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ECONOMICS OF THE NAMIBIAN MILLET SUBSECTOR

By

Stefan K. Keyler

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1996

ABSTRACT

THE ECONOMICS OF THE NAMIBIAN MILLET SUBSECTOR

By

Stefan K. Keyler

Facing a national grain deficit and recognizing that more than half of Namibia's population concentrates in the primary millet production zones Ovambo and Kavango (further called study zone), Namibian policymakers decided to prioritize the development of the millet sector. During the 1992/93 production year household, trader, and price surveys were conducted in the study zone. Based on the collected data this study uses descriptive and regression analyses to identify the main performance determinants of the millet sector. To predict the effects of grain policy/technology changes on household food security, millet's competitiveness, and national grain import requirements, three models are developed simulating potential reductions of millet production and marketing costs and comparing various millet processing options.

Research findings demonstrate that few farmers are millet self-sufficient and only ten percent of the millet production is commercially traded. Most people in the study zone prefer millet over maize. But millet's scarcity and high price leaves imported maize to dominate the commercial food market and attracts millet imports from Angola.

Research findings indicate that millet yields can be increased if fertilizer and improved agronomic practices are introduced. But contrary to expectations,

Okashana 1, a millet variety introduced in 1988/89, does not significantly increase farmers' yields. However, Okashana's capability to mature within three months can protect farmers from crop failures in short rainy seasons. Due to higher annual rainfall and the availability of more fertile land Kavango has a greater potential for commercial millet production than Ovambo.

Results from the simulation models reveal the following: (a) Small scale hammermill technology on the community level is the most cost effective millet processing solution; (b) Even under improved millet production and marketing conditions a quarter of rural households remain food insecure; (c) If current population growth rates persist, the study zone will further depend on grain imports.

Because many small holders lack access to adequate production resources even an improved millet sector can not solve all problems of rural poverty and food insecurity. This finding leads to the recommendation that policymakers have to look beyond the farm level toward income and employment creation in rural non-farm activities.

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To my wife Steffi and our children Annika and Florian with gratitude.

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LIST OF ACRONYMS

FIH	Food insecure household
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit, GmbH
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
MAWRD	Ministry of Agriculture, Water, and Rural Development
NAB	Namibia Agronomic Board
NDC	Namibian Development Corporation Ltd. (former FNDC or ENOK)
NGO	Non government organization
NEWFIU	Namibia Early Warning & Food Information Unit
SWAPO	South West Africa People's Organization

1. INTRODUCTION

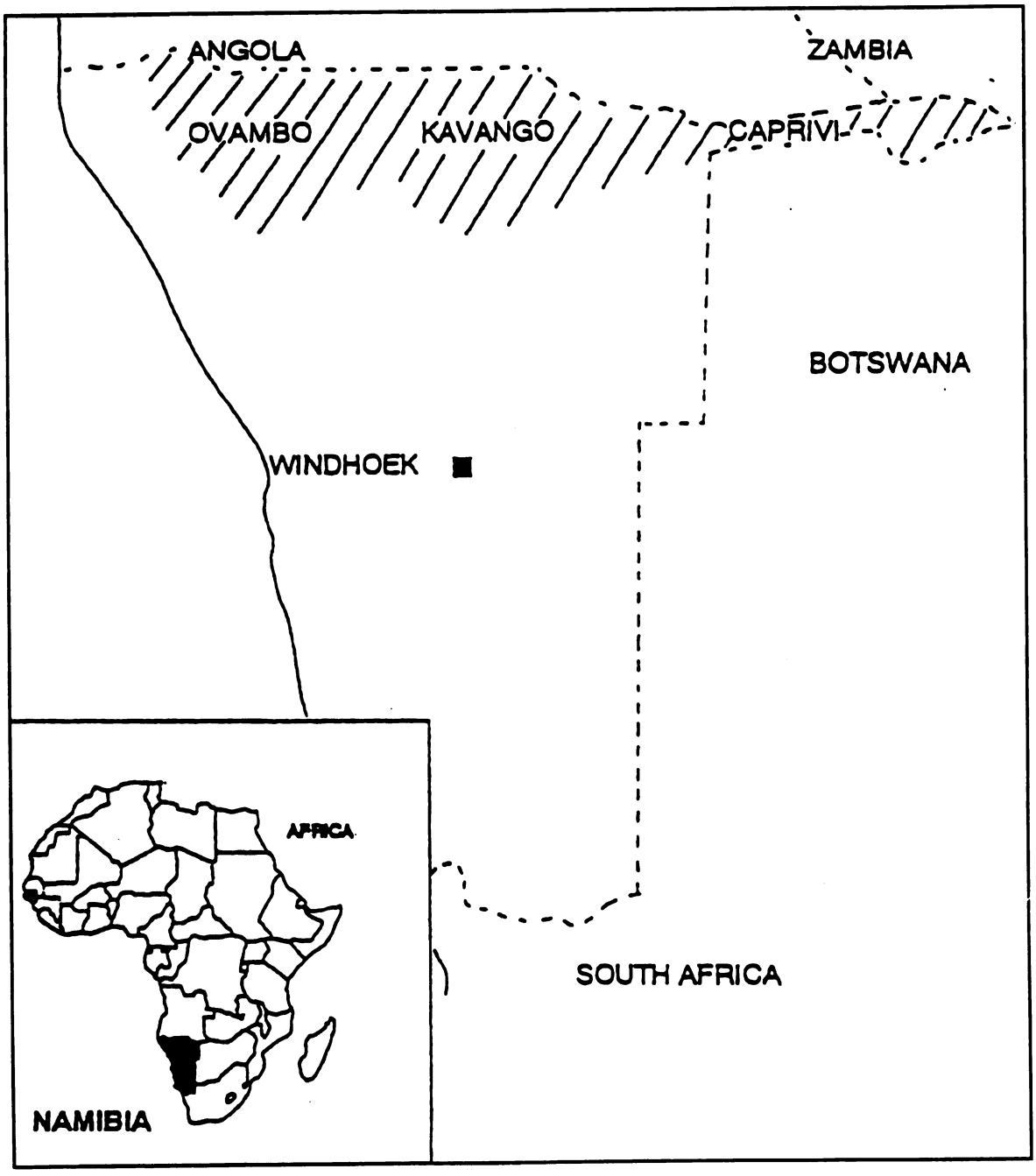
1.1. Background

After independence from South Africa in 1991, the new government of Namibia increased its efforts to improve the living conditions in communal areas. The focus of this study lies on the most populous of these areas, the two millet production zones, Ovambo and Kavango (further called study zones), with an estimated population of 680,000 or 53 percent of Namibia's total population. (Figure 1-1) While health and education in both zones have shown relatively fast progress through the installation of hospitals and schools, the progress in the subsistence-oriented sector of agricultural has been slow. Two of the factors causing the slow progress in agriculture are evident: first, the agricultural potential is generally limited by the dry and drought-prone climate. Second, private or public institutions that provide support to farmers through extension and/or provision of production inputs like fertilizer or credit are either inadequate or missing.[1]

---

[1] In their Draft of "National Agricultural Policy", November 1994, (MAWRD, 1994a) the Policy Task Force and the Directorate of Planning of the Ministry of Agriculture, Water, Rural Development (MAWRD) acknowledged that the Agricultural Extension Service located in areas of former homelands is still lacking well-trained manpower, a coherent extension message regarding crop production and communal livestock husbandry, and a suitable system to disseminate information to the large number of farmers living in remote areas. The Draft also recognizes the fact that a credit system that serves the need of the communal farmers is missing and that the current activities of Namibia Development Corporation Ldt. (NDC), the former colonial development organization FNDC, are still rather project-oriented instead of addressing the needs of rural communities.

Figure 1-1. Location of the study zones Ovambo and Kavango



Within the study zones' cropping system, about 80 to 90 percent of the calories produced by the communal farmers stem from pearl millet production.[1,2] However,during the last two decades, the production of millet could not keep pace with population growth. The decline of the average annual rainfall by at least 100 mm over the last 20 years and the increased occurrence of droughts during the last 10 years has further aggravated the situation. The expansion of crop land and cutting of bushes and trees for firewood has led, especially in Ovambo, to soil degradation and the desertification of large areas. Today, most of the rural households produce millet that covers consumption needs for only four to six months after the grain harvest (Hay, et al., 1990, p. 20).

Before independence, the continuous increase in Ovambo and Kavango's grain deficit was not perceived as a problem by South African decision makers. The male labor force from the study zones was expected to earn income for food purchases either through work in the mines of southern Namibia or through work for the South African troops deployed along the Angolan boarder. In fact, many communal households that earned money from such or similar employments balanced their grain requirements with maize meal that they purchased from the

---

[1] According to Hay, the term millet refers to pearl or bulrush millet (Pennisetum glaucum:sys., P. typhoideum, P. americanum). (Hay, et al., 1991)

[2] This estimation is based on household level yield data acquired through household surveys of the Millet Subsector Research Project, 1992/93.

urban-based retail system developed during the presence of the South African Army.[1]

1.2. Problem statement

With the achievement of independence, the grain deficit in the millet production zones became more apparent and critical. The withdrawal of the South African troops led to a decline of employment opportunities in northern Namibia, while decreased demand for diamonds and uranium on the world market reduced the need for seasonal migration labor in Namibia's mines. As a result, many communal households lost their cash income sources and experienced problems paying for their basic food needs. The influx of 33,000 returnees from Angola to Ovambo and the severe drought during the 1991/92 production season aggravated the economic situation.

---

[1] The maize meal that was and is bought by the communal population originates predominantly from commercial farms in South Africa and Namibia. The marketing of imported and nationally produced maize are controlled and facilitated by the Namibian Agronomic Board. Besides determining maize producer prices in collaboration with the Namibian government, the NAB guarantees to purchase all maize production, holds stocks, supplies millers and controls maize imports to maintain prices and margins. However, the customs union agreement with South Africa obligates Namibia to first import maize from South Africa and to only seek other sources on the international market if South Africa is unable to provide enough maize from its own production. The latter happened after the severe drought in 1992. According to the Directorate of Planning, MAWRD, total imports of white maize for consumption amounted from September 1992 until September 1993 to a total of 112,000 tons. Of these, about 63 percent came from the USA and 37 percent came from South Africa.

Under the pressure of a continuing grain deficit[1] and recognizing that the majority of Namibia's population is concentrated in the millet producing zones, agricultural policymakers decided to give priority to the development of the millet subsector. This decision coincided with statements from Namibia's Chief Agricultural Research Officer made in an ICRISAT publication that 'Okashana 1', the pearl millet variety introduced in 1989, had enabled Namibian farmers to double their harvest from about 300 kg/ha, to more than 600 kg/ha, and that with improved cultivation practices, Namibia could produce 2.4 tons per hectare in the future. It was further stated that:

> "... with better yields, the country faces the problem of processing and marketing millet flour, which has to compete with the popular maize flour from South Africa" (ICRISAT, 1991).

Based on this information, expectations among officials from the Namibian Ministry of Agriculture, Water, and Rural Development (further called MAWRD) were raised that increased millet production in Ovambo and Kavango could solve many of Namibia's pressing problems.[2]

---

[1] The hope of the newly elected government that commercial maize production would increase within a few years after independence and as such lead to reduced grain imports was soon invalidated. Between 1991 and 1994, national grain production continued to cover only between 50 and 70 percent of Namibia's domestic grain need for human consumption. During this period, commercial wheat production under irrigation increased from 6 to 12,000 tons, while commercial maize production stagnated around 40,000 tons. With an estimated annual production of about 50,000 tons, millet continued to provide about 45 percent of total domestic grain supply or 25 to 35 percent of Namibia's grain need for human consumption.

[2] Interview with the Deputy Permanent Secretary of MAWRD in September 1992 and discussions with the Head of the Directorate of Planning in

On the local level, it was expected that the number of food-insecure households could be reduced by increasing their own production. This expectation was mainly based on the claim that the use of Okashana 1 alone increases farmers' yields to 600 kg/ha. Additionally, it was expected that many households could sell surplus millet to the commercial food staple market (i.e., create income and employment opportunities for a large portion of Namibia's population).

On the regional level, it was assumed that the aggregate grain deficit could soon be eradicated and that the establishment of new marketing channels and processing facilities would generate new employment opportunities. It was anticipated, additionally, that millet meal made from surplus production could become price competitive against imported maize within and outside the millet production zones.

On the national level, government officials hoped that increased grain self-sufficiency in northern Namibia would reduce both national grain imports (i.e., improve the nation's trade balance) and the need for food aid. It was also expected that more employment and income opportunities in the northern agricultural sector could reduce the migration pressure from the communal north to southern population centers.

Responding to the government's desire to demonstrate quick improvements in the communal millet subsector, the Namibian Agronomic Board

---

1992 and 1993.

(NAB) proposed that its mandate to control the pricing and marketing of commercial grain production should be expanded to include millet. The NAB argued that with guaranteed producer prices, it would be possible to (a) acquire about 1000 tons of millet each year,[1] (b) process this millet with large-scale processing units to millet meal, and (c) sell this meal profitably to urban consumers outside the millet production zones. The government, however, opted to postpone its decision to implement price and market controls for millet.[2]

While the approval of the NAB proposal was postponed, MAWRD decided that knowledge about prevailing costs and returns of millet production and marketing was necessary to formulate an effective grain market policy for the

---

[1] It is estimated that 1000 tons cover less than 2 percent of the study zones' total millet production. Therefore, it appears, the argument to offer a stipulated price to all communal farmers was used to justify a marketing scheme that would benefit only a very few communal surplus farmers.

[2] Three main reasons led to the postponement of the government's decision to implement a controlled millet market in northern Namibia: First, a formal marketing scheme that includes (a) the physical infrastructure for intake points and processing facilities, (b) the organization of transport and other marketing activities, and (c) the recurring decision about annual producer prices would be difficult to administer (this includes the problem that millet imports from Angola could not be distinguished from domestic millet). Second, experiences of neighboring countries indicated that formal marketing schemes for food grains bear the risk of straining government finances, not only during the time of implementation, but also over a long period of time. Third, from the specifics of the NAB proposal, it became obvious that only a few and mainly very large surplus producers could benefit from such scheme. It turned out that a specific set of millet communal businessmen and surplus producers was originally meant to be targeted who had already collaborated in a pilot marketing scheme conducted by the NAB and the former colonial oriented FNDC (First National Development Corporation), operating today under NDC (Namibian Development Corporation).

communal north. It was also acknowledged that an analysis about millet's long term competitiveness in the commercial food market was required. In August 1992, MAWRD began the 'Millet Subsector Research Project' in collaboration with ICRISAT. The project's main goals were (a) to collect basic information about the current structure and conduct of the millet subsector, (b) to inform grain market policymakers about alternative ways to support millet producers, and (c) to evaluate the prospects for the commercialization of the millet production.

1.3. Research objectives

The general objective of this dissertation research is to analyze household and market-level data collected by the 'Millet Subsector Research Project' to address the following questions:

1. What are the current patterns of millet production, marketing, and consumption at the household level; i.e., what are millet subsector participants doing?

2. Which factors determine household behavior at the three subsector stages; i.e., what drives households' decisions regarding millet production, millet marketing, and grain consumption?

3. What is the scope for millet yield increases, unit cost reductions for millet production, and unit cost reductions for millet marketing in the future?

4. How would these millet subsector improvements affect the following three millet subsector performance measures: (a) the number of food insecure households, (b) the price competitiveness of locally produced and processed millet against imported maize, and (c) the need to import maize into the study zones ?

5. What recommendations can be drawn from the answers of the previous questions for grain market policy, and what priority areas can be identified for future food policy-relevant research?

1.4. Working hypotheses

The first hypothesis guiding this research is that adopting the millet variety Okashana 1 without changes in production practices neither increases yields to 600 kg/ha, nor does it increase millet production enough to close the gap between northern farmers' grain production and grain consumption needs.

The second hypothesis concerns the commercialization prospects of millet. It is hypothesized that providing incentives through guaranteed prices, as suggested by the NAB, will not automatically convert the majority of subsistence-oriented farmers to commercial producers. Two sub-hypotheses are used to support this argument. First, limitations in both millet production and marketing prevent farm households from responding to price incentives. Second, the fact that most farm households are net grain buyers indicates that once more millet can be produced, most of it will be consumed on the household level and not sold.

The third hypothesis argues, contrary to claims from the Namibian Agronomic Board and the Namibian Development Corporation, that a commercial millet market already exists, albeit, with severe deficiencies. The proof of this hypothesis is important because it could lead to requests that the government support the development of private traders rather than replacing them through a market order that grants the right of grain market control in the study zones to the NAB and the NDC as its executive branch.

The fourth hypothesis is that improved marketing conditions for locally produced crops increase the likelihood of surplus farmers selling their marketable millet surpluses; i.e., there are millet surplus farmers who would sell millet already today if (a) the marketing of their surplus grain became physically feasible, (b) their transaction costs for millet marketing could be reduced and/or (c) the reductions in millet marketing costs made locally produced millet prices competitive against imported maize.

The fifth hypothesis claims that introducing mechanical millet processing, i.e., reducing labor requirements for manual pounding and providing millet in a form that is 'ready-to-cook', makes the purchase of commercially offered millet meal more attractive to potential millet buyers. But it is also hypothesized that the type of processing technology used and the location of millet processing facilities will affect the relative price of millet meal to such an extent that they eventually become main factors influencing purchase decisions between millet and maize meal.

The sixth hypothesis argues that the development and dissemination of improved production technologies and the simultaneous improvement of millet marketing conditions generally increase household food security, but do not fully eradicate the existence of food insecure farm households in the study zones.

The seventh, and last, hypothesis states that even if potential increases in millet production are achieved, they will not be large enough to provide aggregate grain self-sufficiency in the study zones in the long-run, i.e., middle and long-term population growth in the millet production zones Ovambo and Kavango will overcompensate for potential millet production increases.

In sum, the study examines the production, marketing, and consumption of millet in northern Namibia. The answers to the research questions and the confirmation or rejection of the stated hypotheses will provide information about (a) the conditions under which the current sector operates, (b) the factors that propel or limit the development of the existing system, and (c) important outcomes that government can expect from the introduction of a better millet production technology and an improved grain marketing system.

1.5. Methodology

This research concentrates on the farm-household level within the millet subsector. Accordingly, most research questions are behavioral questions. They ask either about rural households' current behavior and its determinants or about how changes in rural households' opportunity set might affect their behavior and the performance of the millet subsector as a whole.

Because most farm households from the study zones supply the majority of their inputs that they use in farming and retain a substantial part of their output for home consumption, farmers' production and consumption must be examined within the context of the farm household. However, because of limited data available a comprehensive application of agricultural household decision theory was not possible.

For this study, three methods are employed to answer the first three research questions stated above:

The first method targets the first research question and is primarily of a descriptive nature. Descriptive analysis of quantitative and qualitative data from household and market level surveys will be used to establish a base of information about the current circumstances of subsector participants at the different sector stages.

The second method is used to answer the second research question. The driving forces in household production, marketing, and consumption behavior are determined with the help of regression analysis of cross sectional data collected during the production season of 1992/93. For a better interpretation of the regression results, attitudinal statements of household representatives regarding their motivations, goals, and limits are additionally employed.

The third method uses spreadsheet simulation models to address the following three questions about the effects potential improvements in millet production and marketing have on: (1) the price competitiveness of millet meal against meal made from maize imports; (2) the number of food insecure farm

households in the study zones; and (3) study zones' short-term and long-term grain import requirements. Each of these models relates with simple mathematical equations the millet subsector parameters: (a) hectare yields, (b) unit costs of production, and (c) unit marketing costs with one of the following subsector performance measures: (a) procurement costs per unit millet meal , (b) number of food insecure households, and (c) amount of grain import required.

Within the established models, the millet subsector parameters take the role of independent variables, while the subsector performance measures are dependent variables that have to be estimated. To predict how much the millet subsector parameters might change due to the availability of improved production technologies and due to improvements in the communal grain marketing system, informed estimates are made on the basis of primary cross sectional and secondary data collected during the Namibian Millet Subsector Research Project, 1992/93.

In order to relate millet subsector conditions with millets' price competitiveness (Question 1), simple cost accounting is used to calculate current and potential millet meal procurement costs, i.e., accrued unit cost of millet production, processing, and marketing are calculated. Based on the assumption that market competition keeps profit margins of grain market participants close to zero, the calculated procurement costs are treated as potential millet meal market prices. Millet meal prices are finally compared with both currently observed maize meal prices and with reduced maize meal prices, simulating potential price declines of grain imports in the future.

The second model relates millet production and marketing parameters with the number of food insecure households. (Question 2) For this purpose, the model identifies households as food insecure if they neither produce enough grain to cover their annual grain requirements nor earn enough cash income to purchase the amount of grain necessary to balance their grain production deficit. Based on this definition, sample households' food security levels are estimated by comparing their annual grain consumption requirements with the sum of their annual grain production and the amount of potential grain purchases they could have made with their annual cash earnings. Finally, it is assumed that the proportion of food insecure households among the surveyed household sample reflects the actual distribution of food insecure households in the study zones.

The third model relates millet subsector conditions with aggregate grain import requirements of the study zones (Question 3). For this purpose, study zones' grain import requirements are calculated by subtracting (a) the estimated amount of subsistence production of millet and (b) the estimated amount of purchased millet from (c) the aggregate grain consumption requirement of the study zones.[1]

After modeling the mathematical relations between millet subsector parameters and subsector performance measures in three separate models and determining potential changes of millet subsector parameters under improved conditions, each model is executed under four different scenarios:

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[1] The factors named under a, b, and c are extrapolated from the values estimated for the household sample of the Millet Subsector Household Surveys.

- Scenario 1 uses millet production and marketing conditions of the year 1993;

- Scenario 2 assumes, ceteris paribus, that millet production conditions have been improved according to the estimates made before;

- Scenario 3 assumes, ceteris paribus, that millet marketing conditions have been improved according to the estimates made before; and

- Scenario 4 assumes, ceteris paribus, that the improvements simulated in Scenario 2 and 3 are achieved simultaneously.

1.6. Study outline

The study is organized in three sections. The first section consists of this opening chapter and the second chapter. Chapter II shows where and how primary data were collected and how these data are organized to match the methods used during this study.

The second section of this study covers Chapter 3, 4, and 5. Each of these chapters concentrates on one millet subsector stage. Chapter 3 covers millet production by focusing on farmers' millet production practices, performance criteria of the millet production system, and main determinants of this performance. Chapter 4 deals with millet marketing issues by concentrating on price positions of millet and maize in the informal and commercial market, millet marketing in the commercial food market, and millet marketing practices of farm households. Finally, Chapter 5 centers on farm households' grain consumption

pattern and their purchasing behavior. The performance of each sector stage is assessed through descriptive analysis of household level behavior, while the main determinants of rural households' behavior are identified through regression analysis and through explanatory statements that originate directly from survey participants.

The third section of the study contains chapter 6 and 7. Based on findings from the previous chapters, three simple simulation models are developed in Chapter 6. The purpose of these simulations is to estimate the effects that potential changes in millet production technology and/or marketing conditions might have on local household food security levels, regional price competitiveness of millet against imported maize, and national grain import requirements. Finally, Chapter 7 summarizes the main findings of the study, their policy implications, and suggests areas of focus for future food policy relevant research.

2. DATA COLLECTION AND ORGANIZATION

2.1. Zone description

The two main millet production zones, Ovambo and Kavango, were surveyed by the 'Millet Subsector Research Project' during the 1992/93 production year. Each of these zones covers the area of an ethnic group with its own tradition and language. Due to Namibia's colonial past, the zones' logistical infrastructure (transport and telecommunication) as well as its social infrastructure (education and health) are poorly developed. The agricultural sector is dominated by low input levels and low yields.

Because Ovambo and Kavango were used for almost a century as cheap labor reserves by the white South Africans, many northern farm households are still used to sending each year seasonal migrating labor south to seek employment either in the mining or fishing industries or in commercial agriculture.

In the north, both zones share long borders with Angola established during the colonial period at the end of last century. Tribal culture and dialects still reach from Namibia far into the southern Angolan territory. Although this territory provides a better base for rain fed agriculture due to better soils and higher annual rainfall, many of its areas are even less populated than those of the study zones. This is probably caused by the very poor infrastructure of roads provided by the Angolan government to its southern provinces. It is therefore not surprising that despite the civil unrest over the last years in the Angolan territory, many of the study zone farmers herd part of their cattle across the border. On

the other side, Angolan farmers who produce agricultural surpluses, but can not reach Angolan consumer markets are often trying to sell these to the study zones in exchange for western consumer goods imported from South Africa.

2.1.1. Ovambo zone

Ovambo, located in the northern center of Namibia, has an estimated population of 671,000, of which 90 percent live in rural areas. Although the zone comprises about 44 percent of Namibia's total population, it covers only about 6.3 percent of Namibia's total area. Accordingly, the zone's population density is the highest in the country.

The vegetation of Ovambo is mainly bush savanna with many areas that are experiencing severe and ongoing desertification. The zone has no perennial rivers that would permit extended crop production under irrigation. With an average annual rainfall between 360 and 470 mm and 37 to 53 days of rainfall during the year, the agro-climate of Ovambo is very poor. The food grains, millet, and to a lesser extent, sorghum, are suited to this drought-prone climate.

2.1.2. Kavango zone

Kavango is located directly east of Ovambo. With an estimated population of 136,000 (roughly 95 percent of those live in rural areas), this zone comprises 9 percent of Namibia's population. With an area similar to the one of Ovambo, Kavango's average population density is much less. However, about

90 percent of the population is concentrated in a strip 10 to 20 kilometers wide, which follows the perennial Kavango river, the border to Angola.

With an average annual rainfall between 540 and 620 mm and 55 to 66 rain days per year, Kavango's agro-climate is better than that of Ovambo. The vegetation varies mainly between bush and forest. However, Kavango's annual rainfall is still so poor that again, only millet is grown as the main food grain. Because in most cases the accumulated soil moisture dries up very early, maize does not fully ripen. It is therefore only produced in small patches and eaten, like a vegetable, in a green state before the millet harvest is available.

Although production conditions are better in Kavango, only a little immigration occurred from Ovambo in the past. This is probably due to former apartheid laws imposed by South Africa prohibiting movements from one homeland to another. Still today, barriers to moving exist due to the differences in culture, language, political perception, and tribal organization fostered by the former apartheid regime.

2.2. Data collection methods

The data for this study originate primarily from four different surveys carried out by the 'Millet Subsector Research Project' in 1992/93. Two of the four surveys focused on data collection about the current conditions in the millet subsector from the household level, while the remaining two gathered

Table 2-1. List of Namibian Millet Subsector Surveys, 1992/93

Survey	Sample Size	Date and Sector Activities	Information Gathered
HH Survey (Phase 1)	320 HHs, 16 communities	December 1992: Field Preparation	family composition; food prices; input used; field preparation practices; plot data; storage practice; crop sales; taste preferences; investment needs.
HH Survey (Phase 2)	320 HHs, 16 communities	April 1993: Grain Growing Phase	non-farm income; consumption pattern; food prices; labor input into crop production; production limitations; crop sales; livestock sales; expectations from government.
Price Monitoring Survey	19 areas, 45 retail outlets, every two weeks	February 1993 to January 1994 June 1993 to January 1994	retail prices of maize meal, millet (unprocessed), bread, rice, sorghum producer prices of millet in quantities of buckets (20 liter) and 50 kg bags
HH Survey (Phase 3)	320 HHs, 16 communities	August 1993: Millet Harvest and Threshing	non-farm income, consumption pattern, food prices, labor input into crop production, millet harvest data, production limitations, crop sales, livestock sales, main expenditures, investment priorities
Field Measurement Survey	320 HHs, 16 communities	August through November 1993	size of plots used for grain production during 1992/93 season
Trader Survey	59 Millet Traders	September through November 1993: Marketing Season	business information; millet acquisition and selling information; marketing margins; topology of millet sellers; characterization of millet and maize consumers; cost of value adding activities; maize trade; perceptions about grain market development

Data Source: Namibian Millet Subsector Research Project, 1992-93

information from millet traders about the existing marketing system and monitored staple food prices in rural and urban areas during the year 1993.

