.

To carry out these tasks, UNCC was organized in four "divisions," with specific responsibilities.

The Production Division was entrusted with planning and controlling the execution of various programs (mainly irrigation "perimeters") and also the research of ways of improving productivity.

The Cooperative Division was in charge of promoting the establishment of cooperatives from "mutualist" groups. The cooperative groups are organized in three levels: (1) the village mutual group (GMV); (2) the village cooperatives (VC); and (3) the local cooperative associations (LCA).[34]

The Administrative and Financial Division functions are to administer all financial and administrative matters of the organization.

The Credit Division which was responsible for establishing terms of credit and preparing loan applications was transferred to the National Agricultural Credit Fund (Caisse Nationale de Credit Agricole - CNCA) which is a government-owned agricultural bank. CNCA carries its loan activities by serving as intermediary between the development bank (BDRN) and the central bank, BCEAO and UNCC. There are some inconsistencies and sources of disincentives in the UNCC/Village Cooperatives Organization.

In most of the irrigated perimeters, UNCC claims fee payments in kind, at the government set price which is lower than what the product could sell in the open market. This constitutes a subject of frequent disagreements between farmers and UNCC officials. In the provision of inputs, such as peanut seed, the interest rate is quite high since it involves repayment in kind of the seed with 50 percent interest (Bonnie A. Stewart, 146-147). This certainly is enough of an incentive to

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[34]For more detail on the organizational structure of UNCC, see Guy Belloncle, Cooperative et Development en Afrique Noire, Sherbrook, 1978.

induce farmers to seek other alternatives, including withdrawal from the cooperative and purchasing zero level of the input from UNCC.

Loan repayment delinquencies, delays in processing loans and the delivery of inputs at the right time, quantity, place and quality have also been and still are an impediment to the performance of the organization.

3.3.8 The State-Licensed Traders

This body of participants may appear to be the most powerful in the whole system. They are quite industrious, possess a diversified business, including usually a transportation component, consumer good delivery system and grain and other agricultural product trade. Often times they are linked with the city-based bureaucracy, have access to formal credit and may as well have strong linkages with businessmen outside the country. Through their licenses these traders take full advantage of their granted monopoly power.

As we consider Figure 3.2, one can see the strategic link position they enjoy by being the only recognized and legal bridge between the private sector and the public sector marketing loops where they are represented at various levels in both loops through their agents.

The power of these participants is magnified by their information-scale economy, because when they do not live in the capital city, they are likely to make several quarterly trips to the capital city where they can get the information right at the "source" from the bureaucracy and other business-like sources. In addition, they can significantly influence the system by obstructing the distribution phase, given they are likely to control a large share in the transportation industry.

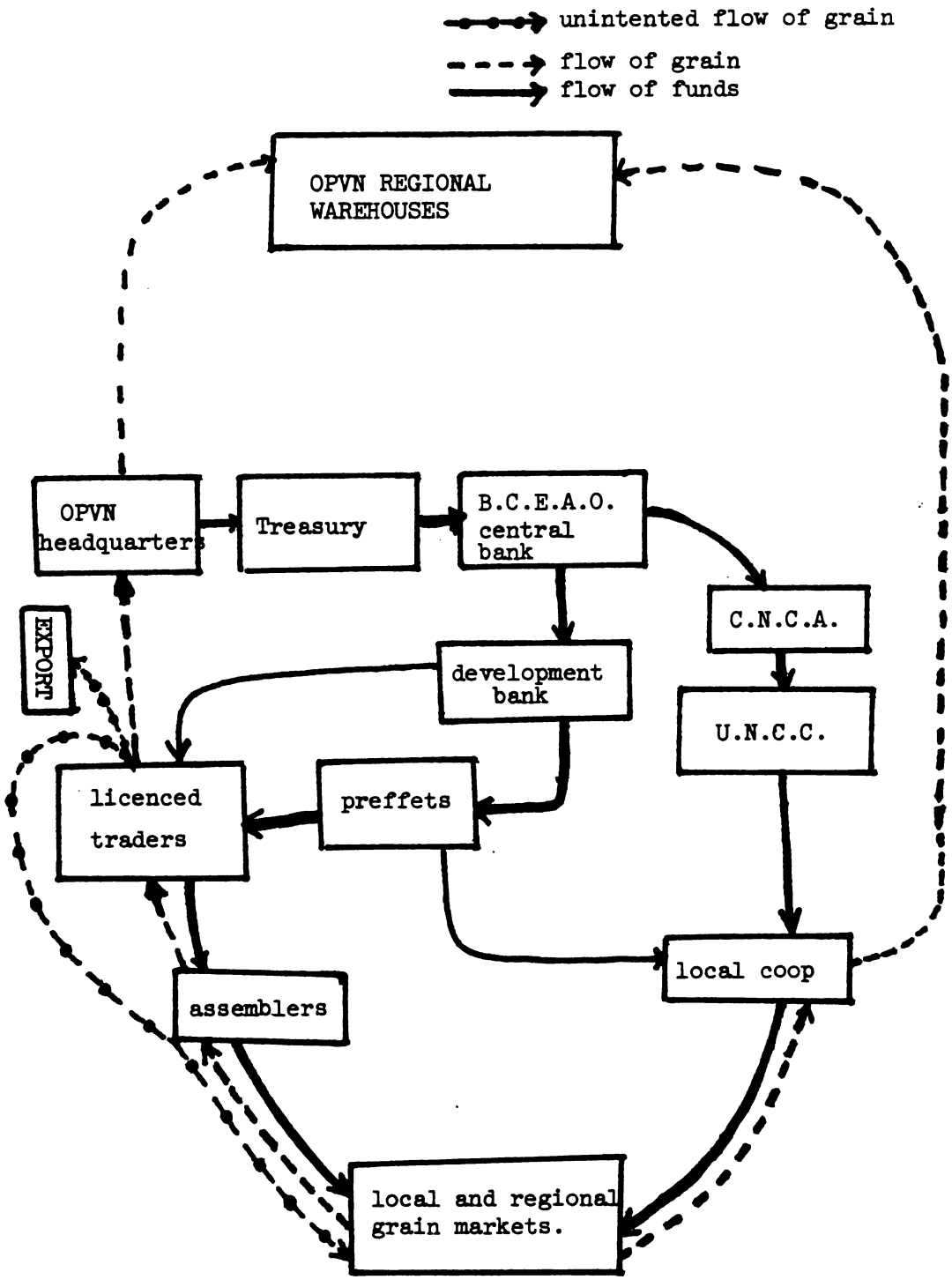

Figure 3.2

The Parastal Marketing Channels

Under the actual state of affairs, it would seem very difficult to prevent these participants from exploiting their monopoly power. In their buying activities they do not usually use scales, thus leaving room for producer rip-off. The lack of standards and norms makes it likely that large amounts of foreign matters are shipped along with the grains and thus adding to the cost of the system.

Also, given their likely good storage capacity and their linkages with the businessmen in neighboring countries (mainly Nigeria), they use their monopoly power to buy the grain at the state fixed price, if not lower, and sell it to OPVN with an agreed upon margin. As long as the grain supply conditions are good within Niger and abroad, they will likely sell to OPVN. However, when they feel better opportunities, they will not sell to OPVN and would rather export it or put it back into the system through their brokers and other "bush collectors"[35] and small retailers. This sequence is what is represented by the dotted lines designated by unintended flow of grain in Figure 3.2 in the sense that according to the contract with the state, these licensed traders should deliver all their purchases to OPVN.

Figure 3.2, in which these licensed traders occupy a well-privileged position, shows also how rigid, complex and full of bureaucratic lags the public sector marketing can be. The prefects who are the regional governors choose who is to be granted the privileges of being a licensed trader. The prefects also handle all monetary transactions between the bank, the trader and UNCC cooperatives. The complexity and confusion

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[35]The designation of bush collector is commonly given to small traders, either in the grain or livestock sectors, who usually live in small villages, trading consumer goods and collecting grain or livestock products.

created by having the prefect designate the licensed trader and also hold such an important position in the middle of the financial transaction add enormously to the cost of the system in terms of transaction costs.

Any measure which would increase the number of traders by giving to a great many more of them the opportunity of entering the formal credit market would enhance the efficiency of the system through increased competition. Getting the prefects out of the direct handling of the money and have them rather perform the role of arbitrator would likely enhance the performance of the system through reduced transaction costs and reduced bureaucratic decision lags.

CHAPTER IV

METHODOLOGY

4.1 Review of Agricultural Supply Studies

Knowing the price responsiveness of marketable surplus is crucial in assessing overall supply responses and to guide policy. Yet, marketed surplus estimates in subsistance economies are difficult.

Overall, analyzing supply responsiveness, be it for the aggregate supply or the supply of some given individual commodity, has long been a subject of controversy inside and outside the profession of agricultural economists. The controversies are of several natures.

(1) Disagreements arise on the estimate of the magnitude of the supply responsiveness to price changes. Askari, Cummings and Harik (1976)[1] found wide-range variations in the millet acreage response price elasticities ranging from .54 to 1.78.

(2) The direction of the responses, albeit the universal validity of the law of supply and ample empirical evidence (T.W. Schultz[2] and Krisma[3]) as of the unquestionable managerial ability of subsistance farmers to respond to economic incentives remains an unsettled matter.

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[1]World Bank: "Methodologies for Measuring Agricultural Price Intervention Effects," World Bank Working Paper No. 396, June 1980, pp. 74-75.

[2]T.W. Schultz, Transforming Traditional Agriculture, New Haven: Yale University Press, 1964.

[3]Rajs Kvishna, "Agricultural Price Policy and Economic Development," in Agricultural Development and Economic Growth, ed. by H.N. Southeworth and B.F. Johnson, Ithaca: Cornell University Press, 1967.

Widely varying negative supply responses to price ranging from -25 to -.85 are being reported in the literature.[4]

(3) Even the relevance of supply elasticities, for policy purposes, has been challenged by economists.[5, 6] Along these lines, there still remains methodological problems rising out of the length of the run, normative and positive concepts distinguishing between supply function and response function.[7] Asset fixity theory, which derives a partially irreversible supply, poses the question of the point at which supply elasticity will be computed, given the differential elasticity between price increase and price decrease, and also the erratic nature of such a partially irreversible supply. Measuring the responsiveness of home consumption and the marketed surplus in the context of developing countries is even more difficult and less reliable. Some of the reasons for these difficulties include: lack and inaccuracy of data, methodological belief or irrationality on the part of subsistance agriculture farmers, etc.

Yigiro Hayami, et al.,[8] using indifference maps analysis, showed as expected that a price change actually embodies two effects: (1) a

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[4]World Bank: "Methodologies for Measuring Agricultural Price Intervention Effects," op. cit.

[5]T.W. Schultz, "Reflection on Agricultural Production, Output and Supply," Journal of Farm Economics, Vol. 38, p. 748f.

[6]Glenn Johnson, "The Dynamics of Supply: Estimation of Farmers' Response to Price," a book review, in Agricultural Economics Research, January 1960.

[7]Willard W. Cochrane, "Conceptualizing the Supply Relation in Agriculture," Journal of Farm Economics, Vol. 37, 1955, pp. 1161-1179.

[8]Zenaida Toguero, Bart Duff, Teresa Anden, Lassina and Yuigiro Hayami: "Marketed Surplus Functions for a Subsistance Crop: Rice in the Philippines," American Journal of Agricultural Economics, Vol. 57, No. 4, November 1975, p. 705.

substitution effect which would shift consumption in an opposite direction to the price change; and (2) an income effect which increases the quantity of home consumption (sorghum and millet assumed to be normal goods). A simplifying assumption in their model is that, given the individual is deriving utility from consuming both rice and other goods, rice is considered to be the sole source of cash income. These authors found a composite response of the total supply of rice:

(1) The partial price elasticity for the marketable portion of supply.

(2) The elasticity of marketable surplus to total output.

They found a highly significant response for the output elasticity of marketable surplus, which is greater than the proportional output increase.

Their estimate of the home consumption elasticity showed some interesting results: (1) The short-run response of home consumption is negatively related to price changes. This is in conformity with the theory that suggests that for a normal good such as rice the substitution effect is in opposite direction of the price change. (2) The short-run elasticity of home consumption to change in the level of output is found positive, while the long-run effect is negative. This can be explained by the particular functional form used and also due to the fact that in the long-run, a certain level of saturation beyond which home consumption is no longer sensitive to the level of output is reached.

Their conclusion was that the price response of the marketed surplus, though weak, remains definitely positive contrary to what some authors have traditionally believed.[9]

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[9]P.N. Mathur and Hannou Ezekiel, "Marketable Supply of Food and Price Fluctuations in Developing Economy," Kyklos 14 (1961), pp. 336-406.