2.2.1. Household level surveys

The purpose of the household level surveys was to gather quantitative and qualitative data about general household characteristics, cash income from local and off-farm employment, general crop and livestock production patterns, millet production practices including information about labor input and the use of draft power, harvest results and hectare yields, grain marketing practices, general food consumption pattern, amounts and prices of food purchases, investment goals, needs, and expectations from the government.

The household level surveys consisted of three household surveys and one field measurement survey. All four surveys aimed at the same sample of 320 rural households. Each of the three household surveys was carried out during a particular millet production phase. The first survey was launched during the period of field preparation in December 1992. In April 1993, the second survey was conducted during the actual grain growing period, when field management activities, such as weeding, insect and bird prevention, prevailed. The third household survey, conducted in August 1993, covered the time after millet harvest and threshing, when the results of the growing season became evident. The field measurement survey stretched from August through November 1993. During this period, the land that sample households had used during the 1992/93 season to cultivate grain was measured.

2.2.2. Market level surveys

The two market level surveys differed in their purposes. The trader survey aimed (a) to prove that a commercial but private millet market already exists, and (b) to identify its strengths and weaknesses. So information was gathered about commercial traders' supply, transaction costs, value adding, and selling of millet. The objective of the price monitoring survey was to identify the structure and variation of millet and maize prices in the informal and formal grain market over the period of one production season.

The millet trader survey was conducted between September and November 1993. Because rural households had just finished grain threshing, millet traded most vigorously at that time. For this survey, a total of 59 millet traders have been identified and interviewed in rural and urban areas of the study zones.

During the price monitoring survey (February 1993 through January 1994), retail prices for maize meal, unprocessed millet, bread, rice, and sorghum were gathered every two weeks in 19 different areas from a total of 45 market outlets. From June 1993 through January 1994, when millet was traded by rural producers, millet producer prices were also gathered in the 19 areas covered by the price monitoring survey.

2.3. Research data

This section explains briefly what data have been collected during the Millet Subsector Project and how the study transforms theses data into information that answers the research questions.

2.3.1. Data description

As demonstrated in the previous section, data have been collected on the household and market level across several areas of the study zones at different times during the 1992/93 production season. Table 2-2 presents an overview about the data collected during the 'Millet Subsector Research Project'.

For this study, the available data are grouped into three basic types: descriptive, quantitative, and attitudinal data whose characteristics are as follows:

Descriptive data are not only of qualitative, but also of quantitative nature. However, their information content is more valuable for the description of general behavioral patterns than for quantitative methods that try to explain what drives behavior or what could be expected if certain determinants of behavior are changed.

Examples for descriptive data are the type of inputs used to produce millet; the months when households tend to run short of their own grain production; household grain production per capita; years during which households experienced grain deficit production; the type of containers used to store, transport and measure grain; the food staples different household member

Table 2-2. Data generated by the Millet Subsector Research Project, 1992/93

VARIABLE SET	PERIODICITY / VARIABILITY	COLLECTION LEVEL	DATA TYPE
Household Characteristics	two times during production season	household level	bivariate, continuous
Household Wealth/ Assets	two times during production season	household level	bivariate, continuous
Production Practices	one time during the respective phase of production	household level	qualitative, bivariate, categorical
Amount of Seasonal Rainfall	one time at end of production season	district level	continuous
Input Use	one time during respective phase of production	household level	bivariate, categorical
Crop Output	one time after harvest	household level	continuous
Attitudes about Production Determinants	one time after ploughing and after harvest	household level	categorica
Food Consumption	two times during hunger season and after grain harvest	household level	qualitative, categorical
Grain Transport Cost	one time	household level	continuous
Local Millet Selling	two times during production season	household level	qualitative, categorical
Millet Producer Prices	after grain harvest every to weeks for six month	at the 16 survey villages and to urban markets	continuous
Commercial Millet Marketing	one time at after grain harvest	grain retail -, wholesale level	qualitative, categorical, continuous
Food Staple Prices	three times during production season; every two weeks for eleven month	household level 16 survey villages and two urban markets	continuous continuous
Millet & Maize Purchases	two times during hunger season and after grain harvest	household level	qualitative, continuous
Millet Processing Cost	one time	large and middle scale operation	qualitative, continuous

Data Source: Namibian Millet Subsector Research Project, 1992-93

types prefer; the portion that millet trade provides to the total gross income of a business; etc..

Quantitative data are defined in this study as data that can either be used in cross section regression analyses or in spreadsheet simulations. This means, that in some cases, also qualitative information, mainly from bivariate variables and previously defined as descriptive data, will be considered as quantitative data. Examples for this data category are the sex of the head of household; the ownership of plowing equipment; the use of animal power for field preparation; the distance to the nearest grain marketing place; the transportation cost to the next market place; prices that households pay for food staples; the unit costs of processing according to the types of used technology; etc..

Attitudinal data are based on survey participants' statements that try to explain the outcomes of their own behavior or the outcomes of activities done by others. Although such statements might be grounded on very subjective or judgmental perceptions in an individual case, their explanatory value is significantly increased on the aggregate level. Examples of attitudinal data are reasons given for exceptionally good grain harvests; factors identified as main limitations to grain production or marketing; ranking of various investment options based on the goal to improve the general standard of living; characterization and differentiation of typical millet and maize meal consumers; explanations of the existing price structure of commercially traded food grains; etc..

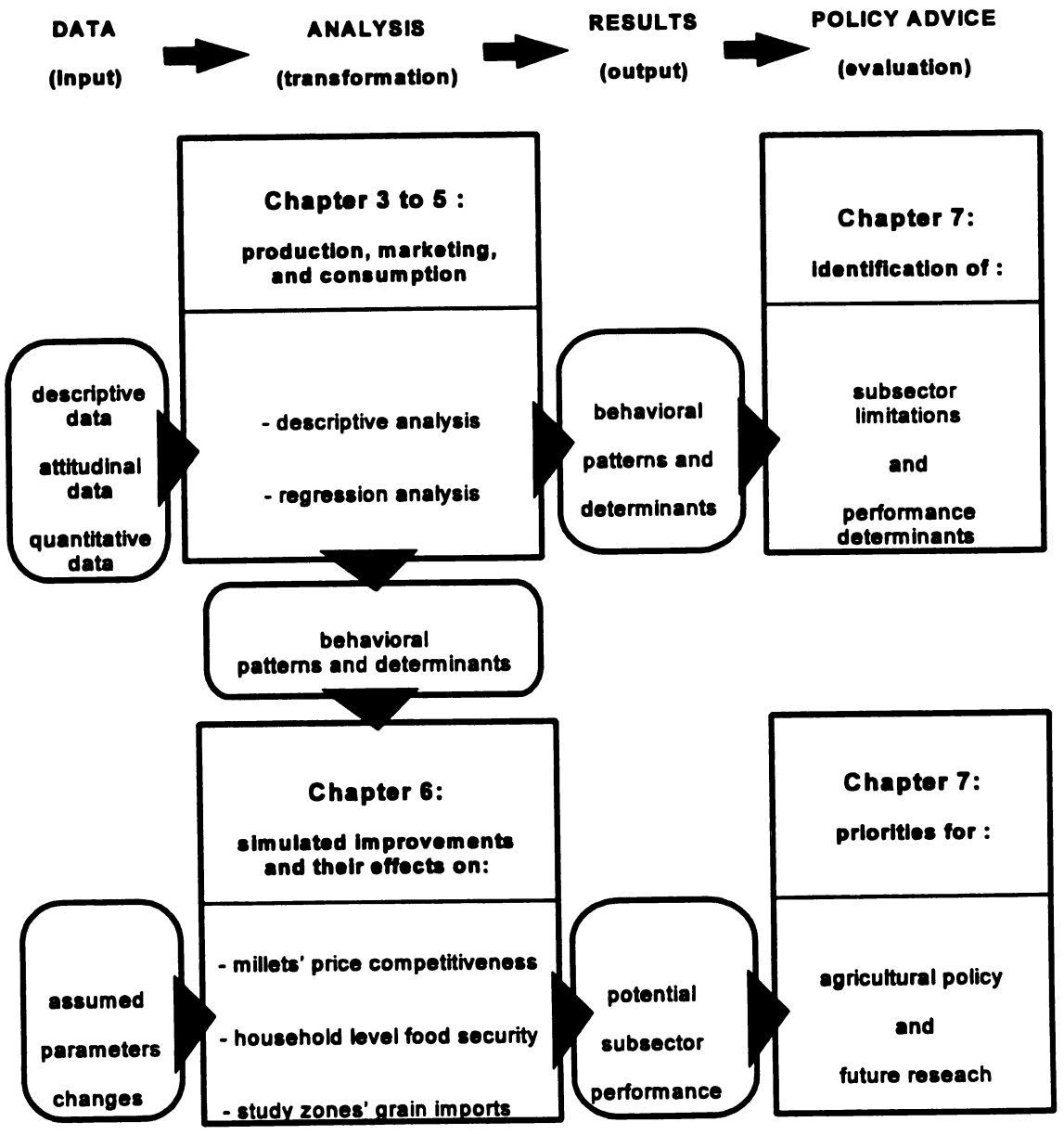
2.3.2. Data organization

Chapters 3 through 5 investigate three different millet subsector levels: production, marketing, and consumption. (Figure 2-1) These chapters transform the above described data through descriptive analyses and regression analyses into knowledge about behavioral patterns and knowledge about behavioral determinants. Part of this gained knowledge can be used to formulate policy recommendations in the final Chapter 7. The other part has to be further transformed through the application of three simulation models in Chapter 6 before grain market policymakers can be advised in Chapter 7. The gained knowledge about behavioral patterns quantifies performance parameters of the different millet subsector stages and thus directs policy- makers' attention towards the most deficient aspects of the millet subsector.

The gained knowledge about behavioral determinant identifies not only the factors that determine the performance of the subsector in general but informs decision makers about those factors that can be influenced effectively by grain market policy.

Part of both types of knowledge gained throughout Chapters 3, 4, and 5 is passed to Chapter 6. On its basis, three spreadsheet models are established that simulate improved millet production and/or marketing conditions and estimate their effects on (1) millet meals' price competitiveness against meal made from maize imports, (2) the percent of households that are food insecure

Figure 2-1. Research organization and information flow



in the study zones; and (3) the grain import requirements the study zones face in the short and long term.

Finally, in Chapter 7, the results from Chapter 3 through Chapter 6 are summarized before recommendations for agricultural sector policy are formulated and further research topics are suggested.

3. MILLET PRODUCTION

Chapter 3 is organized in three sections. The first section briefly describes the prevailing millet production system. Section 2 assesses the system performance in terms of factor productivity and contribution to household income. The final section identifies the main determinants of millet producers' performance.

3.1. Production system

To describe the prevailing system of communal millet production, this section focuses briefly on the following topics: general importance of millet, millet and other crops, rainfall pattern, cropping calendar, land use, soil fertility and fertilizer use, labor input, plowing equipment and draft power, use of local and improved seed, storage practices and losses.

3.1.1. Importance of millet

Without question, millet is the food staple of farmers in Ovambo and Kavango. Of the 320 farmers interviewed during the household surveys of the Millet Subsector Research Project, 95 percent identified millet as their most important food crop.

Grain yield data from the 1992/93 production season show that millet contributes, on average, 85 percent of households' total grain production, while the balance is supplied from sorghum and maize. Of those farm households that do sell part of their agricultural production (Ovambo: 50 percent;

Kavango: 56 percent)[1], the largest group called millet their most important cash crop[2] (Ovambo: 21 percent, Kavango: 35 percent). It is estimated that of the roughly 85,000 tons of millet produced in the study zones during the 1992/93 production year about 10 percent were commercially marketed. Although Kavango's population is only about a fourth of that from Ovambo and although Kavango's 1992/93 production was depressed due to poor rainfall half of the marketed millet came from Kavango. This is an indication that the potential for increases in millet market production lies in Kavango rather than in Ovambo.

According to an expert in breeding grains in semi-arid tropics, it seems unlikely that pearl millet's predominance in the study zones will change in the future:

> "...no other cereal is as well adapted to the climate and soil conditions nor will provide the same stability of production as pearl millet" (Bidinger, 1993, p.18).

3.1.2. Millet and other crops

Although farmers' attention is mostly focused on millet production, they do also grow sorghum and maize. However, the aggregate share of these two grains on the total grain production in the 1992/93 season was only 8 percent in Ovambo and 16 percent in Kavango. In addition to sorghum and maize, most

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[1] Information presented for Ovambo and Kavango in parentheses reflects findings from the Millet Subsector Research Project Surveys, 1992/93.

[2] Estimates from the Grain Import Substitution Model presented in Chapter 6 indicate that the amount of locally produced and marketed millet is equivalent to 12 percent of the study zones' aggregate grain consumption requirements and 27 percent of local millet production.

households intercrop beans (in Ovambo: 95 percent, in Kavango: 96 percent), bambera nuts, watermelons, and pumpkins on their millet fields.

After the grains, millet, sorghum, and maize, beans are probably the second major source of plant protein in rural household diet. Those farmers that grew beans during the 1992/93 cropping season harvested, on average, 25 kg in Ovambo and 40 kg in Kavango. But only a few farmers produce all four crops: millet, sorghum, maize, and beans. In Ovambo, the most frequently used combination of crops consists of millet, sorghum, and beans (59 percent of households), while in Kavango, the largest group of households (30 percent) produces a combination of millet, maize, and beans.

3.1.3. Rainfall pattern

The starting date, the amount, and the distribution of annual rainfall are primary determinants of the agricultural production potential. The mean annual rainfall figures from the last 50 years for the major millet production zones range from 380 mm in western Ovambo to 620 mm in eastern Kavango.

The study zones' beginning of rain season is defined as the date after November 15 when rainfall is accumulated over 3 consecutive days to at least 20 mm and when thereafter no dry spell of more than 7 days occurs within 30 days (Matanyaire, 1995). Because during the last few years dry spells occurred frequently after mid November, many production seasons became extremely short and thus produced yields that were close to those of drought years. January and February are the wettest months and by the end of April the rain

season has usually ended.

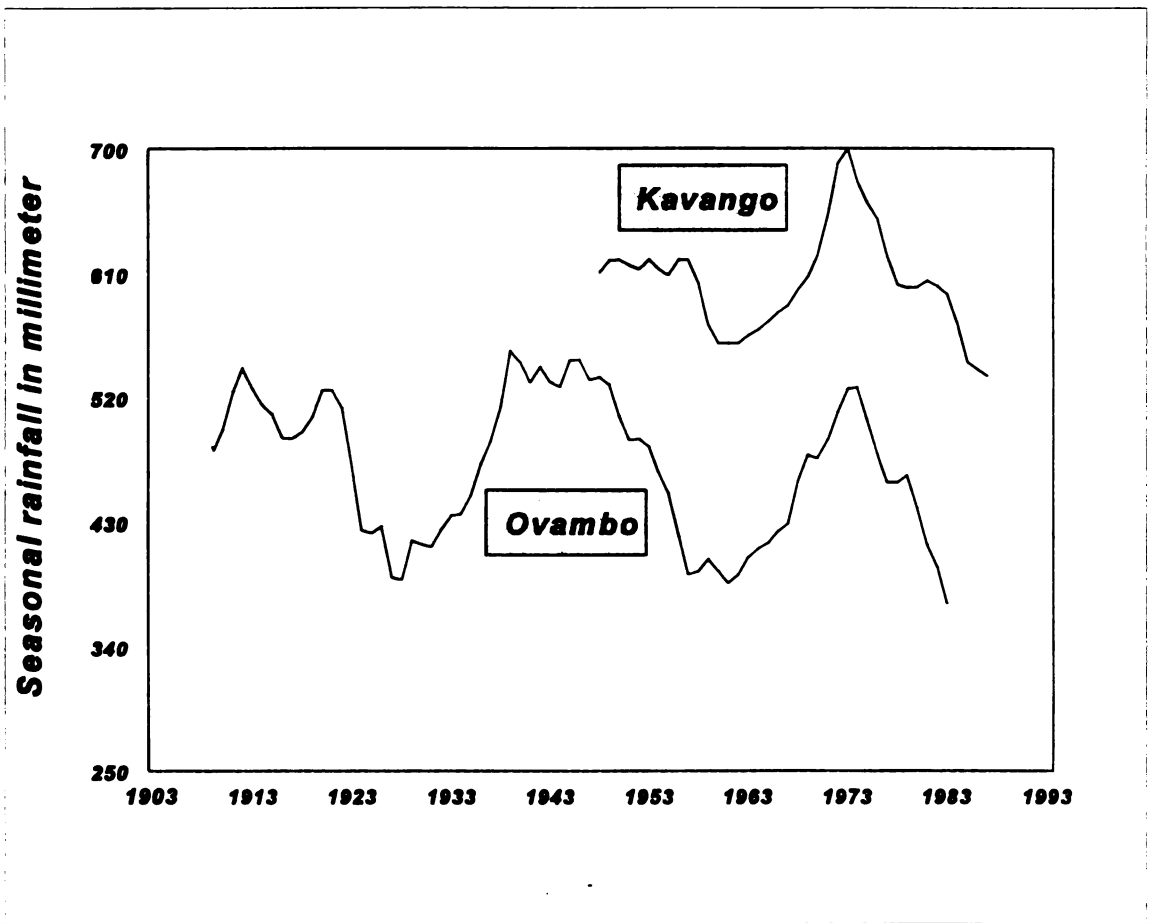
The 12 year average of annual rainfall in the study zones reveals that at the beginning of the 70s the average annual rainfall peaked the last time at about 700 mm in Kavango and at about 525 mm in Ovambo. Since then, annual rainfall continuously declined to the current low levels described in the previous paragraph. (Figure 3-1) Whether the trend of the last two decades will further continue or will come to an halt in the near future is unclear.

According to my analyses of monthly rainfall data, between 1969 and 1993[1] less than a third of all grain production seasons in the study zones can be classified as good rainfall years (Ovambo: 20 percent, Kavango: 30 percent). In both study zones about 30 percent of the production seasons can be classified as middle or still productive rainfall seasons, while 50 percent of the rainfall seasons in Ovambo and 40 percent in Kavango had to be classified as poor rainfall seasons or droughts.

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[1] Besides total seasonal precipitation, this analysis also took into consideration the start, length, number of rainfall days, and dry spells longer than a week.

Figure 3-1. Long term annual rainfall by study zone (12 year moving average)



Data Source: Namibia Weather Bureau and my own calculations

Finally, Table 3-1 compares rainfall of the grain production season 1992/93 with the average rainfall of the last 23 production seasons. The data demonstrate clearly that subzones from Kavango tend to receive more accumulative precipitation than the subzones from Ovambo. However, contrary to expectation, both rainfall data as well as sample farmers' statements about the rainfall distribution of the 1992/93 production season revealed that only western Ovambo had good rainfall distribution leading to an exceptionally good harvest in 1993. Further east, in central Ovambo, grain productivity was still acceptable during the 1992/93 season due to fairly good rainfall distribution. However, east of central Ovambo, i.e., in eastern Ovambo and the whole of Kavango, the rainfall season started very late, and during the rest of the season rainfall, distribution was very poor.

Table 3-1. Rainfall of the 1992/93 production season in comparison to the average rainfall of the past 23 years, by subzone (in mm of annual precipitation)

	Ovambo			Kavango		
	West	**Central**	**East**	**West**	**Central**	**East**
1992/93 season	287	266	na	552	481	571
1967-93 average	305	418	na	559	557	583

Data Source: Namibian Millet Subsector Project, 1992/93

3.1.4. Cropping calendar

Due to millet's predominant position in the cropping system, most farm activities are arranged around its production cycle. Once the rain season has started and enough soil moisture has accumulated, rural households start with field preparation. Due to earlier and more intensive rains, Kavango farmers plow and plant usually between the second half of November and end of February, while the majority of Ovambo households prepare their fields between the beginning of January and the end of March. Weeding, as well as insect and bird prevention, is mainly carried out between January and April. In both zones, harvesting takes place between May and June while threshing is normally finished at beginning of August (see Figure 3-2, next page).

3.1.5. Field numbers and land use pattern

Almost all Ovambo households produce their crops in one field that is located close to or around their homestead. In Kavango, 50 percent of the farm households produce their crops on two fields and another 23 percent have at least three fields. The average distance between Kavango farmers' homesteads and their fields is about 5 to 7 kilometers. The variations in the number of fields and distances are mainly caused by the different availability of cultivatable land.

FIGURE 3-2. Millet cropping calenders for Ovambo and Kavango

OVAMBO	September	October	November	December	January	February	March	April	May	June	July	August
Ploughing & Planting												
Weeding												
Harvesting												
Threshing												

KAVANGO	September	October	November	December	January	February	March	April	May	June	July	August
Ploughing & Planting												
Weeding												
Harvesting												
Threshing												

peak season less intens season

Data Source: Namibian Millet Subsector Research Project, 1992/93

In Ovambo, almost all cultivatable land is cleared and households have settled close to it. On average, only 8 percent of all Ovambo sample households stated they have cleared new land within the last five years. In Kavango, shifting cultivation is still practiced. Forty eight percent of all Kavango households cleared new land and 33 percent gave up at least one field during the same period.

Farmers' perception about the fertility of their fields varies considerably across zones and subzones. The 25 percent of the sample farmers that classify their soils as good in western Ovambo still compares favorably to the 14 percent in eastern Ovambo and the 2 percent in central Ovambo. Contrary to Ovambo, between 50 and 70 percent of all sample farmers from Kavango classify the fertility of their soils as good. Taking into consideration that, due to population growth, shifting cultivation has come to a halt in Ovambo, it is not surprising that soil fertility is more depressed in this zone.

To counter the loss of soil fertility, most Ovambo farmers use either manure (81 percent) and/or chemical fertilizer (9 percent). In Kavango, where households still have the option to clear new land for crop production, much less fertilizer is used. With the exception of households from western Kavango, where much manure is available from cattle herding, only about 5 to 8 percent of all Kavango households use manure on their fields and almost none use chemical fertilizer.[1]

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[1] Neither primary nor secondary data are collected that indicate amounts of manure and/or chemical fertilizer used by communal farmers per hectare.

3.1.7. Labor input

Within the current production system, family labor is one of the most important variable inputs into millet production. From field preparation through threshing, an average of 4.6 household members (51 percent of an average sized household) are occupied with millet production in Ovambo and 3.4 household members in Kavango (43 percent). The time that an average household spends for millet production (including harvest and threshing) is estimated at 127 workdays for Ovambo (44 workdays per hectare) and only 76 workdays for Kavango (25 workdays per hectare).

The comparison between the two zones' average number of workdays spent per hectare of crop production are also far apart. In Ovambo, farm households spent, on average, 73 workdays per hectare, while farm households from Kavango spent only 49 workdays.

In both zones, women contribute 62 percent of the labor used for millet production, while men contribute 33 percent, and children under 15 years contribute 5 percent. Women's over-proportional contribution to millet production is explained mainly by four factors:

1) A high percentage of households have no male head of household that could help with field work (Ovambo: 38 percent, Kavango: 16 percent).

(2) The analysis of seasonal migration patterns show that especially during the months of millet production, significantly more men (Ovambo: 10 percent, Kavango 6 percent) leave their homesteads to seek off-farm

employment or to visit family relatives than women do (Ovambo: 5 percent, Kavango: 2 percent).

(3) Men are traditionally less involved in crop production but more concentrated on livestock husbandry and off-farm employment. Even in cases where households have no livestock and no access to off-farm employment, it is often accepted that men help only to plow and to remove crop residuals from the fields after harvest.

(4) According to complaints from several tribal authorities, alcoholism has become a severe problem among the male population in Kavango.

Labor exchange is common in both study zones. About 29 percent of Kavango households hire laborers, which provide, on average, 39 percent millet related work of these households. Only 14 percent of the Ovambo households hire laborers. These laborers provide, on average, 13 percent of the households' millet-related work.

Again, women contribute most of the hired labor (60 to 70 percent). In Ovambo, between 40 and 70 percent of the labor exchange takes place without direct compensation through money or in kind. In Kavango only 10 to 15 percent of the hired laborers work without payment. The wage rates that are paid for agricultural laborers (cash or in kind) range mostly from N$ 1.50 to N$ 16.00 per workday. In both zones, the average wage rate is roughly N$ 5.00 per workday[1] and applies equally to both sexes.

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[1] US $1.66 per day at the 1993 exchange rate

The data indicate that Kavango farmers face generally more labor constraints for crop production than Ovambo farmers, and that those Kavango farmers who can afford it balance their own labor shortage by hiring less wealthy neighbors for money.

3.1.8. Plowing and draft power

While nearly 60 percent of the study zone farmers own a plow, less than 50 percent own both a plow and animals that could be used for plowing. Less than two percent of the surveyed households have a tractor. Due to this ownership structure, 20 percent of rural Ovambo households and 4 percent of rural Kavango households prepare their fields with a hoe.

Of the households that use animal traction for field preparation (Ovambo: 53 percent, Kavango: 86 percent), a large portion hires draft animals from neighbors (Ovambo: 42 percent, Kavango: 39 percent). Although very few farm households own a tractor, still 30 percent of Ovambo households and 4 percent of Kavango households were able to hire mechanical plowing during the 1992/93 season. The fact that the plowing service rendered by the governmental extension service reaches not more than 2 percent of communal farmers implies that most tractors hired for plowing are owned by private entrepreneurs. The fact that the number of entrepreneurs with considerable investment capital is much higher in Ovambo than in Kavango explains the zones' difference in the number of farmers that have access to mechanical plowing service.

A comparison of the relative cost for hired draft power indicates that hiring of tractors for plowing at the beginning of the 1992/93 production season was about three times cheaper in Ovambo and five times cheaper in Kavango than using hired draft animals. This result explains the often heard request from communal farmers that the government should extend its mechanical plowing service or should at least encourage private entrepreneurs to rent out more tractors.

One reason why the current demand for mechanical plowing service is not covered by the private sector probably lies in the fact that most farmers are holding relatively small amounts of arable land. This makes logistics at the time when field preparation starts with the beginning of rain season difficult and drives transportation costs high from one farmer to the next.

3.1.9. Local millet varieties and the new variety Okashana 1

Traditionally, communal farmers select their millet seed from their own production. During the 1988/89 cropping season, a new millet variety, known as Okashana 1 was introduced by the Rössing Foundation, a Namibian foundation financed by Rössing Uranium Mines of Namibia. Because of the extensive publicity about Okashana 1's high yields, government officials expect a significant yield increase from the dissemination of this so called 'improved seed.'

Because Okashana 1 matures within three months, as compared to about five months for local varieties, it reduces the risk of total crop failure during years

of short rainy seasons. Okashana 1 is also supposed to respond to chemical fertilizer and to have a softer and more uniform kernel that eases manual and mechanical processing.

On-farm research trials have been carried out during the 1992/93 season to compare the performance of Okashana 1 with local varieties. At the Second National Millet Workshop in Windhoek, November 1994, an ICRISAT scientist concluded from the trial results that:

> "...the potential gains due to improved management are much larger compared to potential gains due to cultivar change" (Matanyaire, 1994, p.9).

The on-farm trails demonstrated that improved field management that includes the use of chemical fertilizer can increase hectare yields of Okashana 1 from about 250 to 1650 kg (660 percent increase) and those of local millet varieties from about 250 to 1150 kg (460 percent increase). Matanyaire, the leading agronomist of the on-farm trails concluded that the farmers in the study zones already using fertilizer (mainly manure) may, if their management is improved and the fertilizer is used in line with the up-coming guidelines, result in a millet yield increase by at least 66 %.

Test results from the Mahanene research station demonstrated that under optimal soil and field management conditions, the gap between yields of local millet varieties and Okashana 1 narrows even more in comparison to gains from improved management. During the 1992/93 crop season, the Mahanene station achieved average yields of Okashana 1 at 3870 kg/ha and yields of local

varieties at 3630 kg/ha. Besides high doses of chemical fertilizer, further field management practice included the use of chemical insecticides and fungicides as well as occasional irrigation once the trails got under drought stress.

Most of the survey farmers that used Okashana 1 during the 1992/93 production season planted it only on a small portion of their fields. It was estimated that Okashana 1 covered only 6 percent of the total area under millet production in Ovambo and 8 percent in Kavango, respectively. Three reasons probably caused this combined use of local varieties and Okashana 1:

(1) Farmers' risk adverse behavior with regard to testing a yet-unknown variety on all of their millet fields.

(2) Farmers' goal to optimize the use of scarce labor and soil moisture by planting the slower-maturing local varieties at the beginning of the rain season and by planting Okashana 1 later if time is still available during weeding of the first planted fields.

(3) Farmers' perception about Okashana 1 as a pure cash crop and not as crop for their own home consumption. This perception was probably caused by radio announcements of the agricultural extension service advising farmers to store the Okashana 1 separately from local millet varieties because it was expected that Okashana 1's softer shell might lead to faster insect infestation during storage. Instead of acquiring separate storage containers for Okashana 1, farmers might have opted to just grow as much Okashana 1 as they planned to sell shortly after harvest.

Finally, the analysis of 1992/93 millet yields from survey farmers (see section 3.2.2. further below) reveals that Okashana 1 did not live up to the claims of its promoters that it would double average yields from 300 to 600 kg/ha on the farm level. The survey results rather indicate that local varieties out-perform Okashana in good rainfall years and that Okashana 1 has a comparative advantage only in areas with a very short rainy season.

3.1.10. Storage practices and losses

To prevent the infestation with insects, farmers try to keep freshly harvested millet separate from millet that is already longer in storage. For this purpose, the new harvest is put in clean storage containers, while older millet is consumed first. The types of storage containers used by rural households varies widely between Ovambo and Kavango households. In Ovambo, the majority of households (90 percent) use large woven baskets that are made from branches and sealed with dried clay. These storage containers can hold between one-half and two tons of grain.

In Kavango, households use various types of storage containers and combinations of these. The majority of Kavango households (60 percent) use either 50 to 70 kg bags that are made from sisal or polyethylene, or they use sealed 200 liter oil drums. The rest of the Kavango farmers use either granaries that are lined and sealed with dried clay, or they leave the millet spadix on the stem and store a bundle of stems inside or outside the house.

Households reported that millet can be stored from 1 to 8 years. However, the average numbers of years that millet can be stored in baskets or drums is closer to three years, and that of bags, granaries and storage on the stem is closer to two years.

Grain losses through spoilage and insects seem to be of a lesser concern. In Ovambo, 85 percent and in Kavango, even 93 percent of the farmers said they have no or only little storage losses. Nevertheless, a third of Kavango farmers and 82 percent of Ovambo farmers take measures to prevent insects from infesting their millet. In both zones, roughly 12 percent of farmers use chemicals against insects, while the rest of the farmers use traditional methods like ash or leaves.

3.2. System performance

To assess the performance of the current millet production system, this section concentrates on the following topics: hectares cultivated and crop yields, grain self-sufficiency at household and zone level, returns to land and labor, and contribution of millet production to total household income.

3.2.1. Hectares under cultivation

Field sizes of almost all sample households have been measured with the assistance of the agricultural extension service . Due to limited resources, only the fields that were cultivated during the 1992/93 production season were measured. Pearl millet was the crop that covered most of the cultivated land. Of

the households that produced also sorghum and/or maize, the majority intercropped these grains with millet. Because crops like beans cover relatively little space, no additional measurements have been conducted.

During the 1992/93 cropping season, Ovambo households cultivated, on average, 2.9 hectares (CV=0.87 and 0.41 hectare per adult-equivalent) of grain with a median of 2.5 hectares. Kavango households cultivated on average 3.0 hectares (CV=1.58 and 0.48 hectare per adult-equivalent) but had a lower median at 2.0 hectare.

As demonstrated in Table 3-2, the distribution of farm households by the amount of land they cultivated with grain indicates that the largest portion of farmers produce grain on 1 to 5 hectares of land (Ovambo: 76 percent, Kavango: 36 percent). However, the percentage of households producing less than one hectare is also relatively large in both zones (Ovambo: 14 percent, Kavango: 19 percent), while very few farmers produce grain on more than 5 hectare.

Table 3-2. Household distribution by hectares of cultivated land in 1992/93, by zone (in percent)

	Hectares of Grain Cultivated				
	0.1 - 1	1 - 2	2 - 5	5 - 20	20 +
Ovambo	14	20	56	9	1
Kavango	19	32	34	15	0

Source: Namibian Millet Subsector Project, 1992/93

The calculation of the average number of hectares cultivated per adult equivalent for each of the above presented hectare categories shows that households cultivating less land tend also to have less land available per household member. (Table 3-3.)

Table 3-3. Hectares of grain cultivated per adult equivalent, by hectares cultivated per household and zone (standard deviation in parentheses)

	Hectares cultivated per household				
	0.1 - 1	**1 - 2**	**2 - 5**	**5 - 20**	**20 +**
Ovambo	0.19	0.31	0.46	0.98	9.35
	(0.18)	(0.17)	(0.23)	(0.35)	(8.27)
Kavango	0.15	0.28	0.57	2.24	na
	(0.08)	((0.14)	(0.27)	(1.26)	na

Source: Namibian Millet Subsector Project, 1992/93

3.2.2. Millet yields

The yields of the 1992/93 production season were very low in most areas of the study zones. In eastern Ovambo and whole Kavango millet yields were less than 100 kg/ha. Only in western Ovambo yields averaged 590 kg/ha and in central Ovambo still 240 kg/ha.

One major cause for the poor yield performance in eastern Ovambo and in all of Kavango was the late arrival of rains during the 1992/93 survey year. In these areas the short production season especially affected the performance of local varieties that need about five months to mature. The average yields of

local varieties ranged only between 68 and 96 kg/ha. By contrast because of its faster growing potential, Okashana 1 performed relatively better in these areas, ranging from 127 to 235 kg/ha.

In the areas of western and central Ovambo with better rainfall conditions during the 1992/93 production year, local varieties clearly outperformed Okashana 1. The promoters of Okashana 1 claimed that it would double average yields from 300 to 600 kg/ha on the farm level. However, due to very good rainfall distribution in western Ovambo, local varieties yielded, on average, 644 kg/ha, while average yields of Okashana 1 were only about 234 kg/ha. In central Ovambo, Okashana 1 yielded, on average, only 106 kg/ha compared to local varieties' average yield of 259 kg/ha. The main explanation for the better performance of local varieties in good rainfall areas is their slower growth rate. This permits a longer period of time than Okashana 1 to make use of the available soil moisture and the plant nutrients.

Table 3-4. Millet yields of the 1992/93 production season, by subzone and variety (in kg/ha)

	Ovambo			Kavango		
	West	**Central**	**East**	**West**	**Central**	**East**
Local Varieties	644	259	70	68	78	96
Okashana 1	234	106	127	235	148	n.a.

Data Source: Namibian Millet Subsector Project, 1992/93

The two main reasons explaining why Okashana 1 did not reach the suggested yield level of 600 kg/ha in western Ovambo are (1) the shorter growth period that does not permit the same long use of available soil moisture and soil nutrients than is possible for local varieties, and (2) that the cropping and soil conditions under which Okashana 1 was tested to simulate farm level conditions were still better than those actually occurring in the field; i.e., the achieved yields of 600 kg/ha suggested and published by ICRISAT (ICRISAT, 1991) were not based solely on a cultivar change.

The reason why Okashana 1 performed better than local varieties in Kavango is that local varieties perform very poorly under short rainy seasons because they can not reach full maturity. The Okashana 1 can mature within 3 months; however, it needs higher soil fertility and moisture to perform better than local varieties.

Comparing their 1992/93 harvest with results from previous years most farmers from Western Ovambo (81 percent) categorized their 1992/93 harvest as "good" while majority of the farmers from central Ovambo (53 percent) classified their harvest results as "middle". Seventy percent of the farmers from eastern Ovambo and Kavango perceived the 1992/93 harvest as "poor" in comparison to previous years.

Of those farmers that categorized their millet harvest as "good", the average yield was close to 600 kg/ha. Those farmers that categorized their results as "middle" harvested, on average, about 250 kg/ha, while those who called their results "poor" harvested, on average, 125 kg/ha.

The yield increase eventually used to simulate the application of an improved technology package in the three spreadsheet models are based on Matanyaire's research results from on-farm trails. Matanyaire, ICRISAT advisor to the Namibian government reported:

> " ... a quarter of the pearl millet farmers already using fertilizer (mainly manure) may, if their management is improved and the fertilizer used in line with the up-coming guidelines, result in their pearl millet grain yields being increased by at least 66 %. Yield gains of up to 200 % are also possible" (Matanyaire, 1994, p. 9).

3.2.3. Grains self-sufficiency levels

Estimates of communal farmers' grain production have only existed since Namibia achieved independence in 1991. According to these estimates, the aggregate millet production of the 1992/93 year comes close to the five year average of the production years 1990/91 through 1994/95. (Table 3-5) However, household level data indicate that during the 1992/93 production season, very few farmers produced enough millet to cover their grain need over the period of one year.

On the basis of FAO recommendations regarding energy requirements for different gender and age groups (FAO, 1974) the annual grain needs of survey households were calculated. According to these calculations the average Ovambo household needs 1690 kilogram of grain per annum while the average Kavango household needs 1490 kilogram. (Table 3-6) With the exception of households from western Ovambo that received extraordinarily good rainfall during 1992/93, no other area within the study zones had more than 8 percent of

Table 3-5. Aggregate grain production in Ovambo and Kavango from 1990/91 to 1994/95

Season	Ovambo			Kavango		
	'000 ha	kilogram per hectare	'000 mt	'000 ha	kilogram per hectare	'000 mt
1990/91	157	350	55	8	300	2
1991/92	150	100	15	12	100	1
1992/93	143	240	34	17	260	4
1993/94	272	200	54	22	420	9
1994/95	275	120	34	12	210	3
Average	200	200	39	14	258	4

Data Source: Namibian Early Warning & Food Information System; Crop Assessment Report, March 1996

Table 3-6. Household distribution by grain self-sufficiency levels in 1992/93, by zone (in percent of households)

Grain Self-Sufficiency	Ovambo			Kavango		
	West	Central	East	West	Central	East
less 30 %	20	65	88	69	69	64
31 to 70 %	16	15	11	22	18	25
71 to 100 %	9	13	2	3	8	3
101 to 130 %	6	2	0	0	2	3
131 % plus	49	5	1	6	3	5
	100	100	100	100	100	100

Data Source: Namibian Millet Subsector Project, 1992/93

households reaching grain self-sufficiency. On average, 90 percent of all communal households reached grain self-sufficiency levels that were below 70 percent. And 70 percent of all households reached grain self-sufficiency levels that were below 30 percent.

To estimate the aggregate grain self-sufficiency levels of different areas, the grain self-sufficiency levels of individual households were calculated for the production year 1992/93 and than aggregated by production area. Due to unusual good rainfall western Ovambo reached an aggregate grain self-sufficiency level of 165 percent. The other production areas reached only grain self-sufficiency levels up to 36 percent. (Table 3-7)

Table 3-7. Household average grain consumption requirements and production during the year 1992/93 (in kg per household)

	Ovambo			Kavango		
	West	**Central**	**East**	**West**	**Central**	**East**
Requirement	1490	1780	1790	1550	1320	1600
Production	2460	640	270	340	380	520
Balance	970	-1140	-1520	-1210	-940	-1080
Self-sufficiency	165%	36%	15%	22%	29%	33%

Data Source: Namibian Millet Subsector Project, 1992/93

The average contribution of millet to households' total annual grain production ranged between 83 and 91 percent across different production areas.

With 9 to 12 percent, sorghum was the second important grain in Ovambo, while maize was the second important crop in Kavango, with 10 to 15 percent. (Table 3-8)

Table 3-8. The share of millet on total household grain production during the year 1992/93 (in percent)

	Ovambo			Kavango		
	West	**Central**	**East**	**West**	**Central**	**East**
Millet	89	91	88	83	84	86
Sorghum	11	9	12	2	6	4
Maize	0	0	0	15	10	10
	100	100	100	100	100	100

Data Source: Namibian Millet Subsector Project, 1992/93

3.2.4. Cost and returns

From a farm management perspective, millet production provides not only part of farm households' food requirements but also uses scarce household resources. To better understand the cost and returns of the millet enterprise, millet's unit cost of production, its returns to land, and its returns to labor have been calculated for households from Ovambo and Kavango and for households that reached grain self-sufficiency for one year from the 1992/93 production and those households that did not. (Table 3-9)

Table 3-9. Cost and returns of millet production during the year 1992/93, by zone and households' grain self-sufficiency

		Ovambo (n=200)		Kavango (n=120)	
Grain Self-Sufficient		**yes**	**no**	**yes**	**no**
Cost and Returns					
Gross return/value*	N$	2186	884	1871	394
Variable cost**	N$	1152	918	1490	646
Net return/value***	N$	1034	-34	381	-252
Cost per unit	N$/mt	580	1142	1012	2083
Return to land****	N$/ha	414	-13	100	-48
Return to labor	N$/day	10.30	4.78	6.86	2.29

Source: Namibian Millet Subsector Project, 1992/93

* Millet was valued at informal market prices in Ovambo at 1.10 N$/kg and in Kavango at 1.27 N$/kg.

** Household labor that contributed roughly 85 percent of the total variable cost in Ovambo and 70 percent in Kavango was valued at the current agricultural wage rate of N$ 5 per day.

*** In the case of negative net returns/values valuation household members worked at opportunities cost below the current wage rate of N$ 5 per day.

**** The return to one hectare of land was calculated by dividing households' net return/value by the number of hectare cultivated per household.

At current production practices, the major cost factors of millet production are household labor (Ovambo: 85 percent; Kavango: 70 percent), plowing service (Ovambo and Kavango: 14 percent), hired labor (Ovambo: 1 percent; Kavango: 13 percent), and seed (Ovambo: 1 percent; Kavango: 3 percent).

To calculate millet production cost household labor was valued at N$ 5 per day, the average wage rate for agricultural labor in the study zones during 1992/93. The costs for hired labor and for plowing service were directly used from sample household statements about their respective payments. Seed cost was estimated by assuming an average need of 2 kg of millet per hectare valued at informal market prices. The cost for manure was not directly included because no market value exists and most farmers who used manure used it from their own livestock. However, the amount of labor used for manure collection and distribution on the fields was captured by the data about household and hired labor spent for crop production. Due to the lack of price data of chemical fertilizer and the exact amounts used by farmers, cost for chemical fertilizer could not be included into the cost calculation.

In both zones, grain self-sufficient households had higher total variable costs but lower unit cost of millet production than households with grain deficit. While grain self-sufficient households' higher variable costs are mostly explained by their higher labor input, their lower unit costs can be attributed to significant higher yield levels. The high difference in unit production costs between Ovambo and Kavango is also caused by the different yields reached in the study zones.

The calculation of returns to one day of household labor indicate that only grain self-sufficient households generated more value through their own millet production than they could earn by working on others' fields.[1]

3.2.5. Contribution to annual household income

Of the rural labor force (adults of 15 years and older), only 38 percent in Ovambo and 65 percent in Kavango have crop production and/or livestock herding as their principal employment. (Table 3-10) The relatively low percentage in Ovambo is mainly caused by high proportions of young adults (15 through 30 years) that attend school or vocational training since independence (Ovambo: 62 percent, Kavango: 40 percent).

Major income sources for farm households in the study zones, besides crop production, are migration employment, government pensions, local employment, and livestock herding. Nearly half of all households in the study zones earn income from migration work (Ovambo: 47 percent, Kavango: 46 percent). The annual income (consumption and cash income) of households with migration employment is, on average, five to six times higher than the

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[1] It is not uncommon in developing, as well as in developed, countries that farm households accept returns to labor that are below the average wage rate for hired labor. This kind of "self-exploitation" occurs especially often when household members' opportunity costs (internal opportunity costs) are below the market's, e.g., in cases when their access to labor markets is constrained. When farmers' returns are below, but close to, existing wage rates, they often prefer to stay on the farm because they prefer their "independent lifestyle" and their closeness to nature. Also the holding of land is often seen as an additional security for which farmers are willing to forgo a certain amount of higher income.

income of households without migration employment. (Table 3-11)

Table 3-10. Occupational distribution of the rural labor force, by zone and gender* (in percent of persons older than 14 years)

	Ovambo		Kavango	
	Female (n = 433)	Male (n = 598)	Female (n = 236)	Male (n =280)
Occupation				
Farmer	45	29	75	52
Student	35	35	17	26
Employee**	13	24	6	19
Retired/Unemployed	7	12	2	3
Total	100	100	100	100

Source: Namibian Millet Subsector Project, 1992/93

* The percentage calculation is based on data gathered about all adult members of the households covered by the household surveys.
** Includes both, local self-employment and migration employment.

Although the per capita grain production of households with migration employment is higher than that of households without off-farm employment, the contribution of grain production in percent of their total annual income is much lower (Ovambo: 14 percent, Kavango: 6 percent). But with a share of 44 percent in Ovambo and 41 percent in Kavango millet production is the most important income source for households without migration employment. For those households, the second most important income sources are government pension payments to older people in Ovambo and local self-employment in Kavango.

Table 3-11. Average household income and shares of income sources, by zone and employment status of household (in US Dollar* and percent of total annual income)

	Ovambo (n=199)		Kavango (n=118)	
Households with Migration Income	yes 47%	no 53%	yes 46%	no 54%
Annual Income in US-$				
- per Household	5310	890	3,880	680
- per Capita	910	110	710	100
Income Sources in %				
- Grain Production	14	44	6	41
- Livestock Herding	1	4	1	3
- Local Employment**	3	9	9	37
- Migration Employment	76	0	79	0
- Government Pension	6	43	5	19

Data Source: Namibian Millet Subsector Project, 1992/93

* During 1993 the exchange rate of the Namibian Dollar averaged at 3 N$/US$

** Local employment is mainly based on the following occupations: laborers mainly working for the government (Ovambo 3.3 %, Kavango 3.0 %), teachers (Ov. 2.9 %, Kv. 2.8 %), skilled workers (Ov. 3.2 %, Kv. less than 1.0 %), police and armed forces (both zones 1.2 %), and health support staff (Ov. 1.7 %, Kv. less than 1.0 %).

Two major questions flow from these data: What explains such high income discrepancies between those households with and those without off-farm employment? Second, why are households that earn off-farm income engaged in millet production instead of purchasing readily available maize meal in the market?

The answer to the first question is based on the influence of the apartheid system on the communal labor market. The communal areas have been treated as reserves of cheap labor for the mines and other industries in Namibia and South Africa. It was forbidden to leave one's own communal area, which was formally called "homeland". Only males that applied for a work permit and that were classified in a category suitable for certain employment in demand were granted a pass that allowed them to leave their area for a certain period of time and migrate to a pre-defined employer. Those not allowed to leave work had to find local employment opportunities.

It is not difficult to assume that, although free movement and equal employment opportunities are officially granted to everyone since independence in 1991, many of the old employment structures persisted. Especially those who were formerly excluded from work outside their living areas face the frustration that the decline in Namibia's mining sector after independence led to a significant reduction in employment opportunities for industrial labor.

Chapter 5, which deals with grain consumption issues, will answer the question why households with significant off-farm employment still pursue the production of millet in more detail. In short, millet is preferred among the majority of Ovambo and Kavango people over maize. Even many of those who have been extensively exposed to maize meal while being migrant workers in the south still prefer millet because of its distinct taste. Because until recently, millet was not seen as a cash crop and therefore not available for purchase in the food market, migration workers who wanted to eat millet after their return from seasonal employment had to rely on the production from their own household.

The other reason why households still pursue the production of millet although maize is readily available in the commercial food market is that South Africa was not interested in introducing alternative income opportunities and/or improved production crop technologies in the homelands.

In Table 3-12 the social poverty map for Ovambo and Kavango demonstrates that rural poverty is highly differentiated in the study zones and that various approaches are needed to combat it. It shows that in Ovambo 33 percent of rural households and in Kavango 51 percent cultivate less than 2 hectare of land and that their agricultural income is on average less than a third of total household income. This is an indication that rural poor in the study zones cannot be assisted by increasing the productivity of land use alone. It means that development programs must be directed towards the various income opportunities that characterize the different categories of rural households, and

Table 3-12. Social poverty map for Ovambo and Kavango by size of cultivated land

	OVAMBO					KAVANGO				
Cultivated land in ha	**0.1-1**	**1-2**	**2-5**	**5-20**	**20+**	**0.1-1**	**1-2**	**2-5**	**5-20**	**20+**
	Percent					**Percent**				
Households	13.5	19.8	56.4	9.0	1.3	18.7	31.8	35.2	14.3	0.0
Assets										
Livestock	57	53	48	53	na	66	52	54	43	-
Plough	38	35	63	86	10	50	52	60	71	-
Motor vehicle	0	3	22	29	50	11	10	13	14	-
Adult labor allocation										
Farm work	49	46	49	29	100	53	70	62	63	-
Off farm employment	19	16	18	15	0	15	13	16	12	-
Education	20	27	29	48	0	31	14	19	19	-
Unemployment	9	6	1	3	0	0	2	0	0	-
Retired/disable	3	5	3	5	0	1	1	3	6	-
Sources of income										
Farm income	46	38	37	32	64	58	49	47	55	-
- Agriculture	32	31	33	28	63	29	25	21	21	-
- Handcrafts/trade	14	7	4	4	1	29	24	26	34	-
Wage income	20	24	40	50	16	30	43	39	31	-
Pension	34	38	23	18	20	12	8	14	14	-
	1993 U.S. Dollar					**1993 U.S. Dollar**				
Net income										
Per household	1,710	1,370	3,390	5,205	7,745	2,060	2,000	1,620	3,490	-
Per capita	255	205	360	450	590	230	290	205	430	-

Data Source: Namibian Millet Subsector Project, 1992-93

1993 exchange rate : three Namibian Dollar per one US Dollar

that these programs must look beyond the farm towards employment creation in rural-based non-farm activities linked to agriculture.

3.3. Determinants of millet producers' performance

In this section, three methods are used to identify the main determinants of farm household grain production. First, the results of the analysis of attitudinal data about the driving forces of millet production are described. Second, two regression models are presented estimating (a) the number of hectares of grain cultivated per household, and (b) the grain yields per hectare achieved. Third, correlation analysis is used to investigate how various farmers' characteristics are related to the main determinants of millet production.

3.3.1. Descriptive analysis

During the millet subsector household surveys, farmers were asked to identify problems they expected and experienced during the 1992/93 millet production season. Before field preparation in December 1992, "lack of draft animals" caused by the severe 1991/92 drought was the most often expected problem mentioned by Ovambo farmers, and the "continuation of the serious drought from the previous production year 1991/92" was the most often feared problem of Kavango farmers.

After the field preparation period in April 1993, farmers were asked about the problems that actually occurred during field preparation. It revealed that most farmers focused now less on the initial cause, drought and late rains, but

on those factors that kept them from effectively preparing their fields during the short time-window after the rains had eventually started. In retrospect, farmers in both study zones experienced shortages of labor, draft power, plowing equipment, and seed, and had problems in getting the promised plowing services from the agricultural extension service.

The figures in Table 3-13 demonstrate that Kavango farmers had relatively more problems with field preparation under severe time pressure. The reason for this discrepancy is that Kavango farmers are commonly used to starting their field preparation in mid-November soon after the arrival of the first rains.[1]

At the end of the field preparation period in April 1993, most farm households had not cultivated as much land for grain production as they had intended initially (Ovambo: 74 percent, Kavango 96 percent). The reasons given by the majority of farmers for not having reached their planting goals were: (1) lack of land, (2) lack of family or paid labor, (3) lack of seed, and (4) lack of draft power.

In Ovambo, the most severe constraints of cultivating adequate millet are: (1) limited arable land and (2) a shortage of seed. While the first is more a concern of farmers with little cash income and crop land less than 5 hectares, the latter is more of a concern for farmers that earn migration income and have land

[1] The fact that the millet cropping season of Ovambo is about one-and-a-half months shorter than the one in Kavango explains also why so many more tractors are used in Ovambo for plowing compared to Kavango.

Table 3-13. Field preparation constraints during the year 1992/93 (in percent of farmers*)

	OVAMBO (n = 200)		KAVANGO (n = 120)	
CONSTRAINTS	**expected**	**actual**	**expected**	**actual**
poor or late rains	11	19	40	14
labor shortage	7	7	6	42
lack of draft power	23	14	7	36
lack of equipment	5	24	7	25
problems with plowing service	1	16	0	13
lack of seed	6	10	3	6

Data Source: Namibian Millet Subsector Research Project, 1992/93

* The percentage figures do not add up to 100 percent because sample farmers could indicate more than one problem; i.e., the percentage figures represent the number of farmers raising a certain concern.

holdings larger than 5 hectares. In Kavango the most severe constraints of cultivating adequate millet are: (1) Lack of family labor, the most often stated constraint affecting especially farmers (a) that do not earn migration income and are, therefore, unable to balance their shortage by hiring field workers and (b) that cultivate more than 5 hectares of land. (2) Seed shortage which affected especially farmers with land holdings less than 5 hectares. This is probably due to the fact that smaller farmers were more likely forced by the severe drought of

the previous season in 1991/92 to eat their last grain reserves. (3) Lack of draft power was mainly a concern of farmers that cultivated more than 5 hectares.

Finally, a third of all Kavango farmers, independent from their cash earnings and the size of their land holding, claimed they had problems in gaining access to more land. This seems to contradict the statements made on previous sections about Kavango's abundance of arable land compared to Ovambo. However, general availability of land is a necessary, but not sufficient condition, for land accessibility.

Table 3-14 indicates that many Kavango farmers could not cultivate enough land (access land) because they were short of labor and draft animals. The other component of inadequate accessibility to land has to do with the fact that shifting cultivation practices used in Kavango led to field locations far away from farmers' homesteads. This causes problems in transportation and travel time.