The positive response of home consumption relative to the level of total output may well partly offset the price responsiveness and lower the total response to price change. Thus, when dealing with supply responsiveness in subsistance agriculture, these might be offsetting effects should be kept in mind when comparing various price intervention tion policies.

The majority of supply responses studies concentrate on yields and/or acreage responses, since aggregate production of any crop is the product of yield per unit area and the total area.

Glenn Johnson[10] pointed out that given the many fold and interacting factors that affect supply, attempts to explain agricultural supply response with any one factor will not succeed.

Price-cost relationships are necessary, but not sufficient conditions to explain agricultural supply response. The addition of technology, opportunity for trade, risk and undertainty dimensions, asset holdings and asset fixity[11] concepts are necessary.

Heady[12] attests the price responsiveness of agricultural supply and attributes the short-run, low supply elasticity to: (1) low reservation use for labor; (2) capital limitations; (3) risk premiums; (4) fixed short-run production function, etc.

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[10]Glenn Johnson, "Supply Function--Some Facts and Notions," Agricultural Adjustment Problems in a Growing Economy, I.S.U., 1958.

[11]While fixed costs refer to costs which the farm-firm incures regardless of production levels; fixed assets refer to the farm fixed factors of production, such factors which marginal value product neither justifies intensification nor disposition.

[12]Earl O. Heady, "The Supply of Farm Products Under Conditions of Full Employment," American Economic Review, Vol. 45, No. 2, May 1977, p. 228.

In developing countries, and particularly for those Sahelian countries, weather-related factors play the single most determinant role in shaping supply responsiveness and farmers' behaviors in their rational expectation to allocate their factor of production (mainly labor).

John A. Becker,[13] recognizing the role of expected prices and change in relative products and factor prices, did not actually have a price variable in his equation. Yet, he used rainfall indexes to assess response of supply of millet and sorghum to rainfall variation in Niger. He concluded that producers do respond to incentives in the production of cereals, as measured by lagged rainfall.

Modern econometrics works (Nerlove,[14] Cagan[15] and Koyck[16]) recognizing the role of expectation in input allocations to carry out the productive process have shown that it is not only last year's or the two past year's prices which is important, rather, due to the social and institutional realities due also to the force of habit and behavioral responses to the constraints of the environment, and finally due to fixed technology in the short-term expectations are built in a recursive fashion, constantly adjusting for the errors made in predicting current events, giving more weight to earlier ones.

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[13]John A. Becker, "An Analysis and Forecast of Cereals Availability in the Sahelian Entente States of West Africa," AID/EM/AFR.E 73-20, 1974, pp. 144-145.

[14]M. Nerlove, The Dynamics of Supply: Estimation of Farmers' Response to Price, Baltimore: Johns Hopkins University Press, 1958. "Estimates of the Elasticity of Supply of Selected Agricultural Commodities," Journal of Farm Economics, 28, 1956.

[15]P. Cagan, "The Monetary Dynamics of Hyper-Inflation," in M. Friedman (ed.), Studies in the Quantity Theory of Money, Chicago: University of Chicago Press, 1956.

[16]M.L. Koyck, Distributed Lag and Investment Analysis, Amsterdam: Holland Publishing Company, 1954.

These authors have developed distributed lag models to explain supply relationships.

General forms are as follows:

$$(1)\quad y_t = \alpha + \beta_0 x_t + \beta_i x_{t-1} + \beta_i x_{t-2} + \cdots \beta_k x_{k-1} + \cdots \beta_\infty x_{\infty-1}$$

or

$$(2)\quad y_t = \alpha + \sum_{i=0}^{\infty} (\beta_i x_{t-1}) + u_t$$

or in most practical models the time lag is constrained to have a finite value.

$$(3)\quad y_t = \alpha + \sum_{i=0}^{K} \lambda^K (\beta_i x_{t-1}) + u_t$$

Where:

y_t = the supply of a given commodity;

x_t = the realized value of an independent explanatory variable at time t;

α, β = regression parameters;

u_t = random serially independent disturbance terms with mean zero and finite variance

The disturbance term is required to reflect the net impact of all other unspecified variables influencing y_t. It also takes care of some other specifications and problems of the model. (This does not hold true in some of these models where the disturbance terms are autocorrelated.)

In the Koyck model, the βs are assumed to follow some decay function such that:

$$\beta_k = \beta_0 \lambda^k \qquad k = 0, 1, 2, \ldots$$

$$0 < \lambda < 1$$

Given the restriction of the (λ), it can be seen that partial adjustment coefficient (λ) decreases geometrically as k gets larger, giving more weight to earlier events. The long-run multiplier, which is the sum of the βs, is a finite amount: the sum of an infinite geometric series.

$$(4) \quad \sum_{k=0}^{\infty} \beta_k = \beta_0 (1 + \lambda + \lambda^2 + \lambda^3 \ldots) = \beta_0 \left(\frac{1}{1-\lambda}\right) \qquad 0 < \lambda < 1$$

Due to the particular structure of the lag, the disturbance term is likely to be serially correlated, and given that these model-reduced forms are:

$$(5) \quad y_t = \alpha(1 - \lambda)\ \beta_0 x_t + \lambda y_{t-1} + u_t \qquad \text{where: } u_t = (v_t - \lambda u_{t-1})$$

The presence of a stochastic explanatory variable makes the model autoregressive and estimation using ordinary least square (OLS) techniques may be misleading.[17] For OLS estimations will not only be biased, but inconsistant as well and will remain inconsistant assymptotically (i.e., even if the sample size is increased infinitely).

The Cogan model, though being a first order autoregressive model in its reduced form, does not have a complex disturbance structure which makes it possible to use OLS and get consistent estimates.

$$5' \quad y_t = \delta\beta_0 + \delta\beta_i x_t + (1-\delta) y_{t-1} + \delta u_t$$

Shirley Almon[18] used a polynomial approach to distributed lag models. This model, not restricting the βs to geometrically decline as in the Koyck model, has the advantage to capture the "true" lag structure. This model, which resembles the previous models, has the following general condensed form.

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[17] Gujarati Damodar, Basic Econometrics, McGraw-Hill Book Company, 1978, p. 266.

[18] Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," Econometrics, Vol. 33, pp. 178-196, January 1965.

$$(6)\quad y_t = \alpha + \sum_{i=0}^{K} \beta_i x_{t-1} + e_t$$

or

$$(7)\quad y_t = \alpha + \sum_{i=0}^{K} (a_0 + a.i + a_2 i^2 + \ldots a_m i^m)\, x_{t-1} + e_t$$

$$\beta_i = a + a_1 i + a_2 i^2 + a_m i^m$$

The Almon Scheme assumes that the βs follow some polynomial distribution with degree m. The two major problems of the method are that the length (k) of the lag has to be specified in advance, and the degree (m) of the polynomial also must be specified. Apart from that problem, the model has the nice characteristics of yielding consistent estimators using OLS techniques.

4.2 The Economic and Statistical Models

Economic theory suggests that the market supply of any commodity is expected to increase as the price buyers are willing to pay increases, ceteris paribus.

In the literature revised heretofore, it was shown that many other factors affect the supply response (i.e., input-output relative price, the price of complementary and substitute inputs, the state-of-the-art, behavioral and psychological expectation, weather, government policies, etc.).

In this study, the economic relationships will be formalized in the following (three) behavioral equations:

$$(1)\quad y_t = f\,(y_{t-1}, Pms_{t-1}, PP_{t-1}, AR_t, QRF_t, T, QRF_i, D_i \ldots)$$

$$(2)\quad AR_t = f\,(AR_{t-1}, Pms_{t-1}, Pmr_{t-1}, QRF_{t-1}, QRF_i, T, D_i \ldots)$$

$$(3)\quad Q^S ms_t = (Y_t * AR_t)$$

where:

Y_t = the yield of millet and sorghum in period t (in kg./ha.);

y_{t-1} = the yield of millet and sorghum in lagged one period (in kg./ha.)

Pms_t = the price of millet and sorghum received by farmers in period t (CFA/kg.);

Pms_{t-1} = same as above lagged one period;

PP_{t-1} = price of groundnuts lagged one period;

AR_t = area harvested in millet and sorghum in period t [(000) ha.];

QRF_i* = rainfall index;

AR_{t-1} = area planted in millet and sorghum lagged one period [(000) ha.];

QRF_t = quantity of rainfall in period t (in mm);

QRF_{t-1} = quantity of rainfall last period;

T = time trend (1, 2, ..., 19);

D_i = dummy (0-1) variables used to pick up the impact of qualitative changes such as government, or the impact of the drought period;

PMR_t = price ratio between the price of millet and price of peanuts;

$Q^S ms_t$ = the output of millet and sorghum in year t [in (000) mt].

The third equation - $Q^S ms_t = (y_t * AR_t)$ is a simple identity which specifies that the output of any commodity is the product of the yield of that commodity per unit area, times the total area. One implicit assumption in this definition is that the area figures represent actual harvested areas.

The author is aware of the difference in yield which may exist between the two commodities, and that the yield sensitivity to weather variations, for example, is not the same for the two commodities. A weighting scheme could have been used; yet, it is the author's belief that given the unknown bias in the data set,[19] any further transformation may not lead to better results.

Production economics theory suggests that the supply relationship is influenced by the state-of-the-art, the price of the variable factors of production (such as fertilizers, pesticides, labor, etc.) and also by the elasticity of the factors supply (i.e., the more elastic the factor supply, the more elastic the product supply will be, citeris paribus).

In most yield or acreage responses, researchers use relative prices instead of using the price of the product (i.e., the ratio between price received and price paid, to account for the loss or gain in opportunity).

In this study, based on the author's experience that farmers in the area of study use an insignificant amount of inputs other than land and labor and due to the limited capital asset of the farm-firm, the price of fertilizer and other inputs has not been included in the behavioral equation.

A useful index which would have been used is the ratio between the average price received by farmers and the price they paid to purchase basic consumer goods. These indexes were not available.

In the absence of these indexes, a proxy was used to capture the effect of relative prices. The ratio of the price of millet over the

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[19]John A. Becker, op. cit., on page 105 reports that CEDES has identified an upward bias of 20.8 percent on the area statistics. Yet, we have no indication on the magnitude and direction of the potential bias in yield, nor do we have indication on the confidence that should be attached to the CEDES estimates.

price of peanuts is chosen as proxy. Given that millet and peanuts compete in the allocation of the scarce factor at the disposal of the farmer (here mainly labor and land) and given the managerial efficiency of farmers in their allocations, they will strive to allocate their scarce resources to equate costs and return at the margin. (Here the land and labor it will take to grow millet rather than peanuts, given the price of peanuts will represent the lost opportunity and the returns being those occurring from growing millet.)

If, as hypothesized, millet and peanuts compete in the distribution of productive factors, the coefficient of the (Pms/PP) is expected to be positive, while the coefficient on the price of peanuts is expected to be negative.

4.3 The Statistical Model

The economic model just described provided a framework for the behavioral relationships that exist among the variables. In this section, a statistical model will be developed to quantify the postulated behavioral relationships.

The dependent or endogenous variables (here yms_t, Ar_t, Qms_t) will be considered to be linearly associated with the endogenous variables.

4.4 The Yield Equation

$$Yt_t = \beta_0 (Pms_{t-1}) / (PP_{t-1}) + \beta_1 AR_t + \beta_2 QRF_t + \beta_3 Y_{t-1} + \beta_4 T\text{-}1 + u_t$$

These variable's names have been given in the previous sections. The hypothesized signs of the different parameters are as follows:

$$\beta_0 > 0,\ \beta_1 < 0,\ \beta_2 > 0,\ \beta_3 > 0,\ \beta_4 < 0$$

Several versions of this specification will be tried and the best equation will be retained on the basis of statistical and economic soundness.

4.5 The Area Equation

$$ARt_t = + \beta_0 (Pms_{t-1} / PP_{t-1}) + \beta_1 AR_{t-1} + \beta_2 QF_{t-1} + \beta_3 T + \beta_4 D_i$$

The hypothesized signs of the different parameters are as follows:

$\beta_0 > 0$, $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$

As for the yield equation, varieties of the basic equation will be tried and the criteria for choice will be the same as for the yield equation.

Ordinary least square method (OLS) will be used to estimate the equation parameters. For the (OLS) to yield its desirable characteristics of unbiasedness and consistency, the following conditions are assumed to hold.

(1) $E(Ui/Xi) = 0$. This assumption states that the conditional expectation of the value of the error term (Ui) upon the value of any of the exogenous variables (Xi) is zero.