In Ovambo, seed shortages and limited access to land were mayor problems for many of those earning cash income and/or those with larger land holdings. Those Ovambo farmers with cash income sources complained also about the lack of field workers to hire. Those with larger field holdings had problems with the cost of hiring draft power for plowing.

In Kavango, farmers with cash income from migration employment have problems with accessing arable land, the availability of seed, and lack of family labor. Although they have money to pay, many others complain that hired labor is too expensive. Among those farmers that have larger land holdings, lack of

Table 3-14. Land cultivation constraints during the year 1992/93, by zone, migration income, and number of hectare cultivated (in percent of farmers*)

	OVAMBO			KAVANGO		
	Households earning migration income					
Percent share on all sample farmers:	**yes 46**		**no 54**	**yes 43**		**no 57**
Cultivated not enough:	78		70	96		97
Constraints:						
Limited land access	27	<<	36	31		31
Seed shortage	28	>>	16	33		34
Labor shortage						
- lack of family labor	11		10	35	<	42
- lack of labor to hire	14	>>	4	10		9
- cost to hire labor	9		7	22		23
Lack of draft power						
- lack of draft power						
- cost of draft power	4		0	16	<<	27
- government ploughing	8		6	12		14
service inadequate	7		3	6		6
	Households cultivating more than 5 ha					
Percent share on all sample farmers:	**yes 8**		**no 92**	**yes 12**		**no 88**
Cultivated not enough:	75		73	100		96
Constraints:						
Limited land access	19	<<	33	29		31
Seed shortage	19		22	14	<<	36
Labor shortage						
- lack of family labor	0	<<	13	43		38
- lack of labor to hire	0		4	14		9
- cost to hire labor	6		9	21	>	13
Lack of draft power						
- lack of draft power	6		3	29	>	21
- cost of draft power	13	>	6	29	>>	11
- government ploughing service inadequate	6		5	14	>	6

Data Source: Namibian Millet Subsector Research Project, 1992-93

* The percentage figures do not add up to 100 percent because sample farmers could indicated more than one problem. i.e., The percent figures represent the number of farmers raising a certain concern.

family labor is by far the most often mentioned constraint, while lack of own draft power and high cost of hired draft power are following suit.

3.3.2. Regression analysis of millet area cultivated

The above analysis of attitudinal and descriptive data indicates that farmers' millet production is influenced by a complex set of factors. The following two sections attempt to test the significance of the effects of these factors through econometric techniques. Due to the lack of historical information on key variables affecting the land allocation patterns of households in the survey sample, the estimated regressions are based on cross-section data gathered during the millet subsector household surveys of the production year 1992/93. The two main explanatory variables of grain production are: (a) the number of hectares of millet planted and (b) the yield per hectare achieved by farm households, are estimated in two separate equations and two consecutive sections.

The cross-section regression model of the millet area planted by farm households during the 1992/93 production season encompasses variables that identify (a) the expected returns to resource investment in millet production and (b) the production resources available to households. Because millet is the only important cash crop in the study zones, relative returns to alternative cropping enterprises are ignored. To identify differences in the magnitude of effects from the independent variables in the two study zones, the area of millet cultivated is estimated separately for Ovambo and Kavango.

In the following, the regression equation used for the amount of area cultivated by rural households in the 1992/93 production year is presented together with a brief description of its variables. The variables were all tested for correlation and had met the test:

MILLETHA = f (MILLETPRICE, LANDCONSRT, HHLABSHRT, ADLEQUWRKDS, DRFTANIMPLOW, PLOWHOE, PLOWTRAC, EXPOKASH, CASHINCOME)

where:

MILLETHA	= area of millet planted (HA)
MILLETPRICE	= local price for millet at the begin of planting (N$/KG)[1]
HHLABSHRT	= household experienced labor shortage (DUMMY, 1 = yes))
ADLEQUWRKDS	= adult equivalent workdays spent for grain production (No. in '00)
DRFTANIMPLOW	= ownership of draft animals and plow (DUMMY, 1 = yes))
PLOWHOE	= use of hoe as sole plowing equipment (DUMMY, 1 = yes)
PLOWTRAC	= use of tractor for plowing (DUMMY, 1 = yes)
EXPOKASH	= experience with Okashana 1 before 1992/93 (DUMMY, 1 = yes)
CASHINCOME	= annual cash income from non-cropping activities (N$ '000)

Table 3-15 below presents both the averages and standard errors of the continuous variables and the percentage distribution of the binomial variables included in the regression model.

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[1] 'Local' means that representatives of each survey household stated the millet price they faced personally during field preparation time. In cases where respondents could not supply a millet price, the average of the price data stated by the sample farmers from the same community was substituted.

Table 3-15. Characteristics of the millet hectare regression variables, by zone

VARIABLE	OVAMBO (n = 114) MEAN	S.E.	KAVANGO (n = 50) MEAN	S.E.
MILLETHA (HA)	2.89	1.89	3.02	3.33
MILLETPRICE (N$/KG)	1.46	0.97	1.49	0.21
LANDCONSRT (1 = yes)	76 percent = 1		92 percent = 1	
HHLABSHRT (1 = yes)	10 percent = 1		24 percent = 1	
ADLEQUWRKDS (No. of '00)	1.39	1.19	0.79	0.77
DRFTANIMPLOW (1 = yes)	30 percent = 1		36 percent = 1	
PLOWHOE (1 = yes)	18 percent = 1		0 percent = 1	
PLOWTRAC (1 = yes)	36 percent = 1		12 percent = 1	
CASHINCOME (N$ '000)	7.65	12.10	6.34	7.22
EXPOKASH (1 = yes)	43 percent = 1		14 percent = 1	

Data Source: Namibian Millet Subsector Research Project, 1992/93

The independent variables used and the reasons for their inclusion in the estimated equation are as follows:

(a) the local price for millet at the beginning of planting. (MILLETPRICE) In the study zones, crop production is mostly carried out to provide food for farmers' household consumption. However, because 22 to 23 percent of the interviewed farmers from Ovambo and Kavango identified millet as their most important cash crop, it can be assumed that high millet prices at planting time encourage farmers to cultivate more millet area for the market .

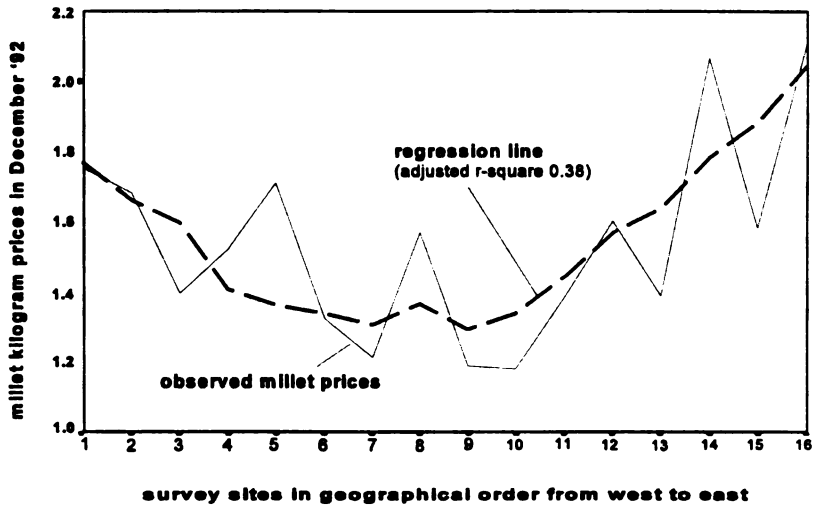
It is expected that the response to millet price changes will be stronger in Kavango because in Ovambo only 30 percent of all interviewed farmers stated they sell millet in some years. In comparison, 54 percent of the interviewed Kavango farmers stated they sell millet in some years, and an additional 18 percent said they sell millet every year.

Also, those households that do not sell grain have more incentive to cultivate lager millet fields if millet prices in their community are higher. Through the cultivation of larger millet fields, these households try to prevent grain deficit production that would force them eventually to purchase high priced millet from their neighbors. To account for the effect that local producer and consumer prices of millet have on the amount of land cultivated, the average of millet prices stated by the sample farmers within one survey community at the beginning of field preparation in December 1992 (MILLETPRICE) is included as a determinant of the number of hectares produced per household. It is hypothesized that the area of millet under cultivation is positively related to the variable MILLETPRICE.

It can be assumed that the millet prices faced by farmers are dependent on factors like local grain supply, price of major substitutes, distance to next shop, roads, market, etc.. Some of these various factors have been tested regarding their relation to millet prices at the beginning of the field preparation period. The tests indicate that two factors, geographic location of survey site and maize meal prices are strongly correlated with millet consumer prices. Figure 3-3 demonstrates the relations between millet prices, location of survey

sites, and maize prices by displaying both observed millet prices in geographical order from west to east and the estimated regression line based on the following variables: observed maize meal prices, ordinal numbers of survey sites (ordered from west to east), and the square of the latter. The adjusted R-Square of this regression was 0.38.

Figure 3-3. Millet prices regressed by maize prices and location (prices from the 1992/93 field preparation period)



Data Source: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

(b) the access to fertile and uncultivated land (LANDCONSRT). Within communal farming areas, various factors influence farm households' access to uncultivated land. Traditionally, tribal chiefs assign land to individual heads of households for payments in kind, and today also in the form of money. The amount of payment is usually negotiated and depends to a large extent on the

relationship between the head of household who wants to acquire land and the local authority. Between 75 and 90 percent of the interviewed farmers stated they face problems expanding their fields. In Ovambo, the most often mentioned obstacles with regard to field expansion were "scarcity of arable land nearby" and "lack of equipment" to clear land. In Kavango, the most frequently stated problem claimed was lack of money to hire labor for de-bushing and clearing new land.

To control for the effects of "lack" of equipment on the amount of cultivated land, the three variables DRFTANIMPLOW, PLOWHOE, and PLOWTRAC are included in the regression further below. To estimate the effect of the residual problems farmers have with field expansion, the dummy variable (LANDCONSRT) is included in the equation. The variable takes the value one if representatives of a household stated that it has difficulty clearing new land. The coefficient of the variable LANDCONSRT is expected to be negative as a result of the negative effect that these problems have on the amount of hectares under cultivation.

(c) farm households' status of labor availability for crop production. (HHLABSHRT) Within a farm household, the number of members available for crop production can vary significantly over time; e.g, if household members find seasonal off-farm employment or if children and young adults that usually help with fieldwork are admitted to distant boarding schools, household capacity to cultivate land is significantly reduced. To account for the effect of labor scarcity that individual households faced during the 1992/93 grain production season, a

dummy variable (HHLABSHRT) is included in the regression model. The variable takes the value one if farmers stated that labor shortage prevented them from plowing the amount of land they had intended before the actual start of the 1992/93 production season. The coefficient of the variable HHLABSHRT is expected to be negative as a result of the negative effect that labor scarcity has on the amount of hectares under cultivation.[1]

(d) the number of workdays household members spent for grain production during the whole production season. (ADLEQUWRKDS) Even if households are capable of plowing a larger number of hectares, labor scarcity for tasks like weeding, prevention of crop damage from insects and birds, harvesting, and threshing might limit the amount of land eventually cultivated. To account for the effect that the use of household labor for the total millet production process has on the amount of land cultivated, the estimated number of adult-equivalent workdays that households actually spent for grain production during the 1992/93 production season (ADLEQUWRKDS) is included as a determinant of the number of hectares cultivated per household. The number of ADLEQUWRKDS per household is based on farmers' statements about the start and end of the various phases of millet production (field preparation, weeding,

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[1] To test whether labor shortage (HHLABSHRT) itself is caused by the fact (a) that households earn income from migration employment or (b) that households live in a certain zone, simple correlation tests are carried out. The Pearson's coefficients indicate that households' statements about labor shortage for fieldwork are (a) negatively correlated with their annual migration income in '000, albeit, at a non- significant level (coef.= -.0134; p=0.816; n= 304) and (b) positively correlated with the Ovambo zone at a 89 percent confidence level (coef..= .0923; p= .108; n= 304).

harvesting, threshing) and the number of hours individual household members worked, on average, per week on crop production during these production phases. Regardless of sex, all workers below 15 years of age or older than 55 years of age were attributed a weight of 0.5, while all workers of an age between these two categories were given a weight of one. The breakdown and weighing by age was based on the conventional equivalence system used by agricultural research institutes that measure farm labor inputs in semi-arid tropics. It is hypothesized that the area of millet under cultivation is positively related to the variable ADLEQUWRKDS.[1]

(e) farm households' ownership of a full set of draft animals and a plow (DRFTANIMPLOW). The majority of the sample farmers used draft animals for plowing during the 1992/93 cropping season. However, only farmers with a full set of draft equipment/animals are assured of the timely availability of draft power when rains start and plowing can commence. The farmers that hire draft power usually face a reduced amount of time for plowing because they have to wait until the owners of the animals have finished the preparation of their own

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[1] To test whether the amount of workdays households spent for grain production corresponds to the amount of labor available to them, a simple linear step regression is carried out. In this regression, ADLEQUWRKDS is the dependent variable, while the independent variables are (a) household members (HHMB), (b) household adults (HHAD), and (c) household adult equivalent (HHAE). The variables HHMB and HHAE were excluded from the model because they yielded insignificant results (p= .62 and p= .59 respectively). However, the number of adults per household (HHAD) is strongly positively related to the number of workdays spent for crop production. It is estimated that an additional adult increases the number of workdays by 18 (coef. 18.27, p= .0000, n= 317).

fields. It is hypothesized that less time for plowing, in combination with the relative high cost for hiring draft animals has a negative effect on the amount of land cultivated by those hiring draft animals. To account for the described effects, a dummy variable (DRFTANIMPLOW) is included in the regression model. The variable takes the value one if farm households own a full set of draft animals with a plow. The coefficient of the variable DRFTANIMPLOW is expected to be positive as a result of the positive effect that the ready availability of animal draft power has on the amount of hectares cultivated with grains.

(f) the type of plowing equipment used that is different from draft animals with a plow (PLOWHOE and PLOWTRAC)[1] . During the 1992/93 field preparation period, about 20 percent of the surveyed households from Ovambo and 4 percent of Kavango cultivated their fields with a hoe. On the other hand, about 30 percent of the sampled households from Ovambo and 4 percent from Kavango hired plowing services from private tractor owners. Accordingly, the two dummy variables PLOWHOE and PLOWTRAC are indicators of the type of plowing equipment farmers use instead of or in addition to plowing with draft animals. PLOWHOE takes the value one for households that used solely the hoe for field preparation and zero otherwise. PLOWTRAC equals one for

[1] It has to be noted that the ownership of a full set of draft animals and a plow (DRFTANIMPLOW) does not mean that farmers did not use the hoe (PLOWHOE) or did not hire a tractor. (PLOWTRAC) It is more an indication that such ownership allowed farmers to start field preparation in time independently from the availability of other equipment. Accordingly, the three variables DRAFT, PLOWHOE, and PLOWTRAC are not mutually exclusive options of field preparation technologies and do not require an n-1 dummy matrix to avoid statistical problems.

households that used mechanical plowing service at least for part of their land and zero otherwise. Due to insufficient cases of farmers from Kavango using solely the hoe for field preparation, the variable PLOWHOE is excluded from the regression of the millet area of Kavango. The coefficient of these variables represents the marginal contribution of the corresponding type of plowing equipment used. The coefficient estimated from PLOWHOE (used solely the hoe) is expected to be negative because field preparation by hand is more labor intensive and more time-consuming than plowing with draft animals. The coefficient estimated from PLOWTRAC (use of a tractor) is expected to be positive because mechanical plowing tends to be less labor intensive and less time-consuming than plowing with animal traction. Thus, mechanical plowing helps to overcome (1) the constraints arising from a short window of time for field preparation, and (2) households' labor shortage during this particular period of time.

(g) farmers' experience with the millet variety Okashana 1 (EXPOKASH). Because the newly introduced variety Okashana 1 requires the same spacing as local varieties, its use cannot explain household differences in the amount of land under millet cultivation. However, farmers that cultivate more land are more likely to have tried out Okashana 1, because of two reasons: First, for many subsistence farmers, the switch from local millet varieties to an unknown, but supposedly improved, variety bears an unpredictable risk. Therefore, as observed during the 1992/93 production year, most of the farmers that tried Okashana 1 planted it only on a small portion of the land under millet production.

It is hypothesized that larger farmers are more likely to try Okashana 1 because they produce generally more food grains and thus can more easily bear the risk of planting a new variety on part of their land (reduced risk adversity).

Second, Okashana 1 was from the beginning of its distribution not only characterized as an early maturing variety that can cope with relatively short production seasons, but was also promoted as a cash crop with a high yield potential on fertile soils. It is hypothesized that farmers that are capable of producing marketable surplus are more likely to use Okashana 1 than local varieties. Therefore, a dummy variable (EXPOKASH) was included in the regression that indicates whether farm households had grown Okashana 1 at least once before the 1992/93 season (one) or not (zero). The coefficient of the variable EXPOKASH is expected to be positive due to the positive relation between adoption or trial of a new variety and (1) the size of land farmers already cultivated, and (2) the perception of Okashana 1 is basically a cash crop and the fact that those farmers that sell grain tend to have larger fields than those who pursue solely subsistence

Two reasons explain why those farmers who actually used Okashana 1 during the production season 1992/93 are not the base of the dummy EXPOKASH. First, it is assumed that not all farmers that tried Okashana 1 in the past might have continued to use it until the 1992/93 survey period. Secondly, after the drought of the 1991/92 production year, the Namibian government and various NGOs distributed Okashana 1 seed widely among farmers to counter potential seed shortages. Employing the actual Okashana 1 use during the

1992/93 production year as determinant of land cultivation would probably under-represent those larger farmers that had already tried Okashana 1 before the 1992/93 production season but did not continue to grow it. It would also over-represent small farmers that would not have tried the new variety but had to do so due to the seed shortage caused by a preceding drought.

(h) the level of farm households' annual cash income (CASHINCOME). Cash income from activities other than crop production (e.g., migration or local employment, livestock herding, and government pensions) might allow farmers to acquire production inputs such as the right to produce on a certain land, seed, field preparation equipment, fences against livestock, fertilizer, hired labor, plowing services, etc.. To account for the effect that cash income has on the area of millet planted per household, the amount of cash income that sample households earned during the 1992/93 period (CASHINCOME) is included in the equation.[1]

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[1] Because the variable PLOWTRAC already controls the use of tractors for plowing, the CASHINCOME variable is meant to estimate the residual impact cash income has on the amount of land cultivated. Correlation tests show that the use of tractors for plowing is strongly related to farmers' cash income, their zone, and the geographic location of their community between west Ovambo and east Kavango. The number of hectares cultivated does not seem to be related to tractor use. The test results are presented below:

		CASHINCOME	HECTARES	ZONE*	LOCATION**
PLOWTRAC	**Coefficient**	.2351	-.0090	.2857	-.2734
	(Cases)	(319)	(247)	(319)	(319)
	2-tailed Significance	.000	.887	.000	.000

* Ovambo = 1, Kavango = 0 ; ** ordinal numbers of survey sites ascending from west to east

The correlation estimates between the CASHINCOME variable and those variables already included in the models indicate that for Ovambo, the variables LANDCONSRT, PLOWHOE, PLOWTRAC, EXPOKASH, and for Kavango, the variables DRFTANIMPLOW and PLOWTRAC are correlated with farmers' cash income earnings (Table 3-16). These results explain why CASHINCOME can only be included in the model to test its residual effects on hectares cultivated, i.e., the effects that are not yet controlled for, like the right to produce on a certain land, hired labor, fertilizer, seed, and fences against livestock.

Table 3-16. Correlations of the CASHINCOME to other model variables, by zone (Pearson's coefficients, 1-tailed Sig.)

	Independent model variables							
	MILLET-PRICE	LAND-CONSTR	HHLAB-SHRT	ADL-EQU-WRKDS	DRFT-ANIM-PLOW	PLOW-HOE	PLOW-TRAC	EXP-OKASH
OVAMBO								
coef.=	.054	-.265	.048	.024	.018	-.111	.237	.197
p=	.255	.001	.278	.384	.415	.089	.002	.008
KAVANGO								
coef.=	-.023	.042	-.024	.125	.144	-.092	.291	.077
p=	.419	.355	.415	.133	.100	.206	.004	.288

Data Source: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

Both simple-linear and log-linear functional forms of the above described equation were estimated for Ovambo and Kavango. The simple linear form was preferred to the log-linear form on the basis of a careful analysis of the sign and

the significance of the estimated coefficients, the size of the coefficient of determination adjusted for the degrees of freedom (adjusted R-Square), and the residuals.

Table 3-17 presents the main statistics of the estimated simple-linear equations. The levels of the adjusted R-Square indicate that the model explains 28 percent of the variability of the number of hectares under millet cultivation in Ovambo and 41 percent of the respective variability in Kavango. These moderate levels are not uncommon for cross-sectional data. They are attributable to: (a) the categorical nature of most of the independent variables considered, (b) the impact of the severe drought of the preceding crop year, and (c) the late start of the 1992/93 cropping season under investigation. The severe drought of 1991/92 and its aftermath had reduced the number of available draft animals or significantly weakened animals that had sustained the long dry season. The late arrival of rains for the 1992/93 cropping season caused many farmers to delay plowing and to cultivate less land than normal. Despite the moderate R-Square values, the signs of all regression results are consistent with expectations, and most of the considered explanatory factors demonstrate a significant relation to the number of hectares of millet cultivated. In the following interpretation of the regression results, the base (control) case represents a farm household that plowed its land with hired draft animals (DRFTANIMPLOW=0, PLOWHOE=0, PLOWTRAC=0), that neither stated constraints on clearing new land (LANDCONSRT=0), nor claimed labor shortage as a cause for not having reached its planting goal (HHLABSHRT=0), and that

had not used the improved variety Okashana 1 before the 1992/93 season (EXPOKASH=0).

Table 3-17. Estimates of the millet hectare equations, by zone

	OVAMBO			KAVANGO		
VARIABLES	COEF.	S.E.	SIGNIF.	COEF.	S.E.	SIGNIF.
Constant	2.33	0.16	0.00	- 1.29	2.76	0.64
MILLETPRICE	0.14	0.38	0.39	3.21	1.79	0.08
LANDCONSRT	- 0.90	0.51	0.02	- 2.41	1.34	0.07
HHLABSHRT	- 0.92	.12	0.08	- 0.57	0.87	0.51
ADLEQUWRKDS	0.35	.33	0.01	0.58	0.49	0.25
DRFTANIMPLOW	0.58	.43	0.09	0.67	0.84	0.43
PLOWHOE	- 0.84	.36	0.06	–	–	–
PLOWTRAC	0.11	.01	0.75	3.04	1.19	0.01
EXPOKASH	0.87	.31	0.01	3.10	0.05	0.01
CASHINCOME	0.03	.56	0.06	0.05	1.07	0.28
Adjusted R-Square		0.28			0.43	
Case Number		114			50	

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

Holding all other factors constant, a rise of local kilogram prices of millet (MILLETPRICE) by one Namibian dollar increases the area of millet cultivated per household by 0.14 hectares (5 percent of the average amount of land cultivated) in Ovambo but by 3.21 hectares (105 percent) in Kavango. In other words, while Ovambo farmers respond to significant millet price increases only with a marginal expansion of their fields, Kavango farmers respond to the same

price change by doubling their field sizes. Taking into account that only in Kavango a larger number of farmers sell millet every year, while in Ovambo less than a third of the farmers is actually able to sell millet every other year, the differential responses to price incentives are not surprising.

The comparable small response in Ovambo can also be explained by the increased population pressure in most parts of Ovambo that led to stationary land cultivation practices and a more rigid structure of land distribution.[1] As demonstrated in Figure 3-4, the MILLETPRICE variable was closely correlated to the geographic location of the survey site and to the price of imported maize. In December 1992, millet prices and maize meal were especially high in the remote subzones western Ovambo and eastern Kavango. The correlation to location might indicate that field sizes in remote areas are larger because there is less land constraint. The correlation to prices of imported maize may indicate that high maize prizes in western Ovambo and eastern Kavango, due to high transportation costs and quasi-monopoly positions of rural grain traders, make increased efforts in millet production necessary.

In Kavango, the average distance of 5 to 6 kilometers between farmers' homesteads and their cultivated land indicates that many Kavango farmers still have the option to find new arable land away from their densely populated neighborhood. The small percentage of Kavango farmers that use manure to

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[1] Under current production practices, farmers who try to increase their millet production have traditionally opted to do this through field size expansion rather than through intensification measures that are independent from the amount of cultivated land.

increase land productivity (5 to 8 percent) helps explain why the expansion of cropland is the predominant measure to increase total millet production.

As hypothesized, the indication of difficulties with field expansion has a negative and significant effect on the amount of land cultivated per household. The estimated marginal effect of the existence of problems with field size expansion (LANDCONSRT) is a decrease of 0.9 hectares of millet area per Ovambo household and a decrease of 2.41 hectares per Kavango household. As explained previously, the most frequently mentioned constraints with respect to field expansion were, in Ovambo, "scarcity of land near by" and "lack of equipment" and, in Kavango, "lack of money to hire labor for de-bushing and clearing new land." The difference in the magnitude of the effects between Ovambo and Kavango can be explained by the greater availability of arable land in Kavango, which leaves Kavango households to be more affected by intrinsic constraints regarding field expansion.

When sample farmers mentioned 'labor scarcity during the phase of field preparation' as a problem and when all other factors are held constant, the expected level of millet area is reduced per household in Ovambo by 0.92 hectares and in Kavango by 0.57 hectares, respectively. The coefficient of the HHLABSHRT variable in the equation applied to Kavango farmers is insignificant. The relatively strong and significant effect (8 percent) of labor scarcity on the millet area in Ovambo is probably due to the large number of Ovambo households that use either the hoe as the only field preparation equipment (20 percent) or that use still the hoe in combination with draft power

from animals or tractors (58 percent). The comparable percentages of Kavango households using the hoe are much lower (4 and 27 percent), indicating that in Kavango, human labor is involved in field preparation to a much lesser extent than it is in Ovambo.

The positive effect that the amount of labor used for grain production has on the millet area supports the view that also the availability of household labor for production phases after planting influences households' land allocation decisions. Ceteris paribus, an increase of labor spent on total millet production during the 1992/93 cropping season (ADLEQUWRKDS) by 10 adult-equivalent workdays is associated with millet area increases per household of 0.35 hectares in Ovambo and 0.58 hectares in Kavango. Although only significant at a 25 percent level, total labor availability for grain production demonstrates a larger effect for Kavango, where labor shortage is more often stated than in Ovambo.

The ownership of draft animals, as well as the use of plowing equipment that is different from a plow drawn by animals, has the expected effects on the cultivated millet area. The estimated marginal effect of the ownership of a complete set of draft equipment/animals (DRFTANIMPLOW), which allows field preparation in a timely manner, is an increase in millet area per farm by 0.58 hectares in Ovambo and 0.67 hectares in Kavango. The coefficient of the DRFTANIMPLOW variable is in the Ovambo equation significant at the 10 percent level, while the respective coefficient in the Kavango regression is insignificant.

The effect of using only a hoe for field preparation on the millet area per household (PLOWHOE) is negative and significant at the 6 percent level for Ovambo. The expected area of millet per household decreases by 0.84 hectares for households that used human labor equipped with a hoe rather than hiring a set of draft equipment/animals. Due to lack of household cases that use only human labor in combination with a hoe in Kavango, the PLOWHOE variable had to be excluded from the Kavango equation.