(2) $E(Ui, uj) = 0$. For all ij. This condition states that there is no serial correlation among the successive disturbance terms and, therefore, these disturbances are distributed randomly.

(3) $E(Ui)^2 = Var(Ui/Xi) = \sigma^2$. This condition is the homoscedasticity condition which states that the variance of the population under study is finite and constant.

(4) $E(Ui,Xi) = 0$. This condition is the nonstochasticity condition which states that the Xi (explanatory variables) are random and not correlated with the error term.

Some of the models in this study will violate this fourth condition. Qualification for still using the (OLS) will be given shortly.

4.6 Test of the Structural Parameters

Each of the selected equations will be tested using the following summary statistics:

(1) R^2 and R^{-2} to test the goodness of fit both not allowing and allowing for the number of degrees of freedom. These summaries would tell us how much of the variability in the dependent variable is being captured and explained by the model.

(2) The student (t) ratio: which is the parameter coefficient over their respective standard errors will be used to measure the level of confidence attached to the estimated parameters.

(3) The (F) ratio to measure the joint confidence interval attached to the parameters of the whole equations (i.e., to measure whether or not all of the βs are statistically different from zero).

(4) The Durbin-Watson (DW) to test whether or not the disturbances (Ui) are correlated to comply with assumption No. 2 as discussed above. However, given that many of the equations which will be estimated will introduce a stochastic explanatory variable, the disturbances will likely be correlated and as pointed out by Nerlove and Wallis: "When lagged endogenous variables are included in one equation estimated by (OLS)." "The DW statistics are biased toward 2.0 value it should take when there is no autocorrelation."[20]

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[21] Rao Potlury and Roger LeRoy Miller, Applied Econometrics, Belman, California: Wadsworth Publishing Company, Inc., 1970, p. 177.

Yet, the (OLS) will still be used in this study because, as put by Rao Potlury and Roger LeRoy Miller,[21] "No estimation procedure has been shown to be better in small samples when lagged dependent variables are on the right-hand side of the equation."

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[21] Rao Potlury and Roger LeRoy Miller, Applied Econometrics, Belman, California: Wadsworth Publishing Company, Inc., 1970, p. 177.

CHAPTER V

ANALYSIS OF THE REGRESSION RESULTS

The preceding chapters have set the stage from which the Nigerien food problems are to be analyzed. In this chapter the impact of the major determinants of millet and sorghum output will be quantified. In light of these results, an assessment of the possible extent of sustained grain output will be made. Finally, through projections of demand and production, self-sufficiency ratios will be computed.

Given some concerns about the quality of the data, the use and/or the interpretation of the results for policy purposes should be made with caution. However, to obtain an approximate indication of the direction of the response and the impact of alternative policies, these results can provide some insights.

In many of the equation formulations that were tried, a multicollinearity problem was observed (i.e., high standard errors, small (t) values associated with high R^2). In the presence of such a multicollinearity problem, some of the correlated variables were deleted from the regression. In spite of the deletion of certain explanatory variables and the use of alternative specifications, we have no guarantee that the multicollinearity problem has been solved. Nonetheless, OLS was used since it does conserve its unbiasedness property even in the presence of severe multicollinearity. The interpretation of the coefficients, however, should be made with caution, given that when severe

multicollinearity exists, OLS estimation is inefficient (i.e., large variance). When serial correlation has been suspected using the D.W. test remedial measures such as the use of maximum likelihood iterative techniques (AR_1) were implemented. However, this technique had not been used in equations containing lagged dependent variables, on the basis of the D.W. test, because of their stochastic nature. Short-run price elasticity of supply has been computed at the mean according to the following formula:

(1) $Qm^S_t = AR_t * Y_t$

(2) $Qm^S_t\ (P) = AR_t\ (P) * Y_t\ (P)$

(3) $$\frac{\partial Qm^S_t}{\partial P} = \frac{\partial AR_t}{\partial P} * \frac{\partial Y_t}{\partial P} * AR_t$$

(4) $$\frac{\partial Qm^S_t}{\partial P} * \frac{\partial P}{Qm^S} = \frac{\partial P}{Qm^S}\left[\frac{\partial AR}{\partial P} * Y_t\right] + \frac{P}{QM^S}\left[\frac{\partial Y_t}{\partial P} * AR_t\right]$$

(5) $$\frac{\frac{\partial Qm^S_t}{Qm^S_t}}{\frac{\partial P}{P}} = \frac{P}{Y_t} * AR_t\left[\frac{\partial AR_t}{\partial P} * Y_t\right] + \frac{P}{Y_t} * AR_t\left[\frac{\partial Y_t}{\partial P} * AR_t\right]$$

cancelling terms in (5) gives:

(6) $$\frac{\frac{\partial Qm^S_t}{Qm^S_t}}{\frac{\partial P}{P}} = \frac{P}{AR_t} * \frac{\partial AR_t}{\partial P} + \frac{P}{Y_t} * \frac{\partial Y_t}{\partial P}$$

$$\underset{\text{elasticity}}{\text{supply}} = \underset{\text{elasticity}}{\text{area}} + \underset{\text{elasticity}}{\text{yield}}$$

The long-run elasticity is computed using the lagged adjustment coefficient. For example, for:

$$AR_t = \alpha + \beta_1 (PM_t) + \lambda (AR_{t-1}) + \ldots$$

The long-run elasticity (ηA) is:

$$\eta A = \frac{(\beta 1)}{(1-\lambda)}$$

Equations in Tables 5.1 and 5.2 are some of the equations representing millet and sorghum yield and area, respectively.

In all equations investigated for yield (Table 5.1) the rainfall variable is positively related to yield and statistically significant at the 1 percent confidence level. The trend variable (T) which was used to capture the effect of unspecified variables such as technology is also statistically significant and negative.

Own price elasticities computed at the mean were very low (0 to .05) and not significantly different from zero at the 5 percent confidence level. The yield elasticity to the price of substitute crop (here, peanuts) has the expected negative sign, but very small (-.02) statistically insignificant (Equation 3).

In the area equations in Table 5.2 the hypothesized price relationships have the correct signs; however, the estimated coefficients were not significantly different from zero. The price elasticities computed at the mean were on the order ot 0.01. The effect of lagged rainfall on the area is positive as expected and significant at the 5 percent level.

Equation 2 in Table 5.1, which introduced the drought period as an independent variable deleting rainfall, shows that the drought period had a strong negative significant effect on yield.

Table 5.1

Regression Coefficients: Millet and Sorghum Yield as Dependent Variables

Equation		Independent Variables									
Y_t	Intercept	QRF_t	AR_t	Pm_{t-1}	PP_{t-1}	PRM_t	PRM_{t-1}	T	D_1	(a) D.W.	R^2
1 OLS	Coef. 72.33 (t) 0.79 Elast.	0.55 (4.9)**	0.1 (2.97)*				6.68 0.32 0.01	-15.72 -(5.27)**		2.67 (I)	.86
2 ARI	Coef. 284.79 (t) (4.88)** Elast.		0.14 (5.52)**				25.14 1.28 0.05	-20.70 -(9.88)**	-90.2 -(6.18)**	2.4 (Ho)	.94
3 OLS	Coef. 81.38 (t) 0.75 Elast.	0.55 (3.39)**	0.99 (2.75)*	0.63 0.57 0.04	-0.30 -0.28 - .02			-15.87 -(3.64)**		2.69 (Ho)	.86
4 ARI	Coef. 130.78 (t) (2.06)* Elast.	0.50 (5.60)**	0.087 (3.51)**	0.56 0.57 0.04				-16.13 -(6.15)**		2.36 (Ho)	.93

*Significant at 5% level or better. **Significant at 1% or better.

(a) Ho - Could not reject the hypothesis of zero serial correlation.
I - Inconclusive test for serial correlation.
DI - 1 in 1968 through 1973 and 0 elsewhere.

Table 5.2

Regression Coefficient: Millet and Sorghum Area as Dependent Variables

Equation		Independent Variables							
AR_t	Intercept	QRF_{t-1}	ART_{-1}	Pmt_{-1}	PP_{t-1}	PMR_{t-1}	T	(a) D.W.	R^2
OLS	Coef. 628.22 (t) 0.98 Elast.	0.76 0.92	0.49 (1.96)*	0.31 0.42 .004			42.9 1.8	2.2 (Ho)	.79
OLS	Coef. 511.42 (t) 0.6 Elast.	0.97 0.75	0.5 (1.9)*	0.67 .09 .01	-1.9 - .28 - .02		48.32 1.38	2.21 (Ho)	.79

*Significant at 10% confidence level.

(a) Ho - Could not reject the hypothesis of zero serial correlation.

Equation 4 in Table 5.1 and Equation 1 in Table 5.2 were considered as best on the following grounds: high R^2, significant (t) ratios, correct signs and lower standard errors, are described in some detail below and will be used in the forecast.

5.1 The Yield Equation

$$Y_t = 130.78 + .087\ AR_t + .5\ QRF_t + .56\ Pm_{t-1} - 16.13\ T$$
$$(t) \quad (2.06)^* \quad (3.51)^{**} \quad (5.61)^{**} \quad (.57) \quad - (6.15)^{**}$$

$R^2 = .93$

$F(4\text{-}13) = 42.56$

D.W. = 2.36

The coefficient of multiple determination (R^2) suggests that the independent variables used in this equation explain 93 percent of the variation in the dependent variable. Below each of the coefficients are the (t) values in parenthesis. The double asterisk means that these coefficients are significant at the level of 1 percent or better. The highly significant (F) ratio suggests that we can strongly reject the hypothesis of all the coefficients (except the intercept) are zero.

This equation suggests that the short-run price elasticity of yield is .04. In other words, when millet/sorghum price increases by 10 percent, yield is likely to increase by 0.4 percent. Little confidence, however, can be maintained in the occurrence of this outcome. Current rainfall is strongly and positively related to yield. When the average rainfall increases by 10 percent, yield can be expected to increase by 5.0 percent, ceteris paribus.

The strong positive relationships between additional area and yield is of some interest. This coefficient was expected to be

negative on well-known grounds of production economics which suggests that if production is taking place in the "rational" area (i.e., where the marginal physical product declining is less than the average physical product), we should expect the change in yield due to an infinitestimal change in area to be negative (see J.P. Houck and P.W. Gallagher, 1976, p. 731). Perhaps, area is picking up some other influences.

This unexpected positive response should not be interpreted as a sign of irrationality on the part of the Nigerien farmer. One possible explanation is that the neoclassical economic theory on which the negative relation is based assumes homogenous units of inputs being brought into the production process. Here, all additional land that is brought into the production process comes from fallow land with higher productive capacity due to their higher organic matter build up. Those lands are brought into the production process when the returns at the margin induce farmers to do so.

This is not to suggest that bringing more and more fallow land into the production process should be encouraged. All that this suggested is fertilizer (up to the environment absorbitive capacity) would result in a strong yield response.

The time trend, which is a proxy for technological change, and other variables appeared negative and highly significant. However trend is a poor proxy for technological change because it picks up the impact of variables which may have had a stronger negative effect, to offset any positive impact due to better knowledge. Yet this negative trend is an indication that ways must be found to improve the biological capacity of the Nigerien soils, and the adoption rate of new technologies by farmers.

5.2 The Area Equation

$$AR_t = 628.22 + .76\ QRF_{t-1} + .49\ AR_{t-1} + .31\ Pm_{t-1} + 42.9\ T$$
$$(t) \quad (.98) \quad (.92) \quad (1.96)^* \quad (.043) \quad (1.8)^*$$

$R^2 = .79$

$F(4\text{-}13) = 12.33^{**}$

D.W. = 2.2

The explanatory power of this equation is satisfactory. However, only the time trend and the lagged area coefficients exhibited (t) ratios significant at the 5 percent confidence level. The sign of the price coefficient is correct, yet not statistically different from zero. Elasticity computed at the mean is small (.02), and remains small even in the long-run (.03). Adding the yield elasticity and the area elasticity, the supply elasticity is found to be (.04 + .02) = .06 which is very small.

5.3 Forecasting Performances of the Yield and Area Equations

The above equations are used to forecast future values of yield and acreage, given particular values of the explanatory variables. To evaluate forecast accuracy, two different methods are used to test the forecasting ability of these equations. The two methods are as follows:

(1) A graphical method of counting turning points using the following convention:

(a) (i) = Predicted a turning point when there exists a turning point.

(b) (ii) = Predicted a turning point when there does not exist a turning point.

(c) (iii) = Fail to predict an actually existing turning point.

(d) (iiii) = Did not predict a turning point when actually there is no turning point.