As hypothesized, the effect of using a tractor for plowing is positive on the millet area per household in both zones. However, for Ovambo farmers, the use of a tractor (PLOWTRAC) does not seem to be significantly related to the millet area per household. This finding can be explained by the high cost for mechanical plowing service and the uncertainty of its timely arrival that led two thirds of the farmers that hired mechanical plowing service also to use a hoe or draft animals. Contrary to Ovambo, the marginal effect of mechanical plowing is quite large (3.04 hectares) and significant (0.01 percent) in Kavango. Because only four percent of the interviewed Kavango farmers received plowing service during the 1992/93 production season, and because the correlation coefficient of 0.35 between Kavango households' annual cash income and tractor use is the highest among the variables included in the Kavango equation, it is assumed that mainly wealthy farmers with larger land holdings have access to mechanical plowing.

As discussed, the variable indicating that farmers had used Okashana 1 before the 1992/93 production season (EXPOKASH) can not explain the variability of the amount of hectares under millet cultivation. However, as expected, the use of Okashana 1 before its wide distribution in 1992/93 seems to be a good predictor of farmers with larger fields. For households that used Okashana 1 before the 1992/93 production year, the expected area of millet under cultivation is increased by 0.87 hectares in Ovambo and by 3.10 hectares in Kavango. Both coefficient estimates were significant at the level of one percent.

The most plausible explanations for the strong and significant relation between experience with Okashana 1 before the 1992/93 production season and hectare size are as follows: First, larger farmers are probably less risk adverse regarding the trial of a new variety. Second, farmers who reached the level of millet self-sufficiency and opted to produce millet beyond their own need probably tried Okashana 1 as a cash crop. The second explanation is tested by calculating the correlation coefficients between the EXPOKASH variable and three bi-nominal variables (SELLNEVER, SELLSOMEYEARS, SELLEACHYEAR) indicating the general millet selling frequency of surveyed farmers (Table 3-18).

The correlation results presented in Table 3-18 suggest that (a) farmers who do not sell millet at all have less likely used Okashana 1 before the 1992/93 production season, and (b) farmers who do sell millet at least in some years have more likely used Okashana 1 before the 1992/93 production season. Because of the low number of farmers selling millet every year, no statistically

significant results could be obtained. The correlation results generally confirm the explanation that those farmers that tend to sell millet had tried to sell Okashana 1 as a cash crop before 1992/93.

Table 3-18. Correlations of EXPOKASH and millet selling frequencies, by zone (Pearsons' coefficients)

	Farmers' millet selling frequency					
	sell never		sell some years		sell each year	
	coef. =	-.2030	coef. =	.2030	coef. =	na
OVAMBO	n =	198	n =	198	n =	198
	p =	.004	p =	.004	p =	na
	coef. =	-.1506	coef. =	.1316	coef. =	.0061
KAVANGO	n =	117	n =	117	n =	117
	p =	.105	p =	.157	p =	.948

Data Source: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

The variable CASHINCOME was included to estimate the effects that purchases of fertilizer and seed, hired labor, and payments to tribal authorities for permission to hold crop land have on the amount of cultivated land. The obtained regression results indicate that the variable CASHINCOME affects the number of cultivated hectares very little. In both study zones, the increase of the annual cash income by N$ 1000 (CASHINCOME) has only a small but positive effect on the estimated millet area. This finding might be explained partly by the fact that alternative employment activities not only provide the financial means to acquire or access the mentioned production inputs but also reduce (a) the number of household members available for millet production and (b) the need to

produce millet as a cash crop.

An additional explanation for the relatively low estimated effect of annual cash income on households' millet area is the incorporation of other variables in the model, like LANDCONSRT, PLOWHOE, PLOWTRAC, EXPOKASH, and DRFTANIMPLOW, that are at least to some extent correlated with household cash income and thus reduce the explanatory power of the CASHINCOME variable itself.

3.3.3. Regression analysis of millet yields

The purpose of the following section is, first, to give an overview about the cross-section model of households' millet yields per hectare, second, to describe the independent variables employed in the equation, and third, to present and interpret the estimated coefficients of the model.

The cross-section model of millet yields per hectare achieved by farm households during the 1992/93 production season encompasses variables that reflect (a) natural production factors that are beyond human control, (b) direct production inputs that are under farmers' control, and (c) household characteristics that might influence indirectly the availability and use of production resources. To better identify zones' differences in the magnitude of effects from the independent variables, yields of millet are estimated separately for Ovambo and Kavango. In the following, the regression equation used is presented together with a brief description of its variables. The variables are all tested for correlation and had met the test:

MILLETHAYLD = **f (RAIN92/93, AEWRKDS/HA, MNRALLFLDS, USEOKASH, CASHINCOME, GENHHEAD)**

where:

MILLETHAYLD = amount of millet harvested per hectare (KG)
AEWRKDS/HA = adult-equivalent workdays per hectare (No. in '0)
MNRALLFLDS = use of cattle manure on all fields (DUMMY, 1 = yes)
USEOKASH = use of Okashana 1 during 1992/93 season (DUMMY, 1 = yes))
CASHINCOME = annual cash income from non-cropping activities (N$ in '000)
GENHHEAD = gender of head of household (DUMMY, 1= male)

Table 3-19. Characteristics of the millet yield regression variables, by zone

	OVAMBO (n = 147)		KAVANGO (n =47)	
VARIABLE	**MEAN**	**S.E.**	**MEAN**	**S.E.**
MILLETHAYLD (KG)	392	559	198	415
RAIN92/93 (MM in '00)	3,62	1,79	3,21	1,81
AEWRKDS/HA (No. in '0)	6.8	7.4	5.5	8.1
MNRALLFLDS (1 = yes)	51 percent = 1		19 percent = 1	
USEOKASH (1 = yes)	47 percent = 1		36 percent = 1	
CASHINCOME (N$ '000)	7.8	11.7	6.9	8.2
GENHHEAD (1 = male)	64 percent = 1		81 percent = 1	

Data Source: Namibian Millet Subsector Research Project, 1992/93

The independent variables used and the reasons for their inclusion in the estimated equation are as follows:

(a) the local rainfall during the 1992/93 production season (RAIN92/93). As described in Part 1 of Chapter 3, rainfall is the most important input for dryland crop production in Namibia. On average, the Kavango zone receives more and earlier rain than Ovambo. However, during the 1992/93 production season, rains arrived very late in Kavango, and during the short growing period left, the distribution of the rain was poor. According to farmers' statements, the area of western Ovambo received the best rainfall season that it had for years. To account for the effect that rainfall has on millet yields, the total precipitation (millimeters in '00) of the 1992/93 production season measured by the rainfall stations closest to the 16 survey sites (RAIN92/93) is included in the equation of millet yields. Although it is possible that poor distribution of local rains can nullify or even reverse the effect of an adequate amount of rain in a production area, it is hypothesized that millet yields are positively related to the variable RAIN92/93.

(b) the number of adult-equivalent workdays that household members spent per hectare of planted millet (AEWRKDS/HA) during the whole 1992/93 production season. At the prevailing low state of production technology, human labor is assumed to be one of the most important determinants of millet yields in northern Namibia. The availability of enough labor to weed grain fields and to protect the crops against insects and birds often decides whether farmers' efforts during field preparation are redeemed at harvest time. To account for the variation of labor input into millet production, the number of adult-equivalent

workdays that farmers spent per hectare of cultivated millet (AEWRKDS/HA) during the 1992/93 production season is included in the equation as determinant of millet yields. As for the preceding regression model of millet area per household, the estimation of AEWRKDS/HA was based on farmers' statements about the start and end of the various phases of millet production and the number of hours individual household members worked per week on crop production during these production phases. Regardless of sex, all workers below 15 years of age or older than 55 years of age were attributed a weight of 0.5, while all workers of an age between these two categories were given the weight of one. The amount of total labor spent for millet production was eventually divided by the number of hectares of millet cultivated per household. The coefficient of the variable AEWRKDS/HA is expected to be positive as a result of the positive effect that the availability of labor for millet production has generally on field management and thus on the productivity of land.

(c) the use of manure and chemical fertilizer on millet fields (MNRALLFLDS). As described in Part 1 of Chapter 3, the combined effects of low clay and low organic matter content result in soils with low water holding capacity and low fertility. To counter the loss of soil fertility through continuous cultivation of millet on the same fields, Ovambo farmers use either manure (81 percent) and/or chemical fertilizer (9 percent). In Kavango, where households still have the option to clear new land for crop production, much less fertilizer is used. Only between 5 and 8 percent of all Kavango households use manure on their fields and less than 1 percent use chemical fertilizer. However, of the cases

employed in the regression equation, only 51 percent of the Ovambo farmers and only 19 percent of the Kavango farmers fertilized all of their fields with manure or chemical fertilizer during the 1992/93 production year. Of those Ovambo farmers who do not, or only partly fertilize their fields, the majority explain their behavior with lack of animals and therefore lack of manure. Of the respective Kavango farmers, the majority explained their behavior with (1) lack of equipment to transport cattle manure to their far distant fields, and (2) the high cost of chemical fertilizer. To account for the effect fertilization has on farm households' average millet yields, the dummy variable (MNRALLFLDS) is included in the regression model. The variable takes the value one if farmers stated they used manure and/or chemical fertilizer on all of their fields during the 1992/93 grain production. The coefficient of the variable MNRALLFLDS is expected to be positive as a result of the positive effect that fertilizer use has on crop yields.

(d) the use of the new millet variety Okashana 1 (USEOKASH) during the 1992/93 season. The distribution of Okashana 1 at the start of the 1992/93 production season through the Namibian Ministry of Agriculture and NGOs led to increased use of this fast maturing millet variety. To measure the effect that the use of Okashana 1 seed had on farm households' overall millet yields, the dummy variable USEOKASH is included in the equation. The variable takes the value 1 if farmers had cultivated at least part of their millet fields with Okashana 1. It is hypothesized that the amount of millet harvested per hectare is positively related to the variable USEOKASH.

(e) the amount of farm households' annual cash income (CASHINCOME). If farm households are limited in the amount of labor they have available for crop production, cash earnings from non-crop production related activities might be useful to compensate for this shortage through hiring labor. Hired labor can be used directly for field work or production related activities like fence making around crop fields or gathering of cattle manure for fertilization. Higher cash incomes might also enable households to have timely access to the service of draft power during field preparation time, which eventually lengthens the actual period of plant growth and leads to higher yields of millet. Additionally, the amount of cash income available might influence households' decision whether and how much chemical fertilizer to apply on crop fields. To account for the effect that cash income has on the use of production inputs that are not captured by other variables, the equation for the amount of cash income earned during the 1992/93 production year per household is included in the equation under the variable name CASHINCOME. Based on the explanations given above, it is hypothesized that millet yields per hectare are positively related to the CASHINCOME variable.

(f) the gender of head of household (GENHHEAD) as an indicator of farm households' access to production inputs like hired labor or timely plowing service that are not only determined by farmers' financial resources, but also by their social status. Of the interviewed farm households, 38 percent in Ovambo and 16 percent in Kavango are female-headed. As demonstrated in Part 2 of Chapter 3, significantly less women (Ovambo: 13 percent, Kavango 6 percent)

earn cash income from local or migration employment than men. (Ovambo: 24 percent, Kavango 19 percent) As a result, female headed households often lack either a male household member who could contribute directly to crop production through additional labor support or lack cash income earned by a male head of household that could be used to acquire production inputs that affect yields.

It is hypothesized that in addition to the effects of reduced labor and cash income already controlled by two other variables in the equation, the lower social status endured by women in northern Namibia affects negatively the access of female-headed households to production inputs. According to a UNICEF report about the situation of children and women in Namibia, the difference in the socio-cultural status of women becomes particularly evident in customary inheritance laws where:

> "... widows may be dispossessed of their deceased husbands' estate through the 'legal' intervention of their husbands' brothers or male relatives. As married women, wives may use, but rarely own, the family's livestock or land, and may not enter into contractual agreements without their husbands' permission" (UNICEF/NISER, 1991, p.123).

To account for the effect that the gender of the household head has on yields, the dummy variable GENHHEAD is included in the regression model. The variable takes the value one if the farm household is headed by a male head of household. The variable GENHHEAD is expected to be positively related to millet yields due to the better access of male-headed households to production inputs.

Both simple-linear and log-linear functional forms of the above described equation were estimated for Ovambo and Kavango. The simple linear form was preferred to the log-linear form on the basis of a careful analysis of the sign and the significance of the estimated coefficients, the size of the coefficient of determination adjusted for the degrees of freedom (adjusted R-Square), and the residuals.

Table 3-20 presents the main statistics of the estimated simple-linear equations. The adjusted R-Square levels indicate that the model explains 27 percent of the variability of millet yields in Ovambo and 60 percent of the respective variability in Kavango. Similar to the regression model of millet area per household, the moderate levels of the adjusted R-Square have to be attributed to the categorical nature of half of the independent variables considered and to the impact of the severe drought of the preceding year in combination with a late start of the cropping season under investigation. Despite the moderate R-Square values, almost all signs of the estimated coefficients are according to expectation and most of the considered explanatory factors demonstrate a significant relationship to the yields of millet.

For the following interpretation of the regression results, the base (control) case represents a farm household during the 1992/93 production year that did not or only partly fertilized its crop land (MNRALLFLDS=0), did not use Okashana 1 (USEOKASH=0), and whose head of household was female (GENHHEAD=0)

Table 3-20. Estimates of the millet yield equations

	OVAMBO			KAVANGO		
VARIABLES	**COEF.**	**S.E.**	**SIGNIF.**	**COEF.**	**S.E.**	**SIGNIF.**
Constant	- 455	121	0.00	- 505	185	0.01
RAIN92/93	152	23	0.01	304	56	0.00
AEWRKDS/HA	14	5	0.01	30	6	0.00
MNRALLFLDS	156	81	0.06	4	104	0.97
USEOKASH	6	85	0.94	100	87	0.25
CASHINCOME	- 1	3	0.81	9	5	0.07
GENHHEAD	189	85	0.03	265	121	0.03
Adjusted R-Square		0.27			0.60	
Case Number		148			47	

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

Holding all other factors constant, a rise of local rainfall (RAIN92/93) by 100 millimeters increases millet yields by 152 kg in Ovambo and by 304 kg in Kavango. The fact that, in Kavango, yields responded twice as much to rainfall increases can be explained by the overall low rainfall levels in Kavango during the 1992/93 season. The estimated coefficients of the RAIN92/93 variable are significant at the 1 percent level.

Compared to the described relationship between rainfall and yields the effect of labor spent per hectare (AEWRKDS/HA) is relatively small. When all other factors are held constant, the expected level of millet yield increase per 10 additional days of adult-equivalent labor spent per hectare is only 14 kg in

Ovambo and 30 kg in Kavango. For both study zones, the estimated coefficients of the AEWRKDS/HA variable are significant at the 1 percent level.

As hypothesized, fertilization of all millet fields affects millet yields positively. In Ovambo, the use of manure on all millet fields of a farm household increases the hectare productivity by a respectable 156 kg (significant level at 6 percent). In Kavango, the marginal effect of manure use on all fields was only 4 kg/ha. However, this result was far from being significant.

The coefficients estimated from the USEOKASH variable were below significance level for both study zones. This is probably due to the small number of household cases that used Okashana 1, the large yield variation among those farmers, and the fact that Okashana 1 was cultivated only on part of households' millet fields. However, the magnitude of both coefficients is coherent with the results from the descriptive analysis. In Ovambo, where rainfall was adequate, the fast maturing millet variety Okashana 1 could not outperform local millet varieties. The use of Okashana 1 increased estimated millet yields only by 6 kg/ha (2 percent of Ovambo farmers' average yield). The almost similar performance of local millet varieties is probably based on their slower growth rate, which allowed longer use of the available soil moisture during this production season. In Kavango, however, where due to late and poor rainfall, yields were generally depressed, average yields increased by about 100 kg/ha (33 percent of Kavango farmers average yield) if farmers used Okashana 1 in addition to local varieties.

For Ovambo, households' annual cash income shows little significant relation to land productivity. The estimated coefficient of the CASHINCOME variable is negative, but close to zero, and at an insignificant level. For Kavango, the sign of the estimated CASHINCOME coefficient is according to expectation. An increase of annual income by N$ 1000 per household increases millet yields by 9 kg. This result is significant at a 7 percent level. As for similar findings from the preceding regression of the millet area, two factors might explain the small effect of increased CASHINCOME income earnings on millet yields. First, farmers that earn considerable amounts of cash income from non-crop production related activities might be tempted rather to invest further in these activities instead of investing in millet production inputs. Second, other variables in the model, like MNRALLFLDS, USEOKASH and GENHHEAD, are at least to some extent related to household income and thus reduce the explanatory power of the CASHINCOME variable.

As hypothesized, the gender of the household head shows an effect on households' millet yields per hectare. Estimated yields increase by 189 kg in Ovambo and 265 kg in Kavango if the head of household is male. As discussed before, it can be assumed that the gender variable takes some explanatory power from the variables that represent households' labor input (AEWRKDS/HA) and annual cash income (CASHINCOME). But the most plausible explanation for such high effects is still the relatively low social position of female household heads (especially of older women) that limits their access to important production factors, like fertile land or timely plowing and weeding services.

3.3.4. Correlations analysis

Descriptive and regression analyses employed in previous sections of this chapter helped to identify the main production determinants of millet. During the discussion of the analysis results, hypotheses were raised as to how these production determinants relate to farm household characteristics like 'income from migration', 'gender of head of household', 'ownership of cattle', 'farm location', and 'grain marketing behavior'. The goal of this section is to determine the characteristics of farmers that are already using production enhancing inputs and those who don't. Table 3-21 presents the factors for which a strong and statistically significant relation to millet production on the farm level could be determined with the regression analyses in the preceding sections.

The method chosen in this section to identify statistically significant relationships is based on simple correlation testing.[1] For each study zone, the correlation coefficients were estimated between the nine production determinants and 30 variables that are grouped in the following categories: (1) household characteristics, (2) household possessions, (3) farm characteristics, (4) farm location, and (5) farmers' millet selling frequencies.

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[1] Theoretically, the most correct (econonometric) way to test on which factors the production determinants are dependent is through the estimation of a simultaneous system. However, this is laborious for more than one input use, and the effort would not be justified, taking into account the limited accuracy of available cross-section data. The same applies to the formulation of separate regression models with the production determinants as dependent variables.

Table 3-21. Main determinants of millet production, by zone

	Ovambo	Kavango
millet prices		X
land constraints	X	X
labor shortage	X	X
plowing equipment ownership	X	
plowing equipment used	X	X
1992/93 rainfall	X	X
use of manure	X	
use Okashana		X
gender of household head	X	X

Data Source: Namibian Millet Subsector Project Surveys, 1992/93 and my own calculations

The correlation results revealed that most correlation coefficients (Pearsons') were low. The level of the highest coefficient reached only 0.32. However, the signs of most coefficients were in line with previously made hypotheses. The following paragraphs discusses relations between production determinants and household characteristics that were found to be statistically significant. The correlation coefficients and respective significant levels on which the discussion is based are presented in Appendix A.

Use of the hoe for field preparation: Regression and correlation results demonstrate that farmers using solely the hoe for field preparation have considerably smaller fields. Farmers that use only the hoe for field preparation

are more often found in eastern Ovambo and eastern Kavango. Ovambo households using the hoe tend to be female-headed, grain self-sufficient, have no or little migration income, have few literate household members, and produce low yields.

Use of draft animals for plowing: Because almost all Kavango farmers use oxen for plowing, no significant relation between the respective variable and other variables could be identified. Ovambo household using either oxen or donkeys for field preparation tend to be: located in western Ovambo with better soils, grain self-sufficient, produce millet for the market, sells millet in some years, and are far away from commercial grain markets.

Use of tractor service for plowing: The Ovambo households using tractor service for plowing are more likely located in central Ovambo and less likely in eastern Ovambo. They tend to be male-headed. Respective Kavango households do not show a geographic pattern. They seem less likely to be grain self-sufficient. In both zones farmers that use tractor service earn cash income from migration work, have more literate household members, own motor vehicles, intend to produce marketable millet surplus, and cultivate more than 5 hectares.

Ownership of draft animals and a plow: Ovambo farmers owning draft animals and a plow tend to be grain self-sufficient, cultivate more hectares than average, are more likely to live in central Ovambo, and live less likely in eastern Ovambo. The respective Kavango farmers cultivate more land so that the land available per adult-equivalent is larger. Their 1992/93 millet production was

comparatively high.

Experience problems with land clearing: Farmers from eastern Kavango tend to have more often problems with clearing new land than farmers from other areas in Kavango. Since Ovambo is more densely populated than Kavango and arable land is scarce farmers have to be high in social status and have to have financial resources to acquire the right from local authorities to cultivate land. Ovambo households having problems accessing new land for crop production tend to be female-headed, have little or no cash income, have few members who are literate, have a current land holding that is very small, produce relatively little grain, are located far away from markets, but sell millet in some years to balance their most urgent cash needs.

Labor shortage: Labor shortage occurs western Ovambo, central and eastern Kavango.

Millet prices: In Ovambo, millet prices were low in central areas close to major urban centers like Oshakati or Ohangwenna. Those Ovambo farmers facing higher millet prices tend to use chemical fertilizer, but do not market their millet. Kavango farmers facing higher millet prices tend to have problems with land clearing, are not motorized, market millet, and live in eastern and central Kavango.

Use of manure or chemical fertilizer: In Kavango, the fertilization is positively correlated to the amount of land cultivated. Ovambo farmers using manure tend to be grain self-sufficient, own a motor vehicle, produce millet for the market, cultivate more land, produced relatively much millet in the production

years 1991/93 and 1992/93, have already good soils, are more likely located in western Ovambo and less likely in central Ovambo.

Use of chemical fertilizer: Ovambo farmers using chemical fertilizers tend to be grain self-sufficient and live either in western or central Ovambo. Kavango farmers using chemical fertilizer are located either in eastern or central Kavango, live close to the road, and tend to sell millet in some years.

Experience with Okashana 1: Ovambo farmers that tried Okashana 1 within the first three years after its introduction in 1989 live in western Ovambo, are male headed, are grain self-sufficient, earn cash income, have high proportion of literate household members, have larger number of household members, own a motor vehicle, produce part of their millet as cash crop, cultivate comparatively more land, had high yields and a large millet production during the 1992/93 season, have good soils, and sell millet in some years. The respective Kavango farmers that cultivate more millet than the average farmer, are located in central Kavango.

3.4. Chapter summary

The final part of Chapter 3 summarizes, first, the description of the millet production system in northern Namibia, second, the assessment of the performance of the millet production system, and third, the relations that important millet production determinants have to farm household characteristics.

3.4.1. Characteristics of the millet production system

The analysis of millet production practices in Ovambo and Kavango reveals a semi-subsistence agriculture that is making limited use of modern inputs such as improved seed and fertilizer. Only about half of the farmers state that agriculture is their main occupation. Low and uneven rainfall and lack of water for irrigation limit crop diversification. While lack of livestock prevents many farmers from using organic fertilizer, chemical fertilizer is only used by nine percent of the farmers in Ovambo and less than one percent of farmers in Kavango.

Pearl millet, the food staple in Ovambo and Kavango, forms also the centerpiece of farming in both regions. Because of increasing population the practice of shifting has been discontinued in Ovambo. Farmers practicing shifting cultivation in Kavango have to clear new crop land further and further away from their homestead. The observation indicates the need for higher yields and labor productivity. The latter is due to the fact that only half of the adult household members in Ovambo and only 40 percent of those in Kavango are mainly employed in agriculture.

The fact that 33 percent of rural households in Ovambo and 51 percent in Kavango cultivate less than 2 hectare and generate not more than a third of their total income through agriculture indicates that development programs in the study zones must look beyond the farm toward employment creation in rural-based non-farm activities linked to agriculture.

Because less than half of the communal farm households own a full set of plowing equipment/animals and because the majority of households cannot afford to pay much for renting draft power, many farmers are unable to cultivate more millet. Also, farmers' choice between different types of millet varieties is limited. While local varieties need a long time to mature to make full use of the low soil fertility levels, the high yield potential of the newly introduced variety, Okashana 1, requires favorable soil conditions.

Figures about the amounts of millet traded in the commercial food market indicate that Kavango has a higher potential for commercial millet production than Ovambo. Although Kavango has only a forth of Ovambo's population and its millet production was depressed in 1992/93 due to poor rainfall, it contributed about as much marketable millet surplus to the commercial grain market as Ovambo.

3.4.2. Performance of the millet production system

Knowing the restrictions of the prevailing cropping system, the low yields of the majority of farmers in Ovambo and Kavango is not surprising. Only about 10 to 14 percent of rural farm households cultivate more than 5 hectares of grain. While the average of 3 hectares of cultivated land per household and 0.4 to 0.5 per adult-equivalent is in line with neighboring countries like Zimbabwe or Zambia, the low average yields of 200 kg of millet per hectare in Ovambo and 250 kg in Kavango lead to a significant gap between grain production and households' annual food need.

The yields of the 1992/93 production season were very low in most areas of the study zones. In eastern Ovambo and whole Kavango millet yields were less than 100 kg/ha. In central Ovambo 240 kg of millet were harvested per hectare. Only in western Ovambo, were rainfall was exceptional good, yields averaged 590 kg.

One major cause for the poor yield performance in eastern Ovambo and in all of Kavango was the late arrival of rains during the 1992/93 survey year. The short production season especially affected the performance of local varieties that need a relatively long time to mature. The average yields of local varieties ranged only between 68 and 96 kg/ha. By contrast because of its faster growing potential, Okashana 1 performed relatively better in these areas, ranging from 127 to 235 kg/ha. In western Ovambo were the rainfall distribution was very good local varieties clearly outperformed Okashana 1.

The promoters of Okashana 1 had claimed that it would double average yields from 300 to 600 kg/ha on the farm level. However, in western Ovambo, local varieties yielded, on average, 644 kg/ha, while average yields of Okashana 1 were only about 234 kg/ha. In central Ovambo, Okashana 1 yielded, on average, only 106 kg/ha compared to local varieties' average yield of 259 kg/ha. The main explanation for the better performance of local varieties in good rainfall areas is their slower growth rate. This permits a longer period of time than Okashana 1 to make use of the available soil moisture and the plant nutrients.

The calculation of average cost and returns of millet production revealed that those farm households that reached grain self-sufficiency from their 1992/93 production were predominantly located in areas of good rainfall, but also had higher variable cost for labor input than households that produced a grain deficit. Calculation of returns to household labor indicate, that only grain self-sufficient households were able to generate significantly more value per workday through their own millet production (Ovambo: N$/Day 10.30, Kavango: N$/Day 6.86) compared to what they could earn through work on the fields of other farmers (N$/Day 5.00).

Total household income (consumption and cash income) and also the income contribution from grain production vary mainly with the employment status of individual household members. About half of all Ovambo and Kavango households have at least one household member that earns cash income from migration employment. The total income of such households is, on average, six times more than the income of household with no migration employment. While the share of grain production on total income averages only between 6 and 14 percent for households with migration employment, grain production represents a share of 40 to 45 percent for households without migration employment. Thus, for the latter, significantly poorer household category grain production represents the most important source of income. Other important income sources for this household category are government pensions to the elderly in Ovambo (average share of 43 percent) and employment activities such as woodworking and beer brewing in Kavango (average share of 37 percent).