Case (b) and (c) are failure in prediction and are described as type I failure (Q_1) and type II failure (Q_2), respectively.

$$Q_1 = \frac{(ii)}{(i) + (ii)} \qquad Q_2 = \frac{(iii)}{(iii) + (iiii)}$$

The closer to zero are both of these errors, the better the fit is and, therefore, the ability to forecast.

(2) Theil's "U" statistics calculated as follows (Mabdala, 1977, pp. 345-346):

$$U_1 = \frac{\sqrt{MSE}}{\sqrt{\Sigma A_t^2}}$$

where: $MSE = \frac{1}{n} \sum_{i=1}^{n} \left(\frac{P_t - A_t}{A_{t-1}}\right)^2$ = (mean square error)

P_t = Predicted values of the defendant variable

A_t = Actual values of the defendant variable

A_{t-1} = Actual values of the defendant lagged one period

n = Number of observations.

The closer to zero this coefficient is, the better the forecast ability of the model.

The performance of both equations on turning point test is satisfactory, given the relatively small type I error. The computed "U"s for the yield and area equations give a nearly perfect prediction. Therefore, the ability to forecast of these equations is not suspect.

Table 5.3 gives the results of the graphical test of turning point counts, based on Figures 5.1 and 5.2 and the values of the Theil's "U" statistics.

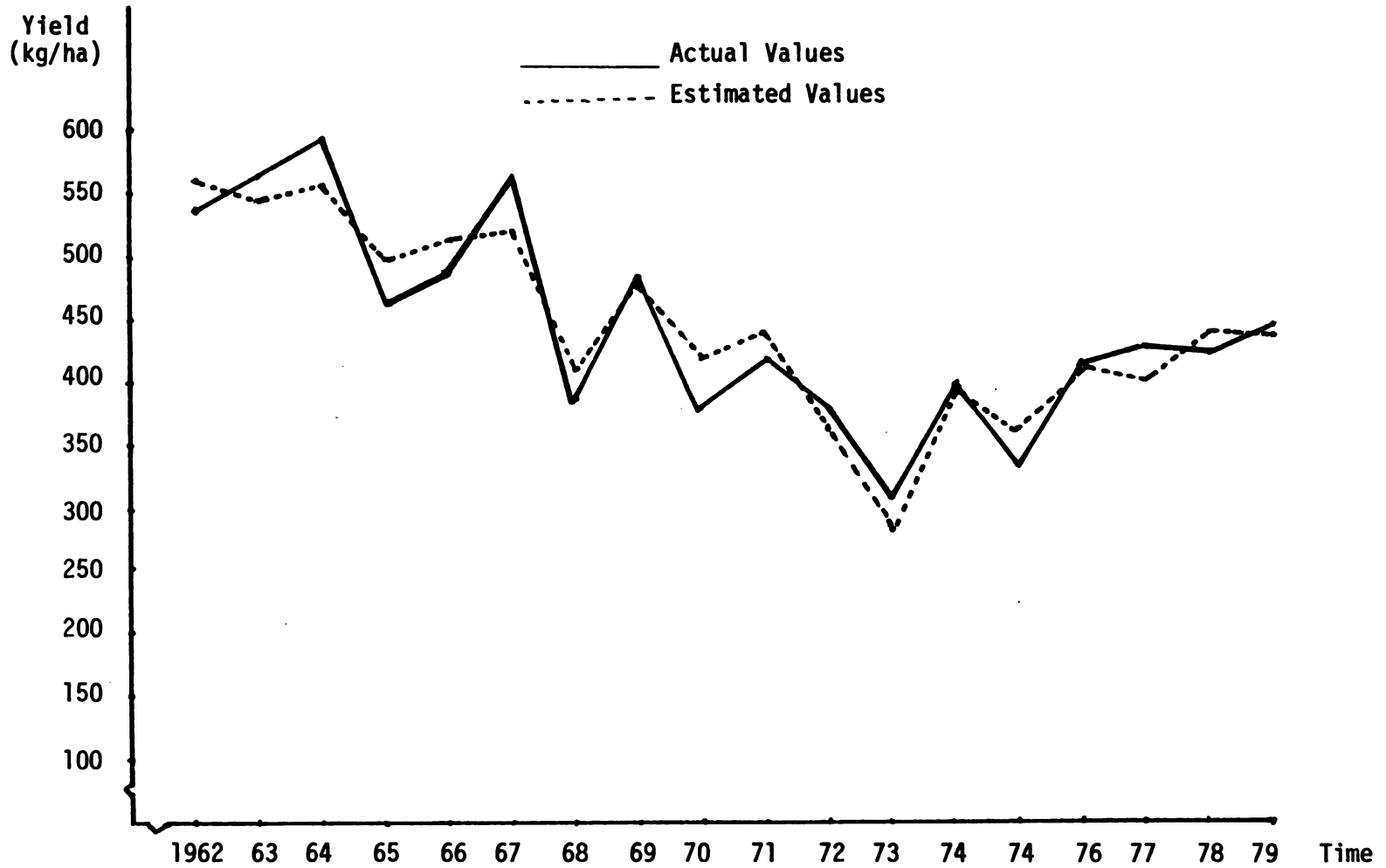

Figure 5.1

Millet and Sorghum Yield Per Ha

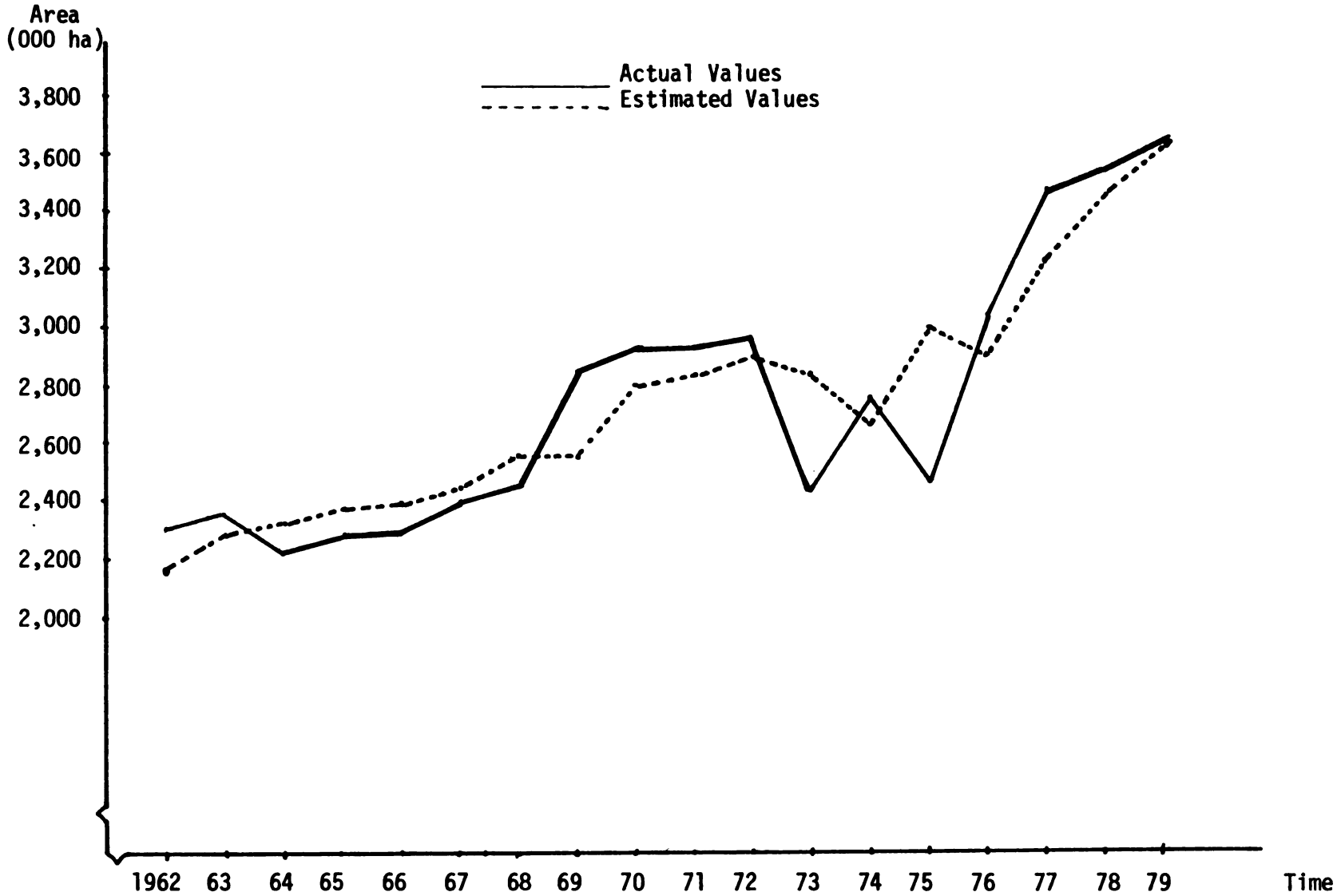

Figure 5.2

Millet and Sorghum Harvested Area in (000) Ha

Table 5.3

Quantitative Measures of Ability to Forecast

Variable	Actual	Predicted		Q_1	Q_2	"U"
		Turn	No Turn			
Y_t Yield	Turn	(i) = 13	(iii) = 0	0.13	0.0	.004
	No Turn	(ii) = 2	(iii) = 2			
AR_t Area	Turn	(i) = 11	(iii) = 2	0.09	0.25	.007
	No Turn	(ii) = 1	(iiii) = 6			

5.4 Forecast of Supply and Demand

To examine the food security position of the Nigerien population, a forecast of the domestic supply and demand of millet and sorghum will be made. Provided an adequate distribution within and across households as discussed earlier, self-sufficiency ratios will be computed to assess the import gap or export potentials. Supply will be projected directly from the structure of the behavioral equations assuming no structural change in the forecast period occurs.

Given the paucity and general lack of confidence in the data pertaining to the determinants of demand, no demand equation has been estimated. A simple extrapolation of the national norms of food requirements will be used. Given that these norms have, over time, proven to be good estimates, the results may well be superior to any other crude trend extrapolation technique or econometrics models built on weak data base to estimate demand. Thus, not having a demand equation, future prices will have to be forecast in some fashion. A polynomial time trend has given the best results and will therefore be used to forecast the values of the independent variables in the supply equation.

Table 5.4 shows the projected demand using alternative population growth rates and per capita grain requirements. To account for the differential in city based and rural consumption patterns and also to account for the possibility of millet and sorghum exhibiting inferior good characteristics, requirement levels have been arbitrarily reduced to 220 kg from 250 kg of millet and sorghum per inhabitants from 1986 through 1990.

5.5 Projection of Supply

To forecast domestic supply, each exogenous variable in the yield and area equation has been forecast and then used in the estimated structural equations. As stated earlier, future prices have been forecast individually using a polynomial time trend which appeared to give the best statistical results:

5.5.1 Projection of Millet/Sorghum Price

$$Pm_t = \underset{(3.1)^*}{24.96} - \underset{(1.23)}{2.13}\ T + \underset{(2.55)^*}{.207}\ T^2$$

$R^2 = .73$

$F(2\text{-}15) = (20.7)^{**}$

D.W. = 1.96 (accept the hypothesis of no serial correlation)

One asterisk: Coefficient significant at 5 percent confidence level or better.

Two asterisks: 1 percent or better.

Table 5.4

Grain Requirement Projection Under Various Assumptions as of Population Growth and Levels of Requirements (Millet and Sorghum)

Year	Population[a] in (000) Inhabitants		Requirements[b] in (000) m.t.	
	3.0% Growth Rate	3.5% Growth Rate	3.0% Growth Rate	3.5% Growth Rate
1980	5258	5284	1315	1321
1981	5416	5469	1354	1367
1982	5578	5660	1395	1415
1983	5746	5858	1436	1465
1984	5918	6063	1480	1516
1985	6095	6275	1524	1569
1986	6278	6495	1381	1429
1987	6467	6722	1423	1479
1988	6660	6958	1465	1531
1989	6860	7201	1509	1584
1990	7066	7453	1555	1640

[a]Projections are made using 1979 population figures of Table 1.2.

[b]Given that the urban population has been increasing at 5 to 6 percent per year, the trend is expected to continue. To account for the lower urban requirement and also for the eventual fall in millet-sorghum consumption as income (which is expected to increase) increases, 250 kg per capita has been used through 1986 and 220 kg per capita thereafter. (This still remains conservative, since many countries and the FAO already use requirements as low as 160 to 200 kg per capita).

The explanatory power of this equation is weak as measured by its R^2. Given the quality of the data and for all practical purposes, this equation will still be used to predict future prices.

A graphical method consisting of plotting the equilibrium price-quantity from which a demand could be drawn and compared against the plot of the error terms through time was tried. This attempt was not successful given that no pattern could be captured by inspection of the scattered price-quantity distribution to allow the drawing of a demand curve. Given that no pattern was observed in the plot of residuals, prices are therefore directly forecast from the structure to the year 1990. Results of the forecast are given in Table 5.5

Table 5.5

Forecast of Millet/Sorghum and Peanut Price Ratios

Year	Millet Price CFA/kg.	Peanut Price CFA/kg.	Pm_t/Pp_t
1980	67.6	91.26	.74
1981	74.3	102.50	.72
1982	81.4	114.50	.71
1983	88.9	127.40	.69
1984	96.9	141.00	.68
1985	105.3	155.50	.67
1986	114.1	170.76	.66
1987	123.6	186.81	.66
1988	129.2	203.70	.63
1989	143.2	221.30	.64
1990	153.8	239.76	.65

5.5.2 Projection of Peanut Price

$$P_{pt} = 34.26 - 5.15\ T + .4\ T^2$$
$$(5.59)^{**}\text{-}(3.88)^{**}\ (6.57)^{**}$$

$R^2 = .92$

$F(2\text{-}15) = 91.0^{**}$

D.W. = 1.65 (Ho) (accept the hypothesis of no serial correlations)

This equation maintains a high R^2, highly significant (t) ratios (better than 1 percent), and the likely absence of serial correlation among the residuals. The results of the forecast are given in Table 5.5 along with the millet/sorghum price.

5.6 Projection of Rainfall

Weather variables are highly unpredictable by nature. This difficulty is compounded by the paucity and low quality of the data. The result should therefore not be regarded as a prediction with any level of confidence. Furthermore, these results apply only for the 11 stations chosen on the criteria of data availability and relative representativeness of the millet and sorghum growing areas, as explained in the methodological part.

A distributed polynomial lag model was used to estimate the rainfall equation. Among all the lagged structures, lengths of lag, degrees of polynomial, a five year lag length with constraints on the far end lag, gave the best statistical results and therefore was chosen.

The choice criteria was based on the following: highest $\bar{R}^2$; positive sum of the weights (β)s; and smallest standard error. Based on these criteria, the following equation has been estimated:

$$QRF_t = 1.53 + .95\ QRF_0 + .14\ QRF_{-1} - .11\ QRF_{-2} - .05\ QRF_{-3} + .07\ QRF_{-4}$$
$$(t) \quad (.056)\ (17.8)^{**}\ (4.0)^{**}\ -(3.6)^{**}\ -(2.4)^{*}\ +(2.06)^{*}$$

$R^2 = .97$

D.W. = 2.5 (In) inconclusive test.

This equation strongly suggests that this particular lag structure explains the rainfall pattern with a statistical high confidence level. The overall performance of this equation as to its ability to forecast is very good, given the low type I error (0.06), Figure 5.3

Using this equation, rainfall is projected to the year 1990. The results are shown in Table 5.6.

Table 5.6

Projected Rainfall (1980 - 1990)

Year	Rainfall (m/m)
1980	491
1981	481
1982	474
1983	476
1984	472
1985	470
1986	467
1987	464
1988	461
1989	458
1990	456

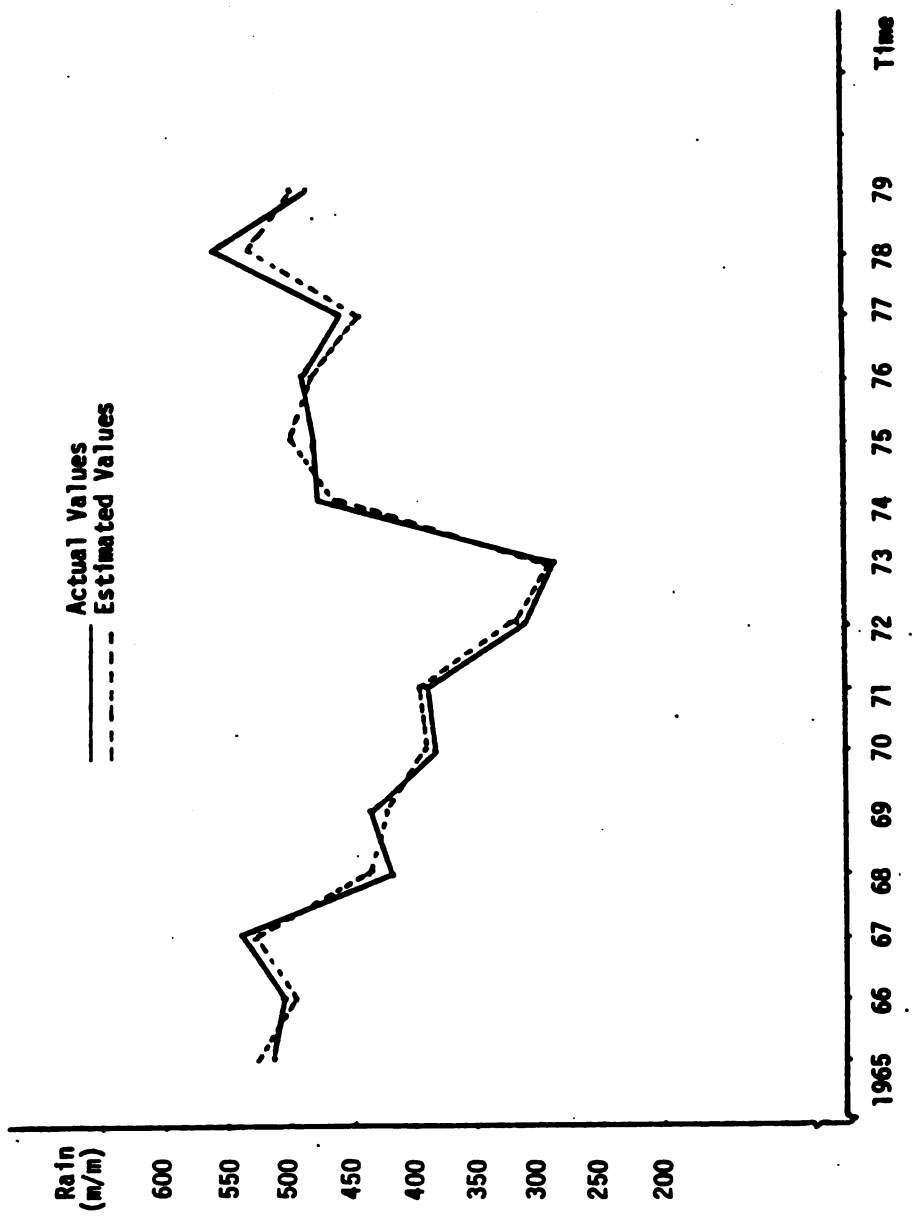

Figure 5.3

Rainfall Distribution in Selected Stations in Niger

5.7 Forecast Values of Area Yield and Total Production of Millet and Sorghum

The forecast value of the price ratio and rainfall will be put into the area equation, and the computed value of the area will enter the yield equation, to determine the forecast yield. The product of the yield and area will give the projected quantity of millet and sorghum in the following way:

(1) $\hat{AR}_t = 628.2 + 0.31\ \hat{PM}_{t-1} + 0.49\ AR_{t-1} + 0.7t\ QRF_{t-1} + 42.9\ T$

Put the estimated area into the yield equation.

(2) $\hat{Y}_t = 130.78 + 0.5\ \hat{QRF}_t + .086\ \hat{AR}_t + 0.6\ \hat{PM}_{t-1} - 16.13\ T$

(3) $\hat{QMS}_t = \hat{AR}_t * \hat{Y}_t$

The results of these computations are given in Table 5.7 along with the grain requirement from Table 5.4, and the actual production and forecast values through 1990 are presented in Figure 5.4.

The data seems to suggest that if the trend continues, grain availability on the aggregate would not be adequate throughout the forecast period. In addition to the inadequacy of grain availability, the slow growth agricultural sector will remain likely as important as it is today. As forecasted, the distribution of the rainfall pattern appears to be smooth and decreasing slowly. This slow and steady decline needs not hold, given the high year-to-year variation observed (coefficient of variation = 17.5 percent). With such a coefficient of variation and assuming that the rainfall pattern in these particular stations follow an approximately normal distribution, there is less than an 8 percent chance that rainfalls fall short of their depressed level of 284 m/m in 1973. Bearing these considerations in mind, the interpretation of

Table 5.7

Forecast Values of Area Yield, Supply and Demand of Millet and Sorghum (1980-1990)

Year	Area (000) ha	Yield kg.	Production (000) m.t.	Requirement 3% Population Growth (000) m.t.	Requirement 3.5% Population Growth (000) m.t.	Self-Sufficiency Ratio a	Self-Sufficiency Ratio b
1980	3,653	407	1,486	1,315	1,321	1.12	1.40
1981	3,714	395	1,467	1,353	1,367	1.07	1.34
1982	3,780	383	1,447	1,395	1,415	1.02	1.28
1983	3,853	379	1,460	1,436	1,465	.99	1.24
1984	3,935	372	1,464	1,480	1,516	.96	1.21
1985	4,017	366	1,470	1,524	1,569	.13	1.17
1986	4,102	360	1,477	1,381	1,429	1.03	1.14
1987	4,186	355	1,486	1,423	1,479	1.00	1.10
1988	4,271	346	1,478	1,465	1,531	.96	1.06
1989	4,355	343	1,494	1,509	1,584	.94	1.04
1990	4,441	341	1,514	1,555	1,640	.92	1.01

[a]These ratios are computed using the assumption of 250 kg/capita requirements, and 3.5% population growth (Table 5.4).

[b]Ratios computed using the assumption of lower requirement 200 kg/capita and 3.5% population growth.

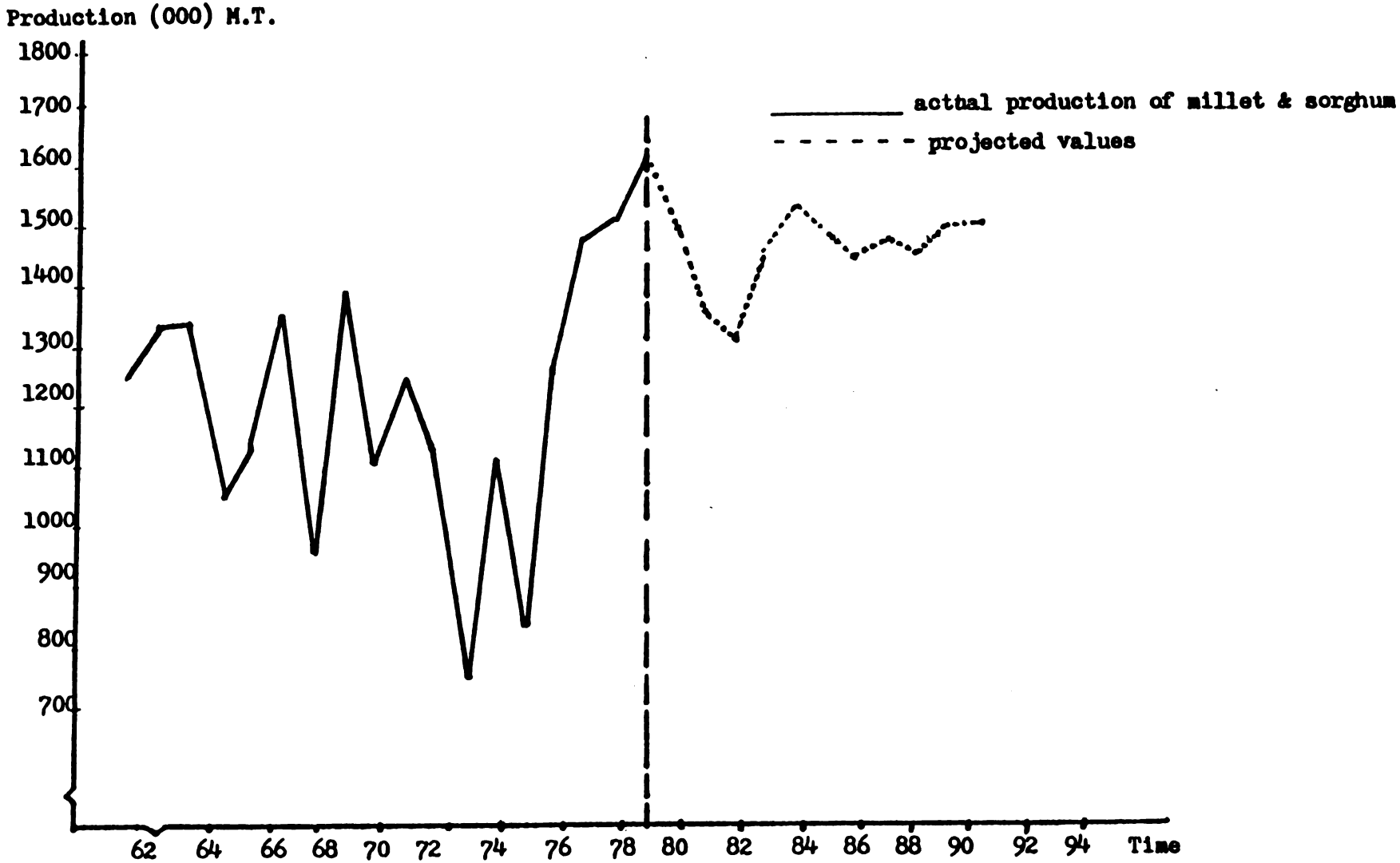

Figure 5.4 Actual and Projected Values of Millet and Sorghum Output.

the results should be made with caution, knowing that there still exists an 8 percent chance that rainfall may fall to 284 m/m in any given year. Should this happen, the grain deficit would be large.