3.4.3. Millet yield determinants

Congruent and complementary results regarding the determinants of millet production are provided by (a) the descriptive analysis of farmers' production problems and reasons for high yields levels, and (b) two simple regressions estimating the area of millet and millet yields achieved per household. Problems experienced by farmers during the field preparation period of the 1992/93 season and the reasons stated by farmers for not having achieved their initial planting goals point to the following production constraints in the study zones. The major constraints on land preparation in Ovambo are (1) lack of arable/fertile land, (2) lack of plowing equipment like hoes and/or plows, and (3) late/non-arrival of the plowing service organized by the MAWRD. In Kavango, the three main obstacles to land preparation are (1) shortage of household or hired labor, (2) lack of draft power, and (3) lack of plowing equipment. In both study zones, crop damage through insects and birds present a continued threat until grain harvest.

The regressions estimating millet area and millet yields per household for the 1992/93 season confirm not only part of the findings from the descriptive analysis, but also quantify the effects of various production determinants and make differences between Ovambo and Kavango more explicit.

In Ovambo, the three variables effecting the area of millet cultivated most are: (1) access to land; (2) household labor; (3) draft power in combination with the used plowing equipment. These results are not surprising if one considers that Ovambo faces increased population density in production areas,

that only half of Ovambo's adult population is occupied with agriculture, and that hand hoeing is the most labor- intensive and time-consuming field preparation technology available.

In contrast to Ovambo, the most important determinants in Kavango are: (1) millet prices at the start of the production season; (2) the use of tractors for plowing; (3) labor for land clearing. These results fit well in the context of Kavango where natural resource levels such as seasonal rainfall and fertile land are generally higher than in Ovambo. Large areas of uncleared and less populated bushland allow producers to react to price incentives with new land clearings. It is obvious that those few Kavango farmers who have tractors can not only plow more land, but also have better access to uncleared land that is far away from the more densely populated areas. Finally, it is understandable that farm households with intrinsic land clearing constraints cultivate smaller millet fields than those who can adjust their field sizes to changes in nutritional needs and/or changes in producer prices.

The results from the regression of millet yields demonstrate that the amount of seasonal rainfall is the most important determinant of land productivity in both study zones. Another main determinant of millet yields in both study zones is the gender of the household head. Regression results indicate that female-headed households have significantly lower millet yields than male-headed households. This can be explained by the low social status of female heads of household that limits their access to important production factors like fertile land or timely plowing and weeding services.

In Ovambo, where continuous cultivation of the same land with millet leads to fast decline in natural soil fertility, the use of manure shows additionally large effects on farmers' yields of millet.

In Kavango, where the very short and dry season of 1992/93 favored fast-maturing crops, farmers' yields were increased if they used the newly introduced millet variety, Okashana 1. However, these yield increases through Okashana 1 occurred at relatively low yield levels and, due to large variability of yield data, only a significance level of 25 percent could be obtained for this result.

Although statistically significant, the relations between households' annual cash income and households' number of workdays spent per hectare of millet production show little effect on millet yields.

3.4.4. Yield determinants and household characteristics

Correlation analysis was used to determine the characteristics of farmers that are already using production enhancing inputs and those who don't. The statistically significant correlations identified between yield determinants and household characteristics were of low magnitude but their sign conformed to the expectations from economic theory.

Those households that use only the hoe for field preparation are often female-headed, have little or no cash income, have low education levels, but reach grain self-sufficiency. Households that experience difficulties expanding their crop land have similar characteristics.

In Kavango, almost all farm households use animal traction (either hired or owned) for field preparation. In Ovambo, plowing with an animal span is concentrated in western Ovambo, which is remote from markets but has favorable production conditions so that cash crop production is common. Farmers owning a plow and draft animals tend to be grain self-sufficient. They also tend to have larger land holdings than other farmers. In western Ovambo such farmers tend to fertilize all their land with manure.

The use of a tractor services is more common among households whose main income stems from migration work. In Ovambo, the use of tractor services concentrated in central areas. Farmers using chemical fertilizer are more likely located in western and central Ovambo and western Kavango. The Kavango farmers that use chemical fertilizer often produce millet as a cash crop and live close to a road.

Early adopters of new production technologies like the newly introduced seed, Okashana 1, tend to be male-headed households that earn cash income, are better educated, own a motor vehicle, have large fields, are grain self-sufficient, grow millet partly as a cash crop, and live in western Ovambo.

In summary, farmers with marketable millet surplus tend to cultivate more than 5 hectare of millet, use manure or chemical fertilizer, possess a full set of plowing equipment/animals and/or have enough cash income to hire tractor service. The production areas that have more farmers with these characteristics and that therefore are more likely to produce marketable millet surplus on the

aggregate level in the future are: western Ovambo, eastern Kavango, and central Kavango.

4. MILLET MARKETING

The preceding chapter demonstrated that most farmers in Ovambo and Kavango are geared rather towards subsistence than to cash crop production. However, as northern Namibia moves from an agricultural to an urbanized, and thus more manufacturing and service-oriented economy, the performance of the rural and urban grain marketing system becomes increasingly important. This chapter deals with three issues of the existing marketing system.

The first section compares the general price structure between staple grains, presents the findings about consumer prices for locally produced millet, and finally, focuses on the price competitiveness of locally produced, unprocessed millet versus processed maize imported into the study zones. The price data used in the first section stem mainly from the food price monitoring survey carried out by the Millet Subsector Research Project, between February 1993 and January 1994. However, some of the used price data are based on information gathered through the millet subsector household surveys.

Section 2 presents findings from the millet trader survey conducted at the end of the 1992/93 production season. It concentrates mainly on the question of how the commercial sector is involved in millet trade. It also introduces new findings about millet imports from Angola to urban Ovambo. Seen as a whole, Section 2 contradicts common beliefs among policymakers in Windhoek that northern Namibia has no commercial millet market and that government institutions have to fill this vacuum in the future. The section proves the existence of private entrepreneurs that are heavily involved in millet trade. It also

indicates areas where support from outside is necessary in order to make locally produced and commercially sold millet more attractive to northern consumers.

Finally, Section 3 focuses on the marketing behavior of millet producers. By describing farmers' millet marketing practices, their limitations of selling millet commercially are revealed. Regression analysis is used to identify determinants of farmers' grain selling decisions. The last point is especially important because it reveals whether the lack of incentives, as argued by the Namibian Agronomic Board, is the main reason that keeps farmers from producing millet commercially.

4.1. Millet prices

This section describes first how millet prices generally evolve in the study zones. Thereafter, findings about seasonal and geographic millet prices are presented that are based on data gathered during the 11-month-long price monitoring survey that started in February 1993.

4.1.1. Formation of millet prices in general

Millet is often sold or bartered between rural neighbors, i.e. between rural households that produce marketable millet surplus and those that are net food buyers. This type of millet exchange that does not involve middlemen is also called 'informal trade.' When talking about 'informal trade' at the aggregate level, this study uses the term 'informal market.'

Informal trade prices of millet are well-known for smaller, traditional volume measures like recycled oil cans and tin buckets. Although there is no official mechanism that regulates food prices in rural areas, institutions like rural churches, as well as the traditional obligation to help neighbors who are in need, keep informal millet prices at low levels compared to prices on the commercial grain market.

Problems arise in the informal millet market after a very poor grain harvest. Due to the fear that the next harvest might also be poor, households that still have millet reserves reduce and eventually stop the selling of millet to neighbors and conceal the amounts of millet left in order to not be further approached for help. Such behavior leads eventually to the collapse of the informal millet market and often leaves grain deficit households no other choice than to rely entirely on commercial grain traders[1] in the area who are offering unprocessed millet and/or maize meal at prices that are much higher than those of informally traded millet.

Besides traditional containers, farmers also use sisal or polyethylene bags for millet. Contrary to the expectation that larger quantities sell cheaper per kg than smaller quantities, millet kg prices that are calculated from 50 kg bags are

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[1] The term 'commercial trader' includes traders from rural and urban areas; traders for whom millet represents only a small fraction of activities and traders for whom millet is the main trading good; traders that move between different areas to exploit geographic price variations; and finally, traders that are only operating in one location or area. This study defines all the grain that is traded via intermediaries such as 'commercially traded grain'. The term 'commercial grain market' aggregates all the activities of commercial grain trade in a specified area.

mostly higher than those derived from smaller traditional measures. The main reason for this is that millet packaged in bags is mainly bound for commercial trade beyond the seller's direct neighborhood; i.e., with increasing social distance to millet buyers, millet producers tend to base their millet pricing decisions less on social obligations and more on prevailing prices in the commercial staple food market.

Commercial food traders sell millet usually in the same bags in which they acquired it. Traders determine their millet selling prices mainly on the basis of their competitive position to other staple food traders; i.e., they are price takers. Other factors that are used by traders to determine the millet retail price are their individual millet supply prices, the general availability of millet in the traders' vicinity, the prevailing price for maize meal, and traders' own profit expectations.

It is estimated that of all millet produced in the study zones only 10 percent are marketable surplus. This is by far not enough to cover the growing demand for millet in the commercial food market . The three main reasons for the growing demand for millet are as follows:

(1) low yields and production of millet over the last couple of years because of drought;
(2) the scarcity of millet on the informal market two to three months after the millet harvest;
(3) the high preference of the Ovambo and Kavango population for millet over maize;

4.1.2. Millet price structure and variation during 1993

Locally produced millet and imported maize are the cheapest food staples in northern Namibia. Table 4-1 demonstrates how far prices of these two grains are apart from other cereals. The presented prices are average consumer prices, i.e., prices that survey households actually paid at the end of the 'hungry season' in April 1993. The price figures show that so-called 'modern foods' like bread, rice, and macaroni are between 50 and 150 percent more expensive than maize meal, the dominant food staple in the commercial market. They also show that, on average, informally traded millet is the cheapest of all calorie sources in the study zones.

Table 4-1. Average food staple consumer prices from April 1993, by zone (N$ per kg, percent of maize meal price)

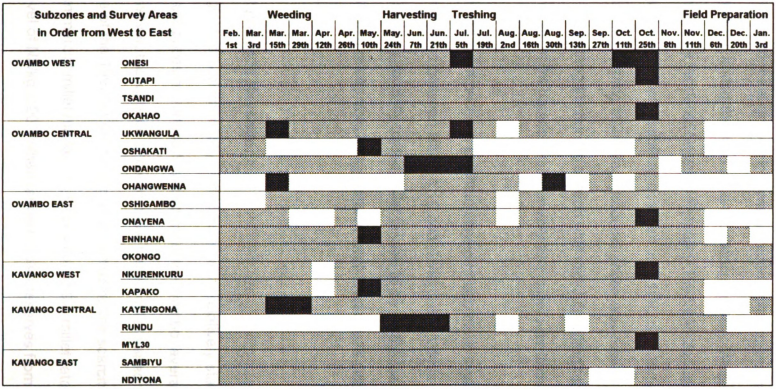
	OVAMBO		KAVANGO	
	N$/kg	%	N$/kg	%
Informally traded millet (unprocessed)	1.10	92	1.27	92
Commercially traded maize (processed)	1.20	100	1.38	100
Commercially traded millet (unprocessed)	1.36	113	1.87	136
Sorghum (unprocessed)	1.75	146	na	na
Bread	2.00	167	2.24	162
Rice	3.30	275	2.97	215

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

The fact that informally traded millet is unprocessed does not reduce its attractiveness to rural consumers with grain production deficits. First, almost all rural farmers are processing their own millet manually and are, therefore, willing to do the same with purchased millet. Second, the majority of the rural population in the study zones prefers millet over maize (see also Chapter 5). Third, although small, the price difference between informally traded millet and maize meal is an incentive for many of the farm households that have only very small cash resources.

The problem with informally traded millet is that it is often not available when it is most needed, i.e., when many farmers face the emptying of their millet reserves a few months after harvest. And because even commercially traded millet is often unavailable in rural areas, no alternative is left for grain deficit farmers than to buy maize meal. Figure 4-1 supports the argument about limited availability of millet for purchase. It presents those time periods between February 1993 and January 1994 during which both informally and commercially traded millet were not available for purchase in the study zones (shadowed and blackened time periods). The figure demonstrates that of the 19 areas where the food price monitoring survey was conducted, only three areas, the urban centers Oshakati and Ohangwenna in Ovambo, and Rundu in Kavango, had millet available over a long period of time.

Figure 4-1. **Availability of unprocessed millet and maize meal at retail level between February 1993 and January 1994, by subzone and sample communities**



Data Source: Namibian Millet Subsector Research Project, 1992/93

millet and maize available

only maize available

none available

Seasonal millet prices in Ovambo

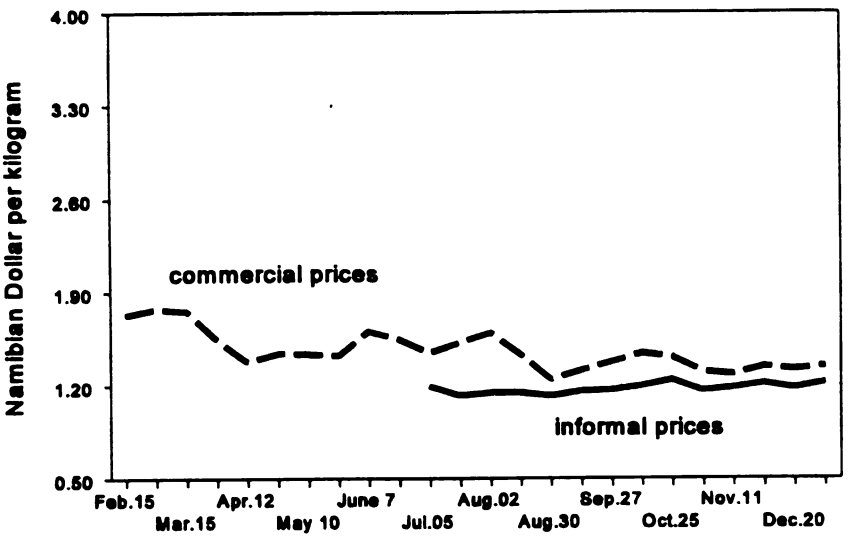
Figure 4-2 and Figure 4-3 present the average millet prices for (a) commercially traded millet and (b) informally traded millet collected in Ovambo and Kavango during the food price monitoring survey. While commercial prices were rendered between February 1993 and January 1994, informal millet prices were only gathered between July 1993 and January 1994. The reason for later gathering of informal producer prices was mainly based on the observation that during the hungry season until mid-July, when farmers had started to thresh their millet harvest, none or very little millet was traded among households.

The observed millet prices in Ovambo stayed mostly close together and moved in a narrow band between N$/kg 1.10 and N$/kg 1.60. Within the described price range, informally traded millet tended to be on the lower end (N$/Kg 1.20), while kg prices from 50 kg bags at retail level where close to about N$/Kg 1.50.

Seasonal millet prices in Kavango

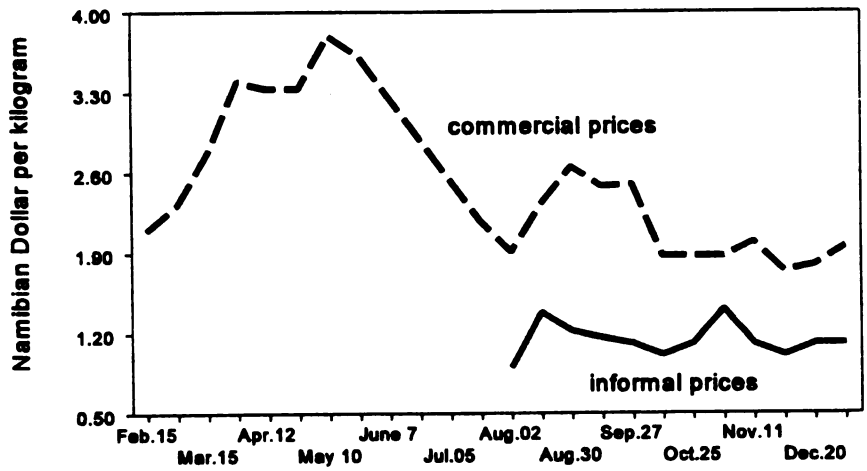
In Kavango, prices of informally traded millet were relatively stable and stayed, close to the prices of informally traded millet in Ovambo, averaging N$/Kg 1.15. However, the kg price of commercial traded millet varied with the different seasons of the 1992/93 production year, reflecting the scarcity of millet offered at the commercial millet market. In December 1992, millet retail prices had been at a level of N$/kg 2.00. When farmers' millet reserves from

Figure 4-2. Ovambo: millet prices on informal and commercial markets from February 1993 to January 1994



Data Sources: Namibian Millet Subsector Research Project, 1992/93

Figure 4-3. Kavango: millet prices on informal and commercial markets from February 1993 to January 1994



Data Sources: Namibian Millet Subsector Research Project, 1992/93

subsistence production became more and more depleted in the beginning of 1993 and when the rain of the 1992/93 season had finally started, late in January, indicating a severely depressed harvest later in the year, retail prices soared until the beginning of May, reaching N$/kg 3.80. Thereafter, millet prices declined to the minimum of N$/kg 2.00 at the end of July, when farmers had finished threshing their harvest.

After the 1992/93 harvest, millet was only temporarily available at retail level. Kilogram prices ranged between N$ 2.00 to N$ 3.00 N$. In October, shipments of Angolan millet arrived via Ovambo in Rundu/Kavango. From then on. retail prices declined to levels between N$/kg 1.50 and N$/kg 2.00. Surplus producers sold 50 kg bags at kg prices between N$ 2.20 and N$ 2.40 in rural areas. This price range stayed constant even in November, when grain retailers from Rundu acquired cheaper Angolan millet and sold it at kg prices below N$ 2.00.

4.1.3. Price competitiveness of millet versus maize

The purpose of this section is to present the price competitiveness of locally produced millet with imported maize as it occurred during the 1992/93 production year. This means that prices of unprocessed millet will be compared with prices of processed maize, further called 'maize meal.'[1] The reason for

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[1] Maize, wheat, and sunflower are regulated by the Namibian Agronomic Board. Almost all nationally produced maize is sold and transported via the NAB to the main Namibian milling corporations: Namib Mills and Agro Mills. After

comparing prices of two grain types that are in different processing states is based on the following two arguments:

First, it reflects the reality. Mechanical equipment to dehull and mill millet to meal is not yet disseminated in rural areas of northern Namibia. Additionally, as mentioned earlier, almost all farmers in the study zones are used to processing their millet themselves. This leads to the assumption that at least those farmers that (a) earn no cash income and (b) have few skills that would help them find off-farm employment value their opportunity costs for millet processing close to zero. In summary, the price difference between unprocessed millet and maize meal is an important purchase criteria for grain deficit households, because the convenience of purchasing grain in a 'ready to cook' form is not yet highly valued in monetary terms.

Second, just adding a cost margin for processing to observed millet prices in order to make them comparable to maize meal is not as easy as it sounds. By adding millet processing as an option, various other issues have to be

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being processed to meal and packaged into various bag sizes, maize is sold to wholesalers and retailers all over Namibia. After Namibia's own annual grain production is estimated, licenses for grain imports, mainly for white maize from South Africa, are issued that enable the commercial traders (mainly the milling corporations mentioned above) to take part in balancing the national grain deficit.

Throughout the year 1993, maize meal was available in most areas of Ovambo and Kavango. However, notable shortages occurred in some areas in June and July during millet harvest time and in October. (see Figure 4-1) These temporary shortages were probably induced by reduced consumer demand after the harvest of farmers' subsistence crops and the reduced supply of maize meal from the milling operations to northern Namibia's wholesale level at the same time.

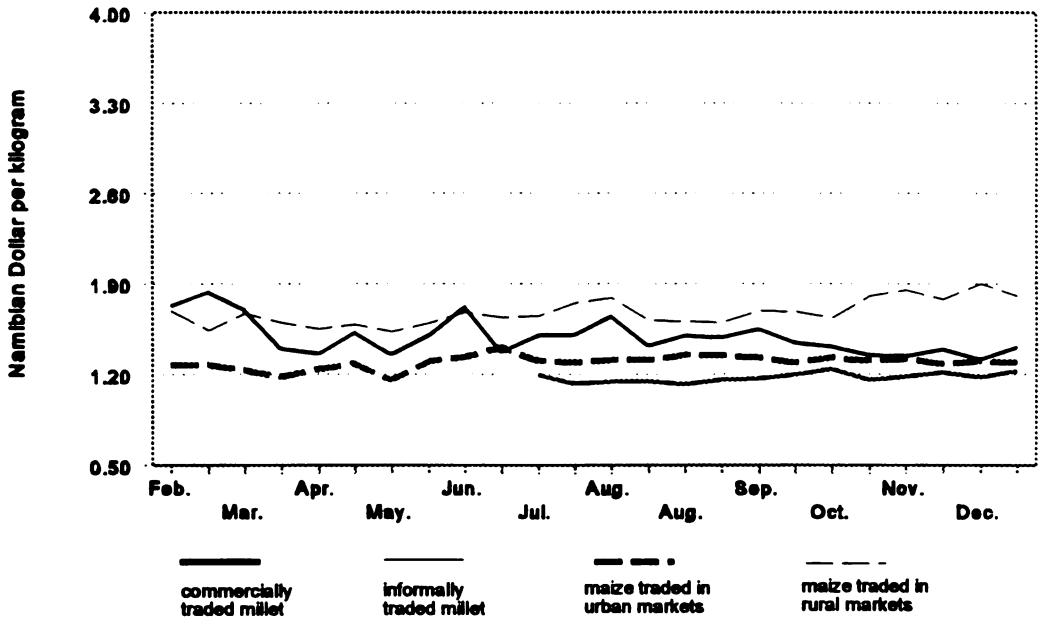
considered such as (a) the variation of production costs according to the production technology employed and the production conditions of various areas; (b) the variation of marketing cost (mainly transportation cost) according to the state of the existing marketing system and the distances in different zones; (c) the type and/or scale of millet processing technology used and where processing operations are located; and finally, (d) whether millet meal has to compete against maize meal at urban or rural food markets of the study zones. To address these issues more adequately, a millet procurement cost model is established in Chapter 6. This model allows the simulation of various production and marketing conditions as well as the use of different processing technologies.

Because the introduction of millet processing in rural areas lies still in the future, the existing level of price competition between unprocessed millet and maize meal is presented in the paragraphs below.

Figures 4-4 demonstrates for Ovambo and Figure 4-5 for Kavango that the price ratios between unprocessed millet and maize meal were more or less stable during the course of 1993. They also reveal that under current production and market conditions, unprocessed millet is considerably more expensive than maize meal.

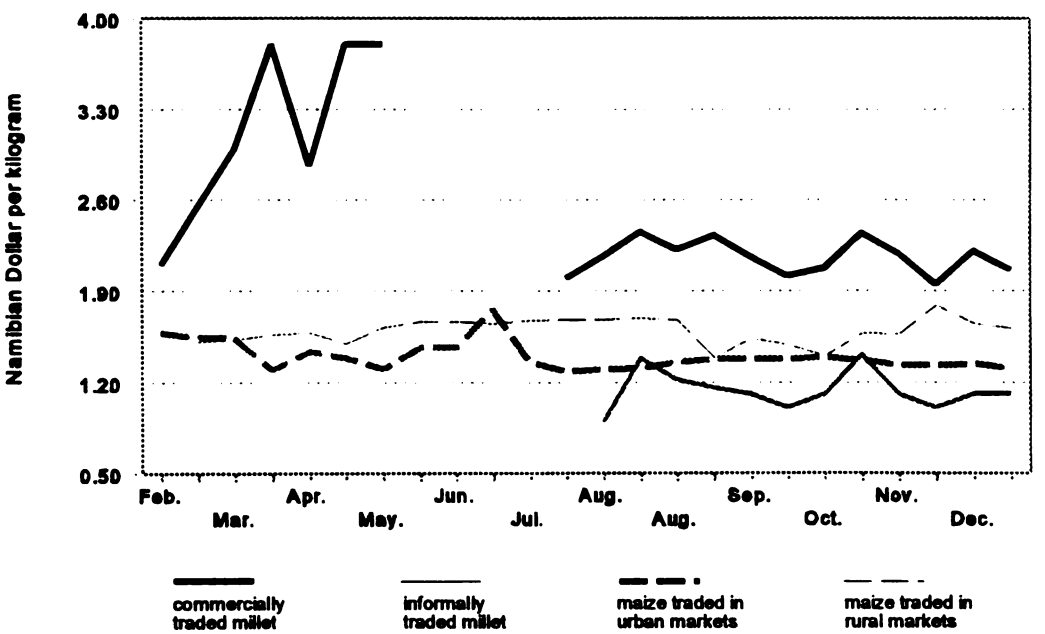
If available, informally traded millet constitutes the cheapest source of calories for rural Ovambo and Kavango households. However, as already described, after consecutive poor rainfall seasons, grain reserves of mosthouseholds are so low that already a few weeks after grain harvest, informal millet trade comes to a halt.

Figure 4-4. Ovambo: price comparison between unprocessed millet and processed maize



Data Sources: Namibian Millet Subsector Research Project, 1992/93

Figure 4-5. Kavango: price comparison between unprocessed millet and processed maize



Data Sources: Namibian Millet Subsector Research Project, 1992/93

Maize meal that is sold in larger package sizes at urban supermarkets and wholesalers represents the second cheapest food for those farmers that have relatively cheap opportunities to travel to and from urban areas. About 25 percent of rural Ovambo households and 15 percent of rural Kavango households acquire maize meal from these distant retail outlets.

In urban centers of Ovambo, the commercially traded millet was only slightly higher priced than maize meal. More than 80 percent of the millet offered by urban Ovambo traders during 1993 originated from Angola. It can be assumed that, similar to maize meal, not more than 25 percent of rural Ovambo households buy millet at urban supermarkets and wholesalers.

Also in Ovambo, maize meal sold at small rural shops and rural supermarkets was the most expensive food staple during 1993. Roughly 50 percent of all rural Ovambo households purchasing maize meal acquire it from local shops and/or local supermarkets.

In Kavango, maize meal sold at small rural shops and supermarkets was slightly more expensive than maize meal sold at the supermarket and wholesale level in Rundu. About roughly 75 percent of all rural Kavango households that buy maize meal acquire it from such local retail outlets

In Kavango, prices of commercially traded (unprocessed) millet were by far the highest among all available food staples. During the first half of 1993, millet cost about twice as much as maize meal. After the millet harvest, millet prices were still 36 percent higher than maize meal prices sold in rural shops and supermarkets. It can be assumed that under such conditions, only households

with high cash incomes could afford to buy larger quantities of millet from commercial traders. From the comparison between millet and maize prices, two important findings emerge:

First, at current production technology and market structure, millet is only competitive against maize meal at informal markets within rural communities. If millet production could be increased without raising average unit cost, millet would probably be available longer at the informal market and could thus substitute for maize meal that is currently purchased to balance households' grain production deficit.

Second, the prevailing prices at which Kavango surplus producers and commercial food retailers offer millet are so expensive that only very few high income households can afford to buy millet at the retail level. At such high price levels it will eventually be attractive to transport Angolan millet via Ovambo to Kavango. Only if, through an increased number of millet surplus producers in Kavango and through an increased competition on the retail level, profit margins of both surplus producers and commercial grain traders are reduced, will millet retail prices decline to more affordable levels. This will eventually make millet shipments from Angola less profitable.

4.2. Commercial millet marketing[1]

This section describes the characteristics of study zones' millet traders, analyzes their trading practices, and discusses trade attitudes about the prospects and limitations of commercial millet marketing. The findings presented

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[1] In this study, the term 'commercial millet marketing' is broadly defined as grain transactions from producers to consumers that involve at least one commercial intermediary.

in this section are important due to two reasons: (a) because they provide, for the first time, information about a group of entrepreneurs (whom policymakers assumed don't exist) that are engaged in millet trade, and (b) because they describe the market environment farmers face when they want to market their millet or have to purchase grain.

The data for this section come from the millet trader survey conducted in the study zones after the millet threshing period between October and November 1993. A total of 58 rural and urban millet traders were interviewed. It is estimated that the survey covered 70 percent of the commercial millet trade volume in urban Ovambo and Kavango and about 8 percent of rural Ovambo and 21 percent of rural Kavango respectively.[1]

4.2.1. Characteristics of commercial millet traders

Of the millet traders surveyed in Ovambo, 22 operated in rural areas and 9 traded millet in one of the three peri-urban townships Oshakati, Ondangwa, or

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[1] There are not many urban grain traders in the study zones. They are generally known and, therefore, easy to identify. From the extent of their other business activities, it is also possible to make some rough estimates about their millet trade volume, even if they refused to be interviewed or were not included in the millet trader survey due to other reasons. It was not possible to establish a sample frame of rural commercial grain traders in Ovambo and Kavango. However, during the household surveys in 16 different communities, respondents were asked to identify grain traders in their area. From the number of grain traders identified for each survey site, a rough estimate was made for the whole of Ovambo and Kavango. The resulting estimates are that Ovambo has about 260 rural millet traders and that Kavango has about 120 rural millet traders. The average trade volume of the randomly selected (within geographic strata) and interviewed millet traders was extrapolated on the basis of these estimates.

Ohangwenna. In Kavango, 23 rural traders were interviewed and 4 millet traders from Rundu. Most of the urban millet traders are wealthy businessmen who own wholesale operations or several supermarkets. Most of the smaller urban food retailers identified as potential survey participants sold only maize meal and no millet to their customers.

Four types of millet retail outlets could be identified in the rural areas:

(1) The majority of the rural outlets were privately owned 'cuca shops' (small retail shops trading basic necessities) and/or somewhat larger and better stocked 'supermarkets'. Most of the owners of these rural retail outlets were also larger farmers who provided part of the millet they sold to their customers from their own fields.

(2) The second type of millet trading places did not differ physically from the cuca shops or small supermarkets, however, they belonged to a chain of retail outlets owned by a wholesaler or by the owner of a large supermarket from one of the northern peri-urban areas.

(3) The third type of millet traders are rural churches. Some of these accept annual membership fees to be paid in the form of millet. The conversion factor between the official church fee and the accepted millet price values millet relatively cheaply (usually N$ 1 per kilogram). Because churches resell the acquired millet during the hungry season to members and non-members at the same conversion factor, the impression that millet has this relative low value is confirmed again, but this time to a larger group in public.

(4) The last type of millet traders are large, urban based wholesale and retail businesses. In urban Ovambo, 7 of the 9 interviewed millet traders were wholesalers and two were owners of large supermarkets. In Kavango, 3 of the 4 interviewed millet traders owned supermarkets, the fourth owned the only private wholesale operation in Rundu. The fifth wholesale operation trading grain in Kavango is the wholesale operation of the Namibian Development Corporation (NDC). This operation is kept competitive in the market because many of its employees are paid by the government, which permits its sales prices to be set below actual costs.

Most of the interviewed millet traders were involved in trade branches other than millet marketing. Table 4-2 presents the share that millet sales have on rural and urban millet traders total business. The figures indicate that millet trade has a larger share of total sales in rural trading operations than in urban. Additionally, maize meal trade has a significantly larger share than millet among Ovambo millet traders' sales volume (not mentioning those urban food retailers who market only maize meal and no millet at all), compared to millet traders in Kavango.

With very few exceptions, commercial millet trade does not have a long tradition in Ovambo and Kavango. Although 84 percent of all interviewed Ovambo traders had started their general trading business before 1982, about 65 percent started to trade millet just recently after the severe drought of the 1991/92 production season. During this year, millet prices and profit margins were high. Of the interviewed Kavango business people, 52 percent started their

millet trade after the 1991/92 drought, although 74 percent had started their general business already before that time.[1]

Table 4-2. Business activities of rural and urban millet traders, by zone and location (in percent of total trade volume)

	Rural Millet Traders		Urban Millet Traders	
	Ovambo	Kavango	Ovambo	Kavango
Millet	19	27	13	13
Maize meal	24	12	31	6
Other food and household goods	25	27	16	68
Consumer goods & services	13	25	24	0
Alcohol	18	7	10	9
Cooked food	1	2	6	4
Total	100	100	100	100

Data Source: Namibian Millet Subsector Project Surveys 1992/93

[1] At this point, it can not be determined whether only the high profit margins due to the 1991/92 drought triggered the expansion of commercial millet trade, or whether Namibia's independence in 1991 influenced this development also.

Almost all millet traders confirmed during the interviews that the demand for millet and also for maize is suppressed after good rainfall seasons, includingafter the 1992/93 harvest, on which this study focuses, while after poor production seasons, like the 1991/92 drought year, millet trade flourishes.[1]

4.2.2. Traders' millet acquisition after harvest

The following section describes market transactions between millet producers and grain traders from the viewpoint of the latter. The motivations behind this section are (a) to familiarize the reader with grain traders' options to acquire millet; (b) to reveal the problems commercial traders face trying to aggregate millet supply from the dispersed locations of surplus farmers; and (c) to lay the basis for farmers' description of their own millet marketing activities presented in Section 4.3. below. The section itself is divided into eight subsections that cover the following topics: (1) millet acquisition period, (2) types of millet suppliers, (3) transportation, (4) amounts traded, (5) payment modes and credit availability, (6) traders' reference prices, (7) comparison of supply prices, and (8) competition from Angola.

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[1] After good millet harvest years, most farmers tend to replenish their depleted grain reserves against potential droughts. The few very large and influential farmers producing marketable millet surpluses every cropping season are financially hurt by the decline in millet market prices after good harvest years. They tend to favor the NAB proposal suggesting guaranteed producer prices every year.

4.2.2.1. Acquisition period

Most rural and urban traders start to buy millet between June and September after millet harvest and threshing. At that time, traders have to judge for themselves whether the harvest results were generally poor, i.e., whether the demand for commercially traded millet will develop soon after the grain harvest or whether farmers' harvest was good, i.e., whether they could sell millet only in later months when the new grain harvest is close. Those traders with relatively limited financial resources try to buy millet immediately after harvest when farmers are happy about their new crops and are willing to accept lower producer prices. Traders with larger financial capacities acquire their millet supply in portions over a longer period of time. This helps them to better judge where they can get the best offer and how much grain they are able to sell until the next millet harvest arrives. However, by the end of December, almost all millet traders have ended their millet acquisition from producers and other traders.

4.2.2.2. Grain traders' millet suppliers

In urban areas, larger producers or long distance traders from Angola approach traders at their business site to offer millet for sale. If millet producers can not organize transportation to the trader they want to sell to, they ask the trader to transport millet from their fields to the retail outlet in town. The transportation costs thus incurred by the traders are usually reflected in the millet producer price they offer.

In rural areas, the transaction between millet producers and traders occurs on three different levels: (1) at the homestead of the farmer who offers millet for sale; (2) at the retail outlet of a rural trader; and (3) when the millet producer sells his millet surplus him/herself and offers it either from his homestead or from a central place in his or her community.

Most farmers offering their millet to traders approach them by chance and inquire whether the trader is interested in buying. Sometimes the farmers know already from other producers about specific traders' willingness to buy. The few traders reaching out in rural areas to purchase millet tend to first approach the farmers they know from previous production seasons. However, farmers also invite traders sometimes to come to their place to buy their surplus.

The type of producers from which traders acquire millet is often correlated with both the location of the traders' market outlet, i.e., whether the trader is located in rural or urban areas, and the zone in which the trader is located, i.e., in Ovambo or in Kavango.

The rural millet traders from Ovambo claim that 65 percent of the acquired millet comes from 'marginal farmers', who are either in urgent need of money or in need of other goods. (Table 4-3.) Only 15 percent of their millet is supplied by 'middle scale millet producers' and only 18 percent by 'large and wealthy farmers'. Middle scale millet producers usually try to balance their millet deficit production from one year with surplus production from previous years. They are less inclined to sell their annual millet surplus. If they are in need of money, they acquire the necessary resources most often through activities that are not

directly related to millet production, like plowing or transportation service, woodwork or handcrafts, etc.. Rural Ovambo traders acquire very little millet from Angolan farmers near the border.

Table 4-3. Millet suppliers of rural and urban grain traders in Ovambo and Kavango (percent of trade volume)

	Rural Millet Traders		Urban Millet Traders	
	Ovambo	Kavango	Ovambo	Kavango
Large farmers*	18	61	12	87
Middle farmers*	15	16	2	13
Marginal farmers*	65	20	3	0
Angola	2	3	84	0
Total	100	100	100	100

Data Source: Namibian Millet Subsector Project Surveys 1992/93

* see definitions in the last paragraph on the previous page

Rural millet traders in Kavango receive 61 percent of their millet from large surplus producers. Another 20 percent of millet is received from marginal farm households and only 16 percent comes from middle scale producers.

One of the most surprising results of the millet marketing survey is that during the year 1993, millet traders from urban Ovambo acquired 84 percent of their millet from Angola. This millet was legally shipped across the Angolan border and custom fees were paid for most of it. Most of the residual millet acquired by urban Ovambo traders came from large and wealthy farm households.

Similar to traders in rural Kavango, wealthy farmers with large surpluses supply about 87 percent of urban Kavango traders' millet. The remaining 13 percent of millet is received from middle scale farmers. The supply of larger quantities of millet from Angola is of less importance to Kavango. This is probably due to the fact that there are no direct transportation routes from Kavango into southern Angola. The main routes from Kavango to Angola's population and grain production centers are via Ovambo, which has a major border transit in the town of Ohangwenna.

4.2.2.3. Transportation

According to statements from rural traders, they arrange transportation for their millet suppliers in at least half of all millet transactions. The average radius of rural traders' millet acquisition is in about 70 kilometers in both study zones. In Kavango, roughly 45 percent[1] and in Ovambo, roughly 70 percent of the millet acquired by rural traders is transported by motor vehicles.

In contrast to rural areas, most of the millet acquired by urban traders is transported to them by producers that own or organize transportation themselves, or, as is the case for Angolan millet, transported by Angolan long-distance traders. The average distance between urban traders in Kavango and the origin of millet production is 120 kilometers. Because urban millet traders

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[1] In Kavango, the use of an oxen sledge that has the form of a canoe is often the only means by which farmers can transport grain from their fields in the bush to potential market places.

from Ovambo acquired, in 1993, most of their millet from the Angolan province Huila, Lubango, the average distance between them and the millet origin is about 500 kilometers. Almost all of the millet transported to urban traders in Ovambo and Kavango comes on trucks or other motor vehicles.

The average transportation cost per ton of millet produced and marketed is N$ 90 in Ovambo and N$ 60 in Kavango. Transportation cost of farmers to local traders are on average only a third of the cost to grain traders in urban centers. Surprisingly cheap is the transportation of millet between Ovambo's central food market Oshakati and Rundu in Kavango. The good road connection between Oshakati and Rundu (600 kilometer) allows the use of large 30 ton - trucks at the cost of only N$ 65 per ton.

4.2.2.4. Amounts traded

After the 1992/93 grain harvest, most of the rural Ovambo millet traders acquired between 1 and 5 tons of millet from producers. Only a few purchased between 5 and 50 tons, and only one rural trader in our sample stocked more than 150 tons of millet for resale. In rural Kavango, only a quarter of the survey millet traders acquired less than 5 tons of millet. About one half of them acquired between 15 and 50 tons of millet for resale. The last quarter acquired between 50 and 200 tons of millet.

In urban Ovambo, the amounts of millet acquired by traders during 1993 for resale varied significantly. At the end of the millet acquisition period, commercial millet traders' stocks ranged from 10 tons to more than 600 tons of

millet. Also, among the four major grain traders in urban Kavango (Rundu), the millet supply for selling varied significantly. The smallest amount acquired was about 15 tons, while the largest amount that was in stock by the end of December was 250 tons of millet.

With the exception of rural Kavango traders, most traders acquired after the 1992/93 production season less millet than in previous years. The three reasons most often given for this were (1) the harvest in the trading area was good, and therefore, the demand for millet was expected to be low; (2) the prices for millet from Angola had increased from the previous drought year 1992/93 with the introduction of custom fees; (3) the traders' own millet production was less than usual, or his/her financial situation did not allow the purchase of as much millet as usual.

4.2.2.5. Payment modes

To see whether commercial millet trade is restricted through cash flow problems on the side of the traders, questions were asked about how traders are paying their millet suppliers and whether they have opportunities to borrow operating funds for their grain marketing activities. Two-thirds of the interviewed traders in rural Ovambo and one-third of those in rural Kavango pay their millet suppliers immediately in cash, while the reminder pay their suppliers both ways, with cash and/or in kind. Among the interviewed urban traders from both zones, 50 percent pay their suppliers in kind and 50 percent pay them in cash.

Only 30 percent of rural millet traders from Ovambo and 15 percent of those from Kavango claimed they could get credit for their trade business if needed. Only 25 percent of the urban millet traders in Ovambo and half of the millet traders from Rundu claim they could receive business credit.

Surprisingly, most of those who claim they had access to credit named the government as their potential source. It has to be assumed that the Namibian Development Corporation (NDC), that has its own wholesale businesses in the study zones, offered private traders operation loans in the past and that traders confused this institution with the Namibian government. Only two rural millet traders named the Namibian Development Corporation directly as a credit source. Two other rural traders from Ovambo indicated commercial banks as a potential credit source.

From the way traders responded to the question about the accessibility of credit, it seems as if (a) business people in northern Namibia who already accumulated considerable wealth are assured of getting loans but chose mostly not to take them; (b) business people who have very limited funds to acquire larger amounts of millet from producers for marketing tend to be excluded from the support through commercial loans.

4.2.2.6. Reference prices

In rural areas, about 50 percent of the traders determine the price at which they buy millet from producers alone, i.e., without negotiating. The other half of the rural traders stated that their millet acquisition prices depend on their individual negotiations with the supplier. All urban millet traders stated that they have to bargain with their millet suppliers about millet supply prices.

The largest group of rural traders uses the millet bucket price, i.e., the informal millet exchange price used among community members as reference for the producer price they offer. Other rural traders use their targeted retail prices together, minus accrued transaction costs like transportation and handling, to determine the price they can pay to their suppliers. All urban millet traders in Ovambo stated that they determine their millet acquisition prices according to the millet retail prices of their competitors.

Table 4-4. Traders' references to determine millet acquisition prices (percent)

	Rural Millet Traders		Urban Millet Traders	
	Ovambo	Kavango	Ovambo	Kavango
Price Indicator				
informal prices	50	33	0	33
competitors' prices	12	19	100	0
own cost	18	30	0	33
maize meal price	0	0	0	33
other	15	18	0	0
total	100	100	100	100

Data Source: Namibian Millet Subsector Project Surveys 1992/93

In urban Kavango, the grain market structure resembles typical features of an oligopoly. Of the four millet traders, the largest grain trader and price leader for millet and maize meal sales did not want to disclose his pricing strategy. One of the other three claimed that it is essential to know the potential millet retail price at which he could sell to his customers before he could decide about the price he was willing to pay to his suppliers. It was explained that the demand for millet in Rundu was closely linked to the price of its closest substitute, maize meal. Millet can be sold with a premium that does not exceed 10 to 20 percent of the offered maize meal.

4.2.2.7. Supply prices

To gain more knowledge about the prices millet traders pay to their suppliers, traders were asked to state their acquisition prices from the last production season 1991/92 and in the ongoing production season 1992/93. The comparison of their answers by zone and by location (rural/urban) leads to the following observations (see also Table 4-5.):

First, as expected, millet prices of the 1991/92 drought year were generally higher than the millet prices from the average production year 1992/93.

Second, on average, millet traders from Ovambo pay lower supply prices than those from Kavango. This finding is surprising because Kavango has, on average, better rainfall conditions than Ovambo, which led to the assumption that Kavango's productivity in grain production is higher, and thus its millet prices

are more likely below those of Ovambo. However, Ovambo has a very well-developed wholesale and retail system that channels grain imports efficiently to deficit households in rural areas. As already mentioned, during the year 1993 year, urban Ovambo, which is relatively well connected to Angola by road, received large amounts of commercial millet imports from Angola. As will be discussed in later sections, these imports are very price competitive compared to local producer prices and thus reduce the general price level of grains in Ovambo.

Table 4-5. Acquisition prices of millet traders in 1991/92 and 1992/93, by zone and trader location* (N$ per ton)**

Production Year	Rural Millet Traders		Urban Millet Traders	
	Ovambo	Kavango	Ovambo	Kavango
1991/92	1020	1860	920	na
1992/93	1030	1200	800	970

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* Include millet transportation costs to traders' market outlets.
** During 1993, the exchange rate of the Namibian Dollar averaged 3 N$/US$.

Third, on average, urban traders face lower millet acquisition prices than rural millet traders. This finding has several explanations: (a) As described above, transportation costs per unit of distance are about two to three times higher in rural areas than in urban zones. (b) Larger producers are more likely to sell their millet surpluses in bulk to urban centers where commercial traders' bargaining power is relatively strong. (c) Smaller rural grain traders have to offer

attractive prices to prevent potential millet sellers from bypassing them and organizing transportation to the next urban center. (d) Relatively cheap millet imports from Angola not only enter Namibia via the urban areas of Ovambo, but are shipped effectively to Rundu in Kavango.

4.2.2.8. Millet imports from Angola

As demonstrated in Table 4-3, urban millet traders from Ovambo acquired most of their millet from Angola. The comparison of (a) millet supply prices (including transportation costs) of selected traders from urban Ovambo buying more than 70 percent of their millet from Angola with (b) prices of selected Kavango traders buying most of their millet from larger Namibian farmers leads to the following results:[1] (see also Table 4-6.)

1) In 1993, Angolan millet supplied to urban Ovambo traders was between 20 and 140 percent cheaper than millet supplied by larger millet producers in Kavango.

2) The price gap between Angolan millet and millet from Namibia increases with the trade volume of individual traders; i.e, millet supplied in bulk from Angola was very cheap in the 1993 post harvest season.

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[1] It seems quite possible that even if supply prices for domestic and Angolan millet were equal, urban traders from the study zones would prefer buying millet in bulk from Angola than trying to purchase it from the dispersed offerings of domestic surplus producers.

Due to the resumption of Angola's civil war in 1993, researchers were unable to visit Angola and collect information on millet exports to Namibia. However, Namibian traders explained that Angolan millet originates from the province Huila, Lubango about 500 kilometers north of Oshakati in Ovambo. The millet production zones are easy to reach via the long-distance roads from Ovambo's boarder town Ohangwenna. Millet is produced on large-scale commercial farms that are fully-mechanized and produce under more favorable climatic conditions than exist in northern Namibia.

Table 4-6. Millet acquisition prices of selected grain traders, by millet production origin and trade volume (N$ per MT)

	Millet supply from Angola*			Namibian producers**	
Trader no. & location	**Trade volume in tons**	**Price per ton in N$**	**Trader no. & location**	**Trade volume in tons**	**Price per ton in N$**
1. Urban Ovambo	60	430	1. Urban Kavango	200	1000
2. Urban Ovambo	150	500	2. Rural Kavango	40	800
3. Urban Ovambo	70	900	3. Rural Kavango	10	1150
4. Urban Ovambo	50	700	4. Rural Kavango	7	1200

Data Source: Namibian Millet Subsector Project Surveys 1992/93

* Average millet supply price of urban Ovambo traders acquiring more than 70 percent of their millet from Angola.

** Average millet supply price of rural and urban Kavango traders acquiring most of their millet from larger millet producers.

Three reasons explain the large millet exports from Angola to northern Namibia at the end of 1993:

(1) The war in Angola blocked access to grain markets in towns and cities so that northern Namibia with its millet deficit production became a welcome market alternative for millet producers..

(2) Due to the poor economic state of Angola's economy, its currency was undervalued to such an extent that Angolan agricultural products became competitive on the northern Namibian staple food market.

(3) The warfare limited south Angola's access to imported goods via Angolan harbors. Thus, the access to consumer goods via trade with northern Namibia became attractive. Many of the Namibian wholesalers bartered Angolan millet for consumer goods that originated from South Africa.

Although it is not clear whether the supply of relatively cheap Angolan millet will continue in the years to come, the findings about the millet imports in 1993 add a new and important piece of information necessary to judge the development prospects of the Namibian millet subsector. Before the 1992/93 grain production year, only maize coming either from South Africa or from Namibia's own commercial farmers was considered a main competitor of millet produced in the communal north. Now, imported millet from neighboring Angola is added to the competition. The main question, however, is still about whose grain will eventually be bought by the increasing number of rural and urban consumers in northern Namibia who are in need of cheap food staples.

4.2.3. Millet traders' value adding and marketing activities

This section describes commercial millet traders' value adding and selling activities: (1) storage practices, (2) cleaning, processing and packaging, (3) selling period, (4) characteristics of millet consumers, (5) setting of consumer prices, and (6) profit margins.

4.2.3.1. Storage practices

With the exception of farmers who sell their own millet to consumers, most commercial millet traders intend to store millet for less than one year, i.e., to buy millet briefly after grain harvest and sell it before the next millet harvest starts. It can be assumed that the short selling targets are prompted by traders' fears of market price variations caused by rapid and unexpected changes in millet and maize supplies. During the period of millet acquisition, commercial millet traders face the risk of underestimating harvest yields and overestimating the demand of those farm households that usually become net grain buyers before the next millet harvest. Unexpected low demand for commercially traded millet might force traders to carry over large millet stocks that can only be sold if poor production seasons follow within one or two years. Throughout an extended storage period, not storage losses, but the retention of valuable trading capital in millet stocks is most damaging to the millet traders.

Most rural millet traders store millet in bags in houses with roofs of corrugated iron. However, about a third of the traders also store millet in traditional granaries. Most of the urban millet traders own large storage buildings

where they store, besides bags of millet, large quantities of maize meal, sugar, alcohol, as well as other food and consumer goods for their trade business. The average storage capacity of the surveyed millet traders was unexpectedly high. Similar to rural farmers' tradition of demonstrating wealth by accumulating large herds of livestock and positioning a large number of big granaries near their homestead, the ownership of large storage facilities seems to be an important status symbol among communal businessmen.

Rural millet traders have an average storage capacity of roughly 250 tons of grain in Ovambo and about 530 tons in Kavango. Urban millet traders in Ovambo reach an average storage capacity of about 2400 tons of grain and about 2000 tons in Kavango. Many of the storage facilities of the surveyed business operations were underutilized. The high grain storage capacities in the private sector indicate that at the current level of market supply, little need exists to construct extra storage facilities for regional grain reserves against drought years.

About half of the rural traders in Ovambo and a sixth of the rural traders in Kavango claim that they have storage losses from insects. Among the urban millet traders, almost none reported insects as a problem for grain storage. Most owners of large storage facilities fumigate them at least once a year.

Storage costs for millet are difficult to acquire from traders. Most storage buildings in which millet is stored are also used for other trading goods. Additionally, traders do not consider the cost of constructing storage facilities attributable to their millet business. However, some traders were able to

attribute the cost for unloading and handling, as well as the cost of security, to their millet business. According to these estimates, labor and security costs are between 15 to 20 Namibian dollars per traded ton of millet.

4.2.3.2. Cleaning, processing and packaging

All interviewed traders were asked specifically whether they add value to millet during the trading process. Most traders said they didn't. The majority judges only the quality of the millet when it arrives from the suppliers to determine the acquisition price accordingly. If necessary, millet grain is refilled into new bags. Together with the labor and security cost estimated above, average millet marketing costs are estimated to be not higher than N$ 100 per ton.

Some urban traders in Ovambo have experimented with processing millet with either small-scale hammer mills or with the roller mills they use to grind maize to maize meal. But none of them seemed to have developed a mechanical millet processing system that worked, so that at the time the marketing survey was carried out, none of their processing operations were running.

Some rural millet traders from Kavango who sell part of the millet production of their own farm explained that they clean and grade their millet at threshing time before they ship it to their market outlet. However, they considered these activities more as a normal part of the production process,

rather than a part of their millet marketing activities. They would also not charge extra fees for this service.

Among the interviewed traders, only two exceptions with regard to millet processing could be identified: The first is the commercial NDC farm in Musese/Kavango, where processing equipment for millet grading, cleaning, dehulling, milling and packaging is redesigned and adjusted for large scale millet processing and marketing.[1] The second is the self-help "Katemo Farmers' Marketing Cooperative" in Rundu/Kavango. In 1993, the cooperative imported, with the help of the Canadian development aid, the same millet processing technology from Zimbabwe, but at a smaller level than NDC had developed its operation from. The cooperative competes with the NDC operation for the same millet suppliers and customers. Its main problems are collecting and transporting millet to its retail outlet in Rundu and effectively managing and selling the aggregated millet reserves. Because many Kavango people still perceive the NDC operation (formerly 'First National Development Corporation') as an instrument of the former apartheid system, Katemo has declined so far any technical collaboration with NDC.

The reasons for such limited activity in the field of millet processing are not obvious. Lack of capital can not be the problem among larger grain traders

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[1] From the proposal made by the Agronomic Board to use a single market channel system for millet in northern Namibia, it became obvious that the large-scale processing facility in Musese/Kavango of the Namibian Development Corporation was meant to become the only official processing facility for millet produced in Kavango. The proposal suggested also that a similar operation should be built in Oshakati with government funds.

in urban areas because many of them are expanding their businesses by investing in new branches like gas stations, bakeries, car repair shops, etc..

Also insufficient demand for processed millet seems not to be the problem. In one of the household survey areas of the Millet Subsector Research Project, UNICEF had tested the adaptability of small-scale hammer mills in rural areas. The purpose of these tests were to offer rural women relief from the burden of the second millet processing step after dehulling, namely millet milling. After the 1992/93 production season, in two of the four UNICEF test sites, an additional small-scale hammer mill could be bought from the funds, which organized groups of female mill operators had generated with the first small-scale mill.[1]

In the area of urban Ovambo, two successful millet service processing operations could be identified during the millet trader survey in November 1993. One of the two is the well-known roller mill operation in Oniipa, located 30 kilometers east of Ovambo's center town Oshakati. This mill has been operated by a church for more than 20 years. The advantage of using a roller mill is that both millet dehulling and millet milling can be done with the same machine. So many farmers organize transportation to Oniipa in order to process their grain that waiting periods are up to three weeks after harvest, due to processing

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[1] An economic analysis of this pilot project is not possible because UNICEF had provided the first small scale-milling machines, set the salaries for the operators and prices for the milling service, paid the fuel, and organized the maintenance of the machines without keeping adequate records of costs and benefits.

backlogs.[1] The second identified millet processing service is located in Oshakati. It is operated by a mechanic who owns, besides a car repair shop, an electrical power driven hammer mill. Although hammer mill processing permits only the milling of already manually dehulled millet, many urban customers are using this service.