As discussed in the area and yield equations, price appeared (not very surprisingly) to play only a minor role in determining the level of grain supply. However, the steady opportunity loss in growing millet for cash as measured by the falling forecast price ratio would have a definite depressing effect on supply.

Price policy is an extremely complex area. For example, to get only a marginal increase in the supply of millet and sorghum, it takes a relatively large increase in price. When these prices are raised to stimulate output increase, tremendous pressure will be put on the great many poor people who spend most of their income on food. These people will suffer profound losses in the quality of their diet, the quality of their lives, and this would certainly decrease their work capability with consequent social and economic costs imposed on the whole society.

Furthermore, artificially raising the price of millet would mean transfer of resources from other sectors of the economy to the millet sector, with subsequent impact on employment and income distribution. Not allowing price to reflect supply and demand conditions will have a definite depressing effect on supply. Given the positive price elasticity and the assumed negative elasticity of home consumption (reflecting a normal substitution effect), any decrease in price will depress the supply and also reduce the level of marketed surplus given that home consumption is expected to increase as millet and sorghum become cheaper relative to other goods. This certainly will pose a serious problem in meeting the urban grain demand.

As the data suggests, if appropriate measures are not taken, the average import gap would be 3 percent between 1982 and 1990 and as high as 9 percent by 1990. Considering only the average deficit, Niger would need to import 45,000 (m.t.) each year. In 1990 this deficit will be as high as 150,000 (m.t.), using the assumption of 3.5 percent population growth figures found in Table 5.4. Importing 150,000 (m.t.) would be a serious drain on the Nigerien foreign currencies and therefore a serious loss on the Nigerien capacity to import most needed technologies.

However, if the lower requirements figures (Table 5.7b) should prevail, grain availability will be adequate throughout the projected period. The extent of this happening is not known, and again availability alone is not a sufficient criteria in assessing the nutritional state nationwide.

CHAPTER VI

SUMMARY AND CONCLUSIONS, RECOMMENDATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

6.1 Summary and Conclusions

The Nigerien food security position is highly dependent on the supply of millet and sorghum, since these crops represent anywhere from 85 to more than 95 percent of the Nigerien diet. The production and distribution of these crops is highly dependent on weather conditions and the structure of production incentives.

Since the drought (1968-73), the Nigerien government has taken steps to make food self-sufficiency a national policy goal. Some of the measures taken have not been proven successful, since population has been growing at the rate of 2.7 to 3.2 percent per year, while the rate of growth in grain production has been less than .5 percent per year. This implies an eventual widening of the import gap.

This research has investigated the state of the Nigerien food problem with the following set of specific objectives:

(1) Conceptualize the Nigerien food problem through a global perspective on the food issues.

(2) Provide a description of the Nigerien food-crop subsector in order to identify potential inefficiencies in the system.

(3) Identify and quantify the effect of the major determinants of millet/sorghum supply.

(4) Analyze the price responsiveness of millet/sorghum yield and acreage to assess the overall supply response.

(5) Assess the Nigerien food security position through a forecast of millet/sorghum supply and demand.

6.1.1 Global Perspective

The world food problems are an extremely complex area in which conflicting interests often block the way to viable solutions. The situation is rendered even more confusing by interest groups propagating distorted information (T.W. Schultz, 1981).

International community food aid has helped to reduce human suffering in a great many areas of the "hungry world" including Niger. However, there seems to be a growing concensus that food aid is not a viable medium and long-term solution, due to its unreliable and circumstantial nature, and also its potential distortion of incentives in the receiving countries. Yet, in the short-run, the participation of the developed nations is important in helping the food scarce nations achieve greater self-sufficiency through improving their productive capacity through "investment in human capital," infrastructure building, etc.

The message of the Chinese proverb advocating fishing lessons rather than gifts of fish would seem to be applicable to this issue. However, the willingness to provide fishing lessons is dependent upon the realization by the developed world that such lessons are in their long-term interests (in terms of market opportunities, long-term social and political stability, and global productivity). It would seem clear that without fishing lessons, many LDCs will be condemned to recurrent episodes of food shortages and that development efforts will resemble

those of the two past decades. A description of the last 20 years of development have been summarized by Robert S. McNamara in the following terms:

> The number of the absolute poor increases and their enforced degradation deepens with every passing year, despite more than two decades of extraordinary worldwide economic growth.[1]

The Sahelian countries, due to their poverty which weakens their ability to deal with random shocks, their particular geographic position at the edge of the Sahara Desert, and other socioeconomic factors, are highly vulnerable to the recurrence of food shortages.

The fairly high correlation coefficient in grain production within the area makes it unlikely that food exchange among the Sahelian countries will occur. This implies that these countries would have to either produce at least certain major categories of their food needs or import it at increasing costs due to high transportation, distribution, and transaction costs in an increasingly unstable world food market (Mellor, 1981).

The analysis of the Nigerien millet/sorghum subsector gave some insights on the structure of the market and the system participants' behavioral response to the constraints of their environment. This analysis provided some explanations of the system's inability to carry out its tasks efficiently.

Some of these reasons for inefficiency include such things as: the fragmented nature of the marketing system; the low absorptive capacity of the system embodied in poor storage capacity; poor transportation

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[1]Uma Lele. The design of Rural Development: Lessons from Africa, (Foreword), A World Bank research publication, 1975.

systems; and poor information. This transforms marginal increases in production into a fairly sharp fall in prices and, therefore, in income losses on one hand; and marginal production shortfalls are translated into serious local calamity with subsequent price hikes and human suffering. The monopoly power granted to few merchants (licensed traders) seems to be one of the major weak points of the system.

Among the causes for inefficiency there also seems to be the problem of a "missing institution." In the analysis, farmers are found to be the most vulnerable body of the system's participants. Under the actual operating conditions, the few cooperatives that exist are "surplus extracting" institutions that barely serve the interests of the farmers. Many farmers strongly feel the burden of belonging to the institution which forces them to sell their product at nonmarket set prices and defacto denying them alternative market opportunities. Thus, the missing institution is perceived to be one which would serve in a dynamic sense as a countervailing power which would represent farmers in their dealing with government and "private" monopoly and/or monopsony.

6.1.2 The Millet/Sorghum Supply Response

Economic theory suggests that price and cost relationships are two major determinants of supply. An investigation of the own price impact on millet/sorghum supply, though positive as expected, was not statistically different from zero. This implies that price can increase greatly without inducing an appreciable increase in the output of millet and sorghum. While this holds true, farmers would respond to any decrease in prices by cutting the marketable portion of their

production to the point where their own food requirements are met and then turn to alternative in- or off-farm activities to meet their unfulfilled cash needs. Thus, any price depressing policy would result in severe fall in the quantity of these grains offered for sale, leaving thousands of people (mainly in cities and those not in agriculture such as herders) with their grain requirements not met. (This is because the marketed surplus is only 10 to 12 percent of the total production). The most statistically significant determinants of millet/sorghum supply were rainfall, area, and trend.

As hypothesized, the strong yield response to area increase may well be due to the fact that fallow land with higher organic and mineral matter content is being brought into the production process. This suggests the depletion of the presently cultivated land and that rebuilding the biological capacity of the Nigerien millet/sorghum growing land is badly needed.

The negative and strongly significant coefficient of the trend variable in the yield equation suggests that the state-of-the-arts has not improved. However, trend is only a poor proxy for technological change. Yet, this strong negative trend raises some concerns about the efficiency of the agricultural extension service in providing the needed information to the small millet/sorghum growers. There seems to be a need to investigate the extent to which the actual "top-down" research and extension system would be improved by designing farming system research units which through adqequate diagnostic and feed back mechanisms, are expected to address the question of the relevance of the technical package and other constraints to its adoption.

6.1.3 Projection of Supply and Demand and Self-Sufficiency Ratio

Unless adequate measures are taken, average grain supplies will not be adequate in Niger throughout the projected period (1980-90). Deficits as high as 150,000 (m.t.) of grain are forecast, assuming no structural changes and no profound adverse decline in the rainfall distribution. Such huge deficits, in front of a world raising food prices, would be a serious drain on the Nigerien capacity to import needed technologies. Consequently, the food deficit is likely to widen, given declining crop yield and biological and technical limits on production and area expansion.

6.2 Policy Recommendations

Both consumers and producers want stable food prices. The former wanting them stable and low; the later stable and high. The policy analyst role is, thus, to make meet these two seemingly conflicting ends. The basic policy issues with which the policy analyst would have to deal with in a developing country such as Niger are as follows:

(1) How to improve the provision of abundant nutritious food at an affordable price for consumers such that to avoid human misery and eventually political unrest.

(2) What would be the optimal price which would give enough incentives to producers without generating an inflationary wage-price spiral which would eventually depress economic growth, generate unemployment which would in turn reduce the national output with consequent human suffering?

In the case of Niger, consumers (mainly those in cities), due to their higher bargaining power, seem to have made their voices heard and

their wants given more consideration. This research has indicated that the goal of food self-sufficiency cannot be achieved through this route.

Given the particular nature of the production and distribution system and also the existance of a social objective function beyond economic efficiency (i.e., equity and concern to maintain social and political stability), "true" market mechanisms cannot be let alone to allocate. However, they (market forces) would be given enough degree of freedom and those people who will likely suffer the most (poor, young, pregnant women, etc.) should be given some means for their entitlement to food outside the market system. Such allocations outside the market system, despite what static economics would suggest, may actually prove in the medium- and longer-run to be a highly efficient use of resources, since healthy and more productive adults are the product of healthy and well-nourished infants.

The following policy recommendations are believed to be of some help for the Nigerien policy makers in the pursuit of food security goals.

(1) Though this analysis has not found the paramount role of price in determining supply yet, the positive price elasticity suggests that consistent pricing policy be followed. The government, when setting prices, would do so early enough in the season (February-March) and these prices should be such that to give in <u>real terms</u> a decent living standard to farmers. This can be achieved through: (a) choosing a base year period (such a period during which prices and supply have been fairly stable) and then constructing indices of prices received and paid by farmers to find such a price ratio which would maintain at least farmers' purchasing power; (b) the cost of production approach could

also be used, and since labor is likely to be found as the most important production factor, commodity prices could be aligned to urban wages after correction for cost of living.

(2) The productive capacity of the Nigerien soil should be enhanced through incentives to use fertilizer, manure, and proper soil conservation and renovation programs. The rock phosphates in Tahoua which have already proven to more than double the yield of millet in experiments under farmers' conditions, should be more effectively extracted and made available to farmers even at subsidized rates. In the medium term, the gain in production may well far offset the social cost imposed by the subsidy.

(3) Given the unpredictable nature of weather variables and given also their strong impact on yield, measures to minimize supply shock due to weather variations must be found.

The already started effort in building small irrigation perimeters by collecting run-off water should continue to be aggressively developed.

Research should be given the means to engage in the selection of more weather tolerant varieties of crops.

(4) The literature reviewed in Chapter II showed that international efforts to build grain reserves on a worldwide or regional basis are not gathering momentum due to conflicting interests. For a land-locked country lacking adequate transportation systems such as Niger, relying on outside sources of supply may involve high costs and human misery. Certainly, building own reserves would involve other costs and efficiency losses (provided better alternatives exist). Aside from such costs, reserves will likely (if adequate) bring more stability in prices and also increase availability. Yet, at the same time, reserves will likely

reduce private incentives to engage in the grain business. On the other hand, when supplies are short and highly variable such as in Niger there is a tendency for individuals throughout the system to increase private stocks and reduce market supply. These individual actions will sum up and amplify the magnitude of price swings. Unstable prices, in addition to their potential wages--price inflationary spiral as already mentioned, will induce some of the system participants to self-insure themselves through claiming a higher margin for their goods and services. This is particularly true for the herders who will justifiably claim higher prices for their livestock and this would put an additional pressure on consumers' budgets with consequent deterioration of their diet, their living standard, and the political climate.

Considering the above ramifications of the impact of unstable prices and of reserves on prices, this study recommends some level of reserve. The reserve needs not be held by government bureaucracy such as OPVN. However, the scale and experience accumulated by this organization can be used to manage a buffer-stock of adequate size such that to influence the market when it is needed so. Studies have indicated that 20 to 30 percent of the market share is required for OPVN action to have any impact. Should OPVN hold a buffer-stock representing say 25 percent of the market, the important question in addition to the size of the stock is the floor buying price and the release price. Enough room should be left between these prices such that to induce private traders to engage in the grain business. As an a priori indication, release prices at 150 percent or 175 percent of the floor price would seem to leave enough margin for private traders to enter the business. It would be unrealistic to narrow the margin and not be able to deliver,

leaving prices to rise higher and higher, as it had been happening all these past years. This system also would not work if only the few licensed traders were allowed to buy. Access to credit should be given to all able and "serious" traders willing to enter the business.

It has been shown in Chapter III that the numerous tasks assigned to OPVN may well be a source of its inefficiency. Actually, OPVN holds two types of reserves with varying degrees of success: a kind of buffer-stock reserve and an emergency reserve (free distribution of food). So far in both operations, OPVN could survive only through government subsidies. To break the costly subsidy cycle, government should gradually pull out of the buffer-stock operation and give incentives to the private sector to become shareholders. Of course, the imposition on OPVN to sell grain at uniform prices regardless of transportation costs, actual supply, and demand conditions should be removed.

Gradually, OPVN should concentrate on the disaster relief emergency stocks. These stocks should be held in places where the likelihood of demand is high from the nearest supply area, such that to avoid costly hauling back and forth of bulky grains as currently practiced.

(5) The big loosers, the ones who have been hardest hit by the drought in Niger, were the herders who in large masses fled to towns having lost their means of entitlement of food. Therefore, any food security policy which would not address the interest of these participants is deemed to fail. As for the agricultural sector, means of guaranteeing the income earning capacity of the herders should be improved through a global system approach. Improved pasture and water management and coordination mechanisms to improve the distributive efficiency of the livestock marketing system are needed.

(6) Infrastructure building. The transportation network plays a vital role in inducing increased specialization and lower food costs. Interregional and market roads are needed along with storage facilities if the goals of maintaining farmer purchasing power and low food prices for consumers are to be reached. These investments, due to their public good characteristics, should be built by the government. Development of adequate storage facilities with local materials may promote economically sound on-farm storage programs with potential gain from reduced losses. Adequate storage may actually prove to be more effective in increasing the grain supply than direct production expansion strategies for which increases remain marginal at best.

(7) Market information, grades, and standards. In the preceding chapters the lack of market information has been mentioned as an impediment to efficient market performances. Simple weekly broadcast of selected commodities prices in various markets may greatly improve performance, reduce price variation, and help decision makers to more efficiently allocate their resources. For an efficient market information system, grades and standards are needed; and those grades and standards will facilitate vertical coordination within the system with appreciable risk sharing, price, and income stability.

(8) Credit and other input delivery systems. The role of credit is paramount in transforming a lagging traditional food system into a dynamic engine of growth and development. As discussed in Chapter III, the fungibility of money and high transaction costs have denied the weaker participants of the system's access to credit. Access to credit, to a large extent, determines who gets control of the dynamic incremental resources and their subsequent use. To stimulate the development

process, all participants in the system should be allowed access to credit on a competitive basis, and where necessary, through group risk pooling agreements.

Timely delivery of the input of the right kind (fertilizer, pesticides, machinery, etc.) and the right quantity, through more careful inventory management, will likely raise farmers' confidence toward the extension service activities and therefore increase the adoption rate and consequently the expected production increases.

(9) The actual land tenure arrangement under which all land belongs to the state and the individuals have only the right of use does not create incentives for land conservation and improvement. Under such arrangement, the land use pattern will eventually lead to irreversible damage of the land resource. To block that trend and avoid the trap of a "tragedy of the common," land ownership rights and privileges should be institutionalized and enforced.

(10) The need for the emergence of a "true" farmers' interest group. It had been described in Chapter III that farmers, though the most numerous body of the system's participants, appeared to be the most vulnerable due to their weak position in the decision making process. The goal of food security cannot be reached if the system continues to ignore the rights of the farmers, or when the decision of their concerns are taken with no input on their part. To increase the efficiency of the system, farmers need to be fully represented in the political power sphere.

However, under the actual conditions in Niger where no constitutional democracy exists to allow such farmers political organization to make its voice heard through its voting rights, an alternative such as

an economic farmers organization(s) may be a dynamic and effective countervailing power.

An effective income earning dimension should be included in the institution. Several alternatives can be sought such as a farmers' owned grain bank, cooperatives, and other bargaining groups in which farmers may be sheltered from the pressure of selling their grain at the lowest harvest price through an on-farm storage loan program. Under such a program, farmers will be given loans on an agreed upon quantity of grain, on the basis of regional average prices[2] (+) storage costs (-) some "reasonable" interest charges. Such organization should not limit itself to simple primary collection, but engage in a more dynamic way in the marketing system including distribution of consumer goods and the input delivery sequence.

(11) Price data collection. Given the paucity of the available data on price and the importance of information in resource allocation, a project to collect such data may prove to have a high benefit-cost ratio in the intermediate and longer run.

These guidelines in no way would assure certainty in achieving the goal of food security. As such, they remain only facilitative steps which can greatly be improved. The implementation of such policy guidelines would involve tremendous capital and human resource. Thus, investments in human capital through education, nutrition, and health

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[2]National average as often used may be meaningless for they don't reflect actual regional endowment differential and local supply and demand conditions.

programs are required. The payoff is not likely to occur in the short-run. Transforming "traditional agriculture" into a dynamic scientific agriculture cannot be accomplished overnight. The first significant results should not be expected in a time horizon of less than 10 to 15 years, which still remains marginal in the life of a nation.

6.3 Suggestions for Further Research

This study has attempted to capture the impact of the major determinants of millet/sorghum supply, using an aggregated national annual time-series data from 1961 to 1979. The information loss due to the aggregation bias is obvious. This once more suggests caution in the interpretation and the use of the results.

A less aggregated investigation of supply and demand determinants on a regional basis, with possibly more information such as the index of price received and paid by farmers, may lead to greater insights.

Prices and farmers' income stabilization through on-farm grain storage under some types of government programs would be an interesting and fruitful research area on both the conceptual and implementation stages.

One of the overriding concerns of the Nigerien people and government is food security. A system rationalization model with built in animal carriers such as camels, etc. may help determine the least-cost size and location of grain warehouses and would prove to be a promising research area which would enhance the efficiency of grain handling and distribution such as short supply areas could get timely efficient help.

APPENDIX A

BACKGROUND SUMMARY ON NIGER

Background Summary on Niger

Niger is a landlocked country of approximately 1,267,000 km^2. Only a narrow strip of fertile land lying in the southern part of the country can be used for agricultural purposes. This small strip of land represents 3 to 5 percent of the total country's area; yet only 10 to 15 percent of it is under cultivation in any given year. The irrigated land area is still very small (Figure A.3).

(1) Ninety percent of Niger's 5,200,000 population (census 1977) live in rural areas, and nearly 55 percent of the population is under 14 years. The rate of the population growth is between 2.7 and 3 percent. The urban population is actually approximately 9-10 percent and is growing faster - 5-6 percent a year.

(2) The soil. Most of the agricultural soil is of sandy nature, with very low water holding capacity, and very low organic matter content.

(3) The Niger climate is highly variable. There is a short rainy season of 3 to 4 months, within the agricultural zone which lies between the 10 and 25 inch isohyets[1] (Figures A.1 and A.2). The mean highest temperature is around 40°C and mean lowest 20°C. Rainfall exceeds evaptranspiration only during two months of the year (July and August).

(4) Very poor road network. No railroad transportation facilities exist within the country. The absence of practiceable roads makes it very difficult to reach certain areas during the rainy season.

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[1] These isohyets, have been shifting over time, reducing at each shift the size of the land available for agricultural purposes (below the isohyet 250 m/m). Figure A.1 represents normal 1931-60 isohyets and Figure A.2 represents those of 1977.

Tremendous transportation cost and time cost are involved in moving product in and out within the different and highly dispersed regions of the country.

The most significant component of the transportation infrastructure within the country is a single highway running in the lower southern part of the country, from the Niger River (Tillabery) to the shores of Lake Chad at N'guigmi (approximately 1,500 km. - 950 miles).

The isolation of Niger can be best measured by looking at the distances that men and merchandizers are obliged to cover across several countries to get to the Atlantic or the Mediterranean shores. To reach the Atlantic Ocean, the shortest distance from Niamey to Cotonou is 810 km. as the crew flies or approximately 1,150 km. (under normal path). Of the 810 km., there are 438 km. of railroad (Cotonou Parakou). From Parakou, most merchandises have to be transhipped and this involves high costs, losses and long delays. The route to the Atlantic through Lome (Tago) is even longer 975 km. The route by Accra (Ghana) is: 1,170 km.

Reaching the Mediterranean coast is even more difficult since it involves traveling more than 2,500 km.: 1,560 miles across the heart of the Sahara Desert, through Algeria.

(5) Agricultural production. The most widely grown staple food crops are millet and sorghum. These two crops alone occupy nearly 95 percent of the land under cultivation in any given year. The land allocation to various crops remains, however, very difficult to determine due to the fact that many crops are grown in association (Fitures A.3, A.4, A.5).

(6) The economy. The principal macro indicators of the economy are summarized in Table A.1.

Table A.1

Basic Macro Economic Indicators, Niger

	1960	1979
Gross Domestic Product (millions of current $)	250	1,710
Agriculture as % of Gross Domestic Product (G.D.P.)	69	44
Industry as % of G.D.P.	9	32
Services as % of G.D.P.	22	24
Gross National Product (G.N.P.)		
Per capita (in US $)		270
Average rate of growth (1960-76)	-1.1%	
Public consumption % of GDP	9	9
Private consumption % of GDP	79	72
Gross Domestic Investement (%)	13	28
Gross Domestic Saving (%)	12	19
Terms of Trade (1975=100)		
Net barter terms	98	90
Debt Services		
as percent (%) of GNP	0.6	0.8
as percent (%) of Exports	3.8	3.6
Gross International Reserves		
in millions of US $	3	118

Source: The World Bank: Accelarated Development in Sub-Saharian Africa. 1981 ANNEX.

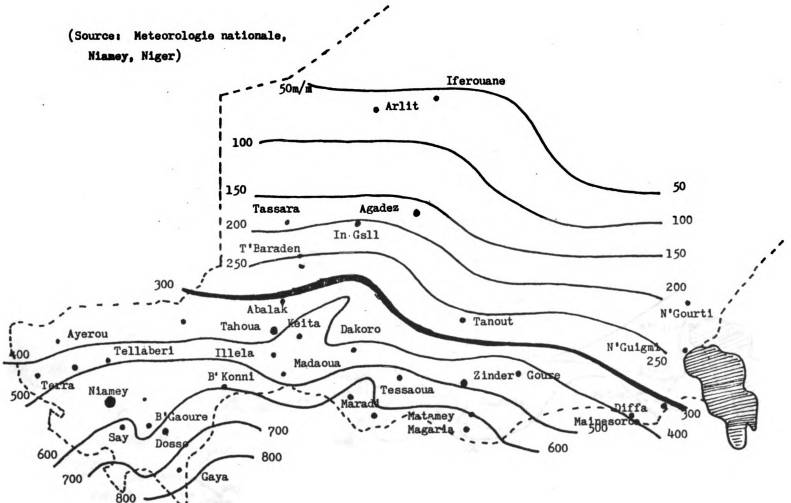


Figure A.1 Rainfall Isohyets "normal" 1931-1960

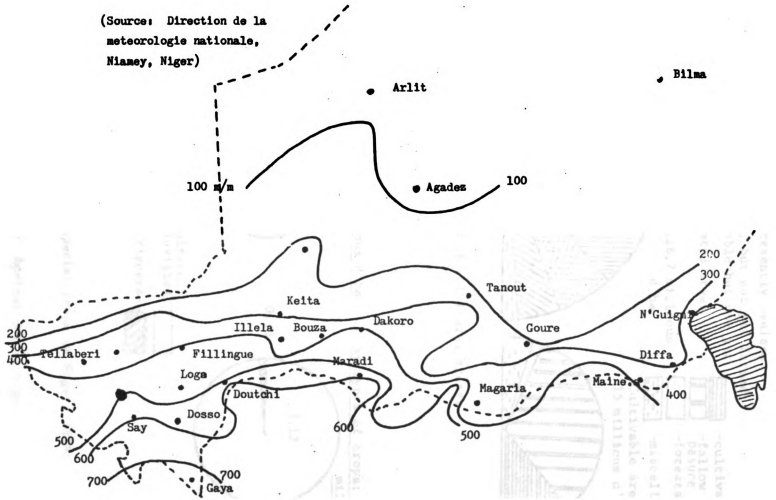
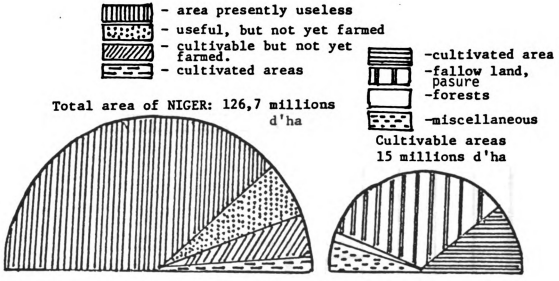
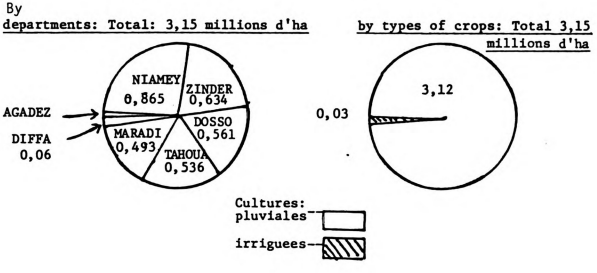


Figure A.2 Rainfall Isohyets 1977

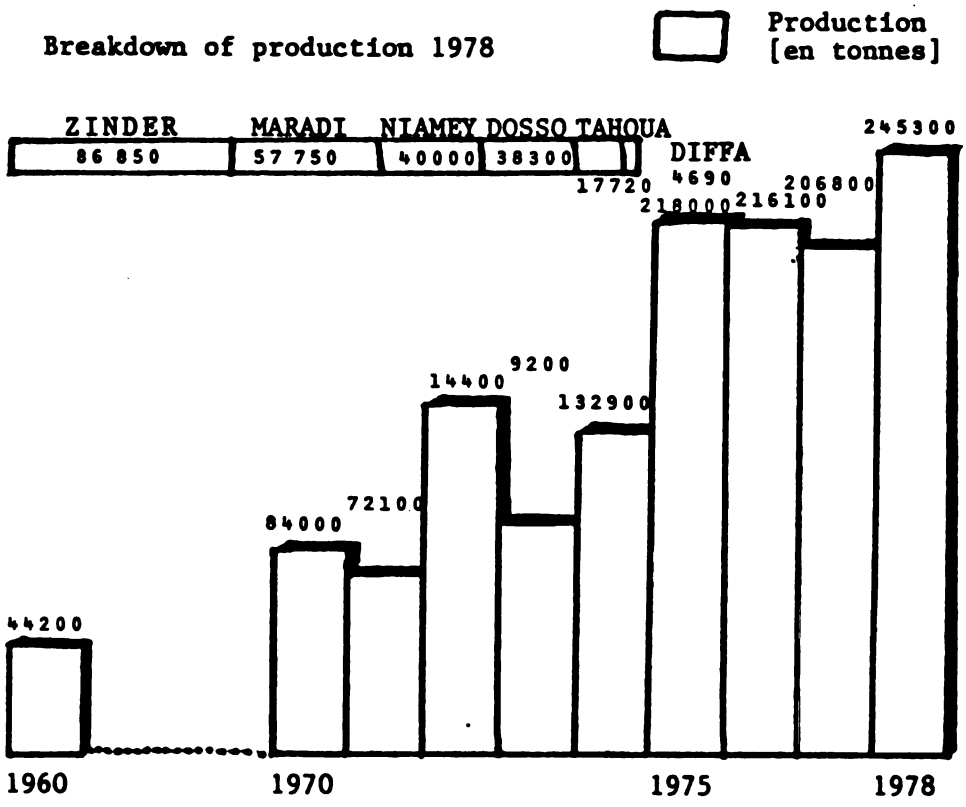


Breakdown of cultivated areas:



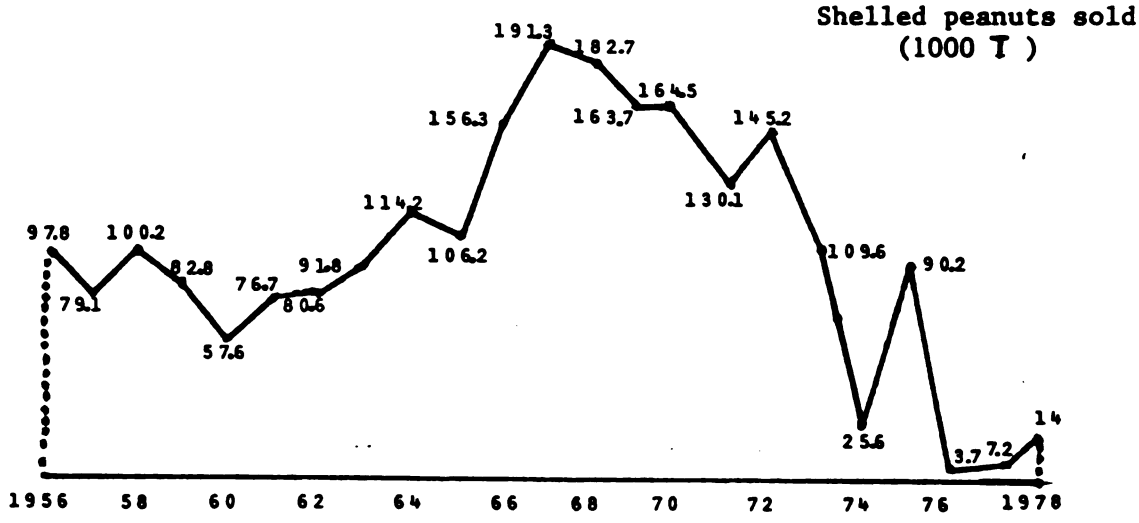
Source: Marches Tropicaux, special issue on Niger, IBID.

Figure A.3 Agriculture in Niger



Source: Marches Tropicaux, special issue on Niger.

Figure A.4 Niger: Niebe Beans



Source: Marche Tropicaux special issue on Niger (op-cit) (from Sonara's Figures).

Figure A.5 Sales of Shelled Peanuts in Niger

APPENDIX B

DATA USED IN THIS STUDY

Table B.1

Raw Data Used in This Study

Year	Production of Millet and Sorghum (000 m.t.)	Price of Millet and Sorghum CFA/kg.	Price of Peanuts CFA/kg.	Area of Millet and Sorghum (000 ha.)	Yield of Millet and Sorghum kg./ha.	Rainfall in m.m.
1961	1,056	20.25	24.00	2,094	504	545
1962	1,249	18.50	22.50	2,308	541	506
1963	1,330	17.50	21.00	2,352	565	473
1964	1,329	15.25	22.50	2,230	596	592
1965	1,055	16.25	22.80	2,275	464	507
1966	1,119	33.25	22.80	2,289	489	500
1967	1,342	21.50	18.50	2,395	561	532
1968	948	15.50	17.80	2,452	387	411
1969	1,385	35.00	20.00	2,867	483	431
1970	1,101	25.20	21.00	2,903	379	377
1971	1,225	18.28	23.00	2,935	418	385
1972	1,118	26.18	24.00	2,950	379	307
1973	753	40.00	24.00	2,456	307	284
1974	1,102	36.80	55.00	2,766	398	468
1975	835	32.70	55.00	2,484	336	470
1976	1,265	38.20	55.00	3,047	415	481
1977	1,472	41.00	69.70	3,461	425	452
1978	1,494	69.57	75.00	3,543	422	554
1979	1,606	63.95	75.00	3,639	441	479

Source: a,c,d,e,f - Nigerien Agricultural Statistical Service (T. II);
b - through 1969, computed averages from John A. Becker, Appendix #3.
1970* = Estimates. From 1970 through 1979 weighted average from Nigerien Agricultural Statistics. $(Pm_t = \frac{Pm(Qm) + Ps(Qs)}{Qm + Qs})$.

APPENDIX C

LOCATION OF THE STATIONS CONSIDERED TO COMPUTE THE AVERAGE RAINFALL FIGURES

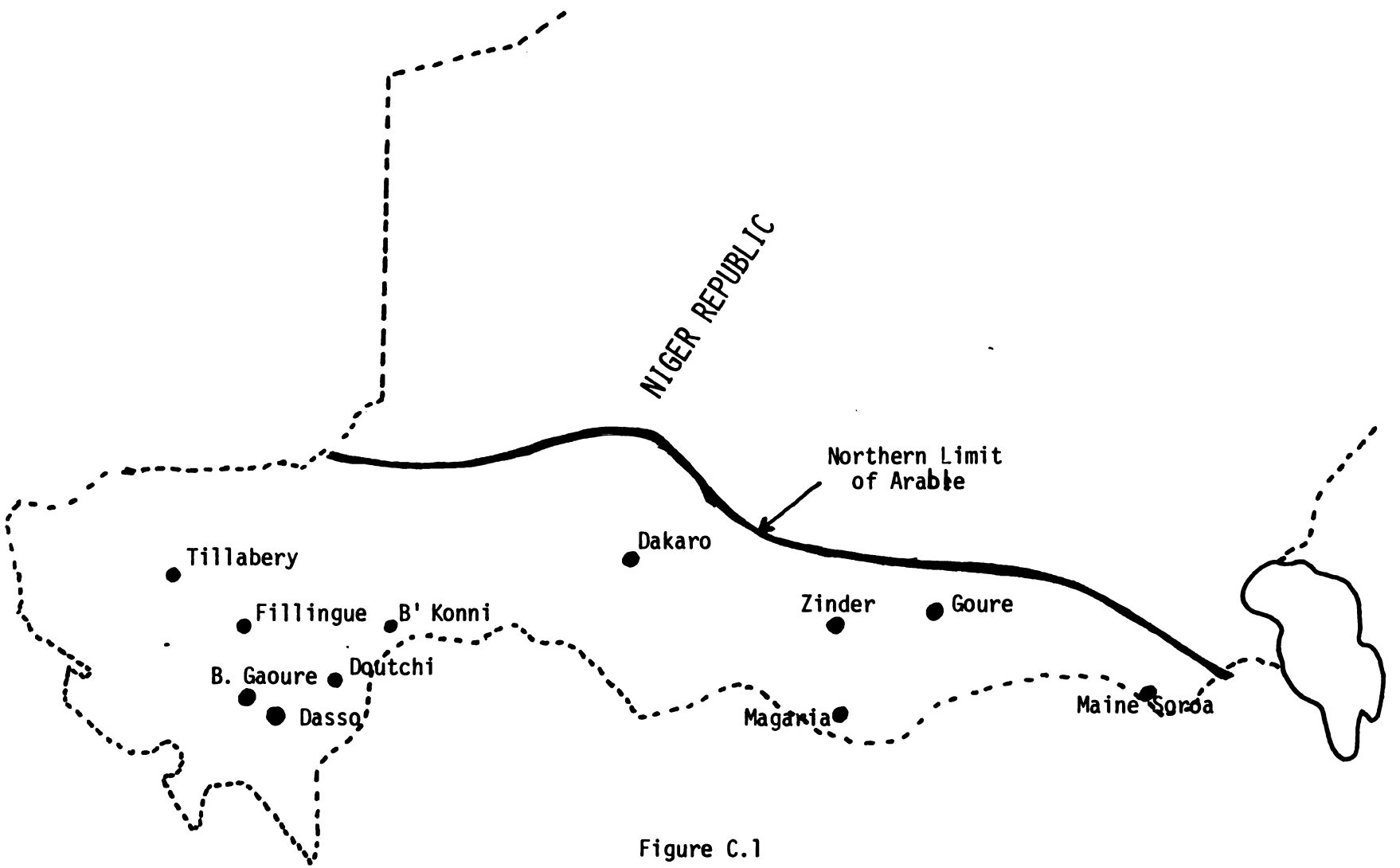


Figure C.1

Stations on Which Average Rainfall Figures Have Been Computed

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