The example of the UNICEF project, together with those of the two privately operated millet processing services in central Ovambo, indicates that mechanical millet processing could be further developed in rural and urban areas of the study zones in the future. However, further research about the suitability of various technologies is necessary. Potential millet meal procurement costs under various scenarios of millet production, marketing conditions, and processing technologies are calculated with the help of a simple cost accounting model in Chapter 6. The simulation results reveal whether millet meal can eventually be offered at prices lower or at least close to those of maize meal already marketed in Ovambo and Kavango.

Independently of the calculation of potential millet meal procurement costs, UNICEF's maintenance problems with the small-scale hammer mills introduced to the rural areas and the fact that commercial grain traders have tried, but not continued to use, small-scale hammer mills for commercial millet processing, are an indication that not only mechanical processing equipment

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[1] According to information from Ms. Gomez, a former ICRISAT food technology expert, the millet meal from Oniipa is of high quality and it might justify the development of similar mills for the commercial sector.

should be disseminated once it proves to deliver price-competitive millet meal, but also appropriate skills in maintenance and business accounting.

4.2.3.3. Traders' selling period

After traders have acquired millet from their suppliers, their main concern is to sell it before the next grain harvest. The beginning and the duration of commercial millet selling from traders to consumers varies between Ovambo and Kavango and according to the traders' location in rural or urban areas. The peak period of millet selling starts in Ovambo in August, while in Kavango, millet selling starts mainly in October. In both zones, rural traders are the first ones to sell millet. Urban traders follow about two months later. Parallel to the increase in millet sales, maize selling picks up again. However, while most commercial millet selling activities come to an end by mid-January, maize meal sales continue until the next millet harvest arrives in May or June. Two explanations can be given for the early end of the millet selling season. First, and most important, traders millet reserves are usually depleted by the end of December. Second, due to the start of the rain season (usually) in November in Kavango and (usually) late December in Ovambo, the first vegetables from subsistence production are available for consumption, which reduces the need to purchase grain.

Traders explain the beginning of the peak selling period with the emptying of rural households' millet stocks. In rural Kavango, half of the interviewed traders claimed that farmers come during this period because they are in need of

seed. About two-thirds of the urban Ovambo traders claimed that, due to the beginning of plowing, people need more food and drinks made from millet. Finally, urban traders from both zones explain that migrant workers return in December to the north to celebrate Christmas with their families. On their way back, they tend to buy millet in Oshakati or Rundu to asure that during the religious festivities their household has enough millet porridge and millet beer to feed visiting relatives and friends.

The time gap between the start of commercial millet selling in Ovambo and Kavango leads to the conclusion that, on average, rural Ovambo households experience a larger grain production deficit than rural Kavango households, which manifests itself in a significantly earlier beginning of millet buying from commercial traders in Ovambo.

4.2.3.4. Characteristics of millet consumers

Although most of the interviewed commercial traders sell more or at least as much maize meal as millet to their customers (see Table 4-2 above), 93 percent of them said that the majority of their customers favor millet for consumption over maize. Of the other traders, 5 percent said that consumers were indifferent in their taste preference between millet and maize, and only 2 percent said that people prefer maize over millet.

Traders' differentiation between customers that actually buy millet versus those that buy maize meal is presented in Table 4-7. A large majority of traders claimed that all people in their zone prefer millet over maize (83 percent of the

answers), and that is why they buy millet. However, some of the traders were more specific and reduced the set to all 'rural' people (10 percent) or 'poor' people who can not always afford to buy millet to balance their grain deficit, but buy it if they want to make 'Oshikundo', a fermented millet drink, or millet beer (3 percent).

Table 4-7. Characterization of typical millet and maize meal buyers (percent of traders, n =58)

Consumer Characteristics	Buy Millet	Buy Maize
All people	83	0
All rural people	10	0
Poor people for bear brewing	3	0
Poor people in urgent need of food	0	16
Migrant workers	0	8
Town residents	0	8
Urban employees and rich people	0	14
Other	4	13
No one	0	38
Total	100	100

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

When asked to characterize consumers who buy maize meal, 38 percent of the millet traders claimed that none of their maize meal buyers really prefer maize over millet. The next largest group of traders (16 percent) claimed that only those people who can not afford the high prices of commercially-traded millet buy maize meal, i.e., the poorer section of the people. From these

answers, it became more obvious that for most people, the decision to buy maize meal and not millet is a forced decision; i.e., maize is bought because it is more affordable.

Few traders associated maize buyers with people that really prefer to eat maize meal over that of millet. People who really prefer maize over millet were mainly characterized as rich and urban-employed people (14 percent). However, town residents in general and migrant workers were also mentioned as typical maize meal consumers (each 8 percent). Only a few traders were able to make a rough estimate about the population share that actually prefers to buy maize meal. Urban millet traders estimated that between 10 and 30 percent of the population belong to those who are rich and urban-employed people. Most rural traders estimated that no one or less than 1 percent of the total population prefer to eat solely maize without millet meal mixed into it.

The amount of millet that individual people buy from commercial traders during a single purchase is generally larger than that which is traded directly and informally among rural households. Most of the commercial traders named quantities between 50 and 250 kg as the typical amount millet buyers acquire. None of the traders indicated average selling quantities below a 50 kg bag. Still a high portion of millet traders (Ovambo: 29 percent, Kavango: 25 percent) claimed that most of their millet buyers acquire more than 250 kg of millet at a time. These relatively large amounts and the notion that commercially traded millet is, for many customers, too expensive indicate that millet traders target a

prosperous clientele that prefers the traditional taste of millet over the taste of maize.

4.2.3.5. Setting retail prices

Of the interviewed traders, 90 percent stated they set their millet retail price unilaterally. Another 7 percent claimed that within certain limits their selling prices are determined through negotiations with the buyers. A third of the traders said they would give discounts to buyers of larger quantities.

Grain traders use three main measures to set their milling selling prices. First, traders' most often used reference for retail price determination is their already accrued cost, i.e. the acquisition price traders paid to their millet suppliers. Second, traders observe the general price development for millet in the market, and third, they observe in particular the prices of their direct competitors.

When asked why commercially traded millet is higher priced than maize meal, traders named three major factors: (1) high production cost (especially for labor, plowing, threshing, and transportation), (2) consumers' strong preference for millet, and (3) the general scarcity of millet and the small number farmers who are willing to sell.

4.2.3.6. Profit margins

Although millet traders make factors other than their own pricing practices responsible for high millet retail prices, differences between their gross margins

and their marketing costs indicate that at least some of the commercial millet traders take advantage of the general scarcity of millet.

During the millet marketing survey, only 26 percent of the traders were willing to disclose both their 1993 millet acquisition/supply costs, including average cost for transportation and handling, and their millet selling prices. Because in most cases millet represents only a small fraction of traders' total retail operations, storage costs are negligibly low. Because most traders neither calculate their marketing cost nor do they incur costs for processing grain, their marketing cost had to be estimated.

Table 4-8. Traders' millet acquisition costs and profit margins in 1993, by trade volume (N$ per MT)

	Trade Volume Categories	
	1 to 50 Tons	51 to 600 Tons
Millet supply price*	1,075	545
Retail price	1,890	1,025
Marketing cost (estimated)	100	100
Profit margin	715	380
Profit in % of retail price	38 %	37 %

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* includes transportation to traders' market outlet and handling to put in storage

The comparison of millet acquisition cost in Table 4-8 between large and small scale millet traders demonstrates that three factors affect millet acquisition prices significantly:

(1) the source of millet (larger traders are supplied by cheaper sources),
(2) the quantity discount (large traders get quantity discounts), and
(3) the bargaining power (larger traders have more bargaining power).

The weighted average millet acquisition price per ton was about N$ 545 for larger millet traders and N$ 1075 for small traders. The comparison of millet traders' retail prices indicates that the cost advantages of large-scale traders are passed on to their customers. The average millet retail price of large-scale traders in urban areas is N$/kg 1.03. This is only 54 percent of rural traders' average retail price of N$/kg 1.89.

Table 4-8 also demonstrates that millet traders profit margins are high. On the average, small-scale traders in rural areas have net returns of N$ 715 per ton, while large-scale traders' net returns average N$ 380 per ton. However, both trader categories reach net returns that are 37 to 38 percent of their retail prices.

Although small-scale traders net returns are almost twice the returns of larger traders, the following points have to be considered before judging them:

(1) Small millet traders have, by nature, lower trade volumes so that their total profits are comparatively low.

(2) Millet marketing has a larger share of rural traders total business. Thus, millet trade absorbs a high portion of rural traders' scarce funds. Due to the larger share of millet trade of small traders' total business, their financial risk from trading millet is higher. Market price variations caused

by unpredictable harvest results or grain shipments from South Africa or Angola might annul small traders' profits expectation and leave them with little cash to replenish their stocks with other tradable goods.

Although profit margins of larger millet traders are, on average, significantly less than of rural traders, commercial exchange of millet can be very profitable. This point is demonstrated in Table 4-9 , which presents two examples of larger millet trade operation in 1993.

Table 4-9. Examples for the profitability of millet trade in 1993

		Example 1: Urban Ovambo	Example 2: Urban Kavango
Trade volume 1993	(MT)	150	75
Millet supply price*	(N$/ MT)	500	800
Marketing cost**	(N$/MT)	100	100
Retail Price	(N$/MT)	1,000	1,400
Net Profit	(N$/MT)	400	500
Total Net Profit 1993	(N$)	60,000	37,500

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* transportation cost to traders' market outlet included ** estimated

4.2.4. Prospects and limits of commercial millet trade

To analyze the prospects and limits of the commercial millet market, this section focuses on four issues: (1) the aggregate size of the existing commercial millet market, (2) millet trader's expectations for future market developments,

(3) the effects of grain imports and seasonal harvest results, and (4) grain traders' expectations from government.

4.2.4.1. Aggregate size of commercial millet market

It is estimated that the millet trader survey of 1993 covered about 70 percent of the study zones' commercial millet trade in urban areas, about 8 percent of commercial millet trade in rural Ovambo. and 21 percent in rural Kavango. Based on these estimates, the total volume of commercially traded millet amounted in 1993 to roughly 8,900 tons. Traders' statements about the millet amounts that various producers supplied after the 1992/93 harvest permit the extrapolation of percentage shares of the main millet sources of the commercial millet market in general (see Table 4-10).

The most important finding from this extrapolation is that in 1993, about half of the commercially traded millet in the study zones was produced in Kavango although (a) its population is only about a quarter of that from Ovambo and (b) Kavango's 1992/93 production was depressed due to late and poor rainfall.

Another important finding is that about 93 percent of Kavango's commercial millet trade takes part in rural areas, while in Ovambo, the respective portion is only 58 percent; i.e., compared to Ovambo, rural grain markets in Kavango seem to be less integrated with Kavango's center market in Rundu. This means the potential exists that in the future, better market integration in

Kavango could lead to an increased offer of millet in Rundu, which might well be suited to being sold in Ovambo.

Table 4-10. Millet supply to commercial grain market in 1993, by zone and market location* (tons)

Market Location:	OVAMBO			
	Rural	Urban	Total	Percent
Supplier Type:				
Marginal farmer	1,660	50	1710	39%
Middle farmer	390	30	420	9%
Large farmer	470	220	690	16%
Angola	50	1,560	1,610	36%
Total	2,570	1,860	4,430	100%
Percent	58%	42%	100%	--
Market Location:	**KAVANGO**			
	Rural	Urban	Total	Percent
Supplier Type:				
Marginal farmer	840	0	840	19%
Middle farmer	670	40	710	16%
Large farmer	2,560	260	2,820	63%
Angola	130	0	130	3%
Total	4,200	300	4,500	100%
Percent	93%	7%	100%	--

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* extrapolated from trade data acquired during the millet trader survey of November 1993

For the 1992/93 production season, aggregate millet production of the study zones is estimated on the basis of the production levels reached by the 320 sample farmers. According to these estimates, Ovambo farmers produced a total of about 70,000 tons of millet, and Kavango farmers produced about 15,000 tons during the 1992/93 production year. The estimated 7,200 tons of commercially marketed millet surplus from the study zones and the 1,700 tons of imported millet from Angola make together 10 percent of Ovambo and Kavango's total millet production during the 1992/93 production year.[1]

Assuming that the poor geographical distribution of millet yields during the 1992/93 cropping season is not an exception, the question arises whether a 10 percent coverage of total millet production by commercial trade is enough to adequately transfer millet between surplus and deficit grain production areas. Because informal millet trade between neighbors is mainly bound within the borders of rural communities, it does not contribute to the redistribution of millet surpluses across long distances. Figure 4-1 in the first section of this chapter demonstrated that during the year 1993, millet was only seldom available for purchase in both informal and commercial grain markets. A part of Chapter 5, about farm households' consumption pattern, will demonstrate that consumption, at least during the year 1993, was constrained by limited access (physical) to millet. In conclusion, commercial millet marketing might have to be expanded if rural households' grain deficit is to be balanced with nationally produced millet.

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[1] No comparable estimates of the commercial millet trade volume have been made by other sources.

4.2.4.2. Trader views about the prospect of millet

The last paragraph questioned whether the trade volume of the commercial millet in Ovambo and Kavango is sufficient to effectively supply areas that are in grain deficit with millet surpluses produced in other areas. This section presents commercial traders' attitudes about the prospects and limits to millet market expansion.

Of the millet traders interviewed in 1993, 93 percent claimed they would like to expand their millet trading operation in the future. When asked about the factors that make it difficult to achieve increases in millet trade, six major themes evolved from their answers:

1. Transportation: Fifty percent of the commercial traders mentioned lack of transportation as a limiting factor. Additionally, forty percent of the traders complained about the poor conditions of feeder roads in rural areas.

2. Market transparency: Forty-three percent of the traders claimed that it is difficult to locate those millet producers that have marketable surplus and are willing to sell.

3. Operating funds: Forty-three percent of the traders claimed they do not have enough operating funds to buy as much millet after harvest as they would like and could sell in the hungry season.

4. Deficit production: Seven percent of the traders mentioned the general production deficit of millet as limiting for their trade supply.

5. Price competition: Five percent of the traders claimed that maize meal is supplied so cheaply that millet is not price competitive.

6. Processing: Five percent of the traders, mainly urban, indicated that maize has the advantage of being already processed, while access to adequate millet processing technology is still a problem.

For the future, most rural traders planned to increase their own millet production to foster their millet trade operation. Field expansion and the use of tractors for plowing and transportation were the methods of choice to achieve such production increases. Investment in transportation vehicles was the second most often mentioned goal for improving millet trade. Rural traders also had the idea to ask the government for business loans to increase the amounts of millet they could buy from farmers after harvest.

Among urban traders, none of whom was a farmer, improved advertising and the establishment of contracts to supply government institutions with millet, e.g., school feeding programs or hospitals, were most often mentioned.

Half of the interviewed Ovambo traders and 70 percent of the Kavango traders believe that the millet market will grow faster in the future than the maize meal market. The most often given explanation for this speculation was that millet is the traditional staple food in northern Namibia, and that the majority of people prefer it over maize. However, most of the traders who believed in a fast growth of the commercial millet market mentioned at least one of the following three conditions as prerequisites to make use of millet's market potential:

1. Supply: More millet has to be produced in Namibia and the access to it must be improved.

2. Price: The supply price of Namibian millet has to become lower so that millet's price competitiveness with maize meal is improved.

3. Processing: Better millet processing technology is necessary because more and more consumers prefer the convenience of already-processed maize.

Those traders who believed that the maize meal market will expand faster stated the same issues used by the previous respondents as prerequisites for the millet market development to confirm their opinion. They claim that:

1. Supply: Millet is not always available in the shops, but maize meal is.

2. Price: Maize meal is cheaper than millet.

3. Processing: Maize meal is already supplied in processed form and people with higher living standards don't like to process grain manually.

Those traders who were indifferent about which of the two food staple markets will develop faster pointed to two important factors that might eventually determine the outcome:

1. Rainfall: If better rainfall conditions allow increased millet production in the future, millet supply for commercial trade will be guaranteed and prices will decrease to competitive levels.

2. Preference: Customers preference will decide which grain will dominate the food staple market in the future.

In summary, grain traders' opinions about the prospects and limits of the commercial millet clarify that the future of the commercial millet sector lies, first, in the capacity of Namibian farmers to produce more and cheaper millet, and

second, in millet's competitiveness against maize meal on the basis of price, taste, and convenience of use.

4.2.4.3. Maize market in the study zones

This section describes some characteristics of the maize market of the study zones and discusses millet traders' attitudes about the dynamics between millet and maize trade, potential effects of import restrictions for Angolan millet, and the effects of good millet harvest results on commercial grain trade in general.

'Maize' or better 'maize meal' is by far the most sold food staple in Ovambo and Kavango. The millet trader survey from 1993 revealed that comparatively few food retailers in the study zones trade millet, but almost all trade maize in the form of maize meal. Even those food retailers who traded during 1993 both millet and maize sold between two and five times more maize meal than they sold millet. The only exception to this pattern were rural traders in Kavango. They sold, on average, seven times more millet than maize meal in 1993.

The largest food retailers from urban areas in Ovambo and Kavango traded significant amounts of maize meal during the year 1993. The average maize meal trading volume of six larger food retailers in Ovambo amounted to 320 tons in 1993. During the same year, the three dominant food retailers from Rundu traded, on average, 480 tons of maize meal. During 1993, rural

supermarkets and rural shops sold, on average, 26 tons of maize meal in Ovambo and 5 tons in Kavango.[1]

In Ovambo, urban maize traders received about a third of their maize meal directly from Namibia's two large milling operations, 'Namib Mills' and 'Agrar Mills', while in Rundu / Kavango, the main food retailers receive almost all their maize meal from these mills. Most rural food retailers receive their maize meal via wholesalers and not directly from the processing industry.

The three most important types of maize meal retailers of Ovambo and Kavango are: (1) retail outlets of wholesalers in urban centers, (2) supermarkets in urban and rural areas, and (3) small private shops in rural areas. Most of the urban and rural food retailers have maize meal available throughout the year. However, because consumer demand for maize meal tends to decline drastically after millet harvest in June for a period of three to six months, wholesalers and large supermarket chains reduce their maize meal stocks during this period to about 30 percent of their normal level. Due to the reduced consumer demand and the reduced supply from wholesalers, many of the rural food traders stock only little or no maize meal after millet harvest.

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[1] The large maize trade volume of individual traders in urban areas might lead to the assumption that maize is mainly consumed in urban areas. However, the number of rural shops and supermarkets selling maize meal to the rural population is also substantial. Therefore, from the location of the traders alone, it can not be derived whether maize is more consumed in urban or rural areas. As will be shown in Chapter 5 about households' grain consumption pattern, a relatively high proportion of rural farm households purchases its maize meal directly from urban retailers.

Millet traders were asked hypothetical questions about how their customers would react to an increased maize offer (ceter paribus) in the market and how they would react to a maize meal price decline (ceter paribus). Ninety-five percent of the interviewed millet traders were convinced that an increased maize supply without a decline in maize meal prices has no effect on their current millet trade volume. Still, 87 percent of the traders claimed that even a price decline in maize meal would not affect their millet trade. Most of the traders argued that 'millet sells as long as it is available' and that 'people with migration income will always buy millet.' The last argument especially indicates that in northern Namibian, consumers perceive maize as an inferior good compared to millet. Some traders considered a decline in millet sales but claimed that 'a certain amount of millet will always be commercially traded.' The traders that assumed that millet price reductions would trigger a drastic reduction in millet trade pointed to the fact that 'poorer customers have no other choice than to buy the cheapest staple food available, no matter what taste preference they have.'

To the hypothetical question of how commercial millet trade would be affected by an official ban of Angolan millet imports, most traders' answers were ambivalent. In the first place, traders claimed a stop of millet imports would aggravate the hunger situation in the study zones because less food would be available. They also indicated that their own millet business could be hurt because less millet would be available for trade. However, most traders also mentioned that a decline of Angolan millet imports could also lead to increased

market prices for nationally produced millet. Most traders assumed that such price incentives could prompt, in the long run, higher national millet production and as such benefit the northern communal population if rainfall and technical assistance would allow farmers to respond adequately.[1]

When asked about the effect that a good millet harvest in the study zones has on millet and maize trade, 72 percent of the interviewed traders responded that commercial trade with millet and maize is generally depressed for several months. Some of the interviewed traders said that millet sales to farmers usually in grain deficit would decline. Others traders said that their commercial millet trade would be unaffected because their urban clientele always needs millet. The vast majority of the sample traders (93 percent) said that poor grain harvest years like the drought year of the 1991/92 season effect their millet trade very positively.

4.2.4.4. Grain traders' expectations from government

The interviewed grain traders made also statements about measures the Namibian government could use to foster commercial millet trade in the future. Traders' recommendations for improving commercial millet sector are as follows:

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[1] Probably due to their own strong background in farming or relationships to farmers, traders reacted from two standpoints. From the trader point of view, they argued that government should not intervene in their trade business and Angolan imports should continued to be allowed. But for the benefit of Namibian farmers they were inclined to accept an import stop for Angolan millet to increase producer prices.

First, to increase production, the government should: (a) improve its plowing service program, (b) provide mechanical threshing equipment, (c) render an effective agricultural extension service, and (d) provide a credit scheme for farm investments.

Second, to improve the millet market government should: (a) provide business loans to ease the acquisition of millet after harvest, (b) foster long distance transport between areas with millet surplus production and millet deficit areas, (c) encourage the organization of local millet markets that would reduce the need of long-distance travel, and (d) help to identify suitable equipment for mechanical processing of millet.

4.3. Farm level millet sales

This section covers three important aspects of millet marketing activities on the household level. It first describes the frequency and extent of farmers' millet sales. Second, it assesses those factors that farmers indicated as most limiting to millet trade. And third, it presents the results from a simple probit regression model that estimates the effects that various factors have on farm households' millet selling decisions.

4.3.1. Frequency and extent of farm level millet sales

During the millet subsector household surveys, several attempts have been made to quantify households millet sales between their harvests of

May/June 1992 and May/June 1993. The results to these inquiries were very meager; i.e., only very few farmers stated that they sold millet during this period and the quantities obtained from these farmers were very vague. The following reasons might have caused such responses:

(1) After poor harvest results of the drought production year 1991/92, farmers might have preferred to keep their millet to replenish their reserves;
(2) The concepts of recalling quantities of marketed millet over longer periods of time might have been too difficult for the respondents so that they stated only the most recent sales; and
(3) Because most farmers received at least some food aid during the production year 1992/93, they might not have wanted to jeopardize further handouts by revealing their own millet selling activities.

To acquire at least some indications about farm households' millet marketing activities, survey farmers were asked more generally how often and under which conditions they sell millet (Table 4-11). Responses to these questions indicate that Kavango farmers sell millet significantly more often than Ovambo farmers. Of the interviewed Kavango farmers, 18 percent claimed they 'sell millet every year.' Less than one percent of the interviewed Ovambo farmers made the same statement. Another 54 percent of the farmers in Kavango 'sell millet in some years.' This is still high in comparison to the 30 percent of the Ovambo farmers from the same category. Finally, the comparison between different production zones indicates that relatively more farmers whose production areas are closer to the fast growing population centers

(central Ovambo and central Kavango) sell millet than those located in peripheral production zones.

Table 4-11. Millet selling frequencies of rural households, by zone and subzone (percent)

Zone	Ovambo (n=200)				Kavango (n=120)			
Subzone	West	Central	East	Mean	West	Central	East	Mean
Selling Frequency								
Never	76	55	80	**70**	34	18	32	**28**
Some years	24	45	20	**30**	42	80	40	**54**
Every year	0	0	0	**0**	24	2	28	**18**
Total	100	100	100	**100**	100	100	100	**100**

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

The households that sell millet every year or at least in some years were asked to point out the conditions under which they usually sell millet. The rank order of important selling conditions is the same for both study zones. Most of the millet selling farmers state an 'urgent need for money or goods' as the primary motivation for their millet sales.

However, especially farmers from Kavango often mention 'enough millet reserves' as a precondition for grain sales. Of the millet-selling Kavango farmers, 40 percent claim that they sell millet only if they have millet reserves that last at least for two years. An additional 30 percent of Kavango farmers require reserves that last at least one year. (Table 4-12)

Table 4-12. Farm households' pre-conditions for selling millet (percent*)

	OVAMBO (n=200)	KAVANGO (n=120)
% of Households Selling Millet	**30**	**72**
Urgent need of money or goods	23	54
If reserves are enough**	11	54
After a good millet harvest***	10	44
Being approached to sell food	6	28
After every harvest	0	18

Data Source: Namibian Millet Subsector Research Project, 1992-93

* Because farmers could identify several of their selling conditions at the same time the presented percentages do not sum up to 100.

** Most farmers have a millet reserve/selling threshhold that makes them accumulate millet reserves until they feel secure against drought. Only if this threshhold is reached they consider selling some of their grain. (this excludes forced sales of grain)

*** This category could but does not have to be congruent with the previous category. It is possible that a farmer had a good millet harvest but decide not to sell millet because his/her reserve/seling threshhold is not yet reached.

Again, compared to Ovambo, a significantly higher proportion of millet-selling farmers in Kavango state they sell millet 'only after a good grain harvest,' i.e., when the above-mentioned thresholds of grain-reserves are achieved. Eventually, not all millet sales at the farm level depend solely on households' grain supply. Half of the millet selling Kavango farmers and 25 percent of the respective farmers from Ovambo are selling millet if they are 'approached by other households who are in need of food.'

The quantities of millet sold during individual selling transaction are especially small in Ovambo. In this zone, 85 percent of millet-selling households sell not more than about 16.5 kg at a time, the amount traditionally used measures can hold. Eleven percent sell millet mostly at quantities of a 50 kg bag. In Kavango, the situation is reversed. Only 25 percent of millet selling households sell millet to individual buyers at quantities below or equal to 16.5 kg, while 61 percent sell millet mostly at the quantity of a 50 kg bag.

Of the millet selling households, only the minority plans to sell millet at the time of planting (Ovambo: 9 percent, Kavango: 38 percent). An active search for millet buyers is undertaken by only a small portion of millet selling producers (Ovambo: 19 percent, Kavango: 40 percent). In both zones, active millet sellers tell their neighbors and community members about their willingness to sell and/or send messages to other communities. A few cases even broadcasted over public radio their willingness to sell millet.

In order to search for potential millet buyers and to transport millet to the homestead, most sellers walk (Ovambo: 58 percent, Kavango: 38 percent).

Those who don't walk use a variety of other means to reach buyers: in Ovambo, bicycles (19 percent), private motor vehicles (6 percent), and donkey carts (8 percent) are used. In Kavango, the oxen sledge is the predominant means of transportation (40 percent), while bush taxis are used by about 29 percent of the sellers, and private motor vehicles by 9 percent.

As stated before, the millet subsector household surveys were not able to collect adequate information about how much farm households sell millet over a specific period of time and in what proportions to different buyers. However, farmers were willing to state to whom or at what location they tend to sell their millet. When asked to whom they sell their millet, neighbors are named by the vast majority millet producers (Ovambo: 100 percent, Kavango: 89 percent). Traveling traders were the second most often mentioned category of millet buyers (Ovambo: 22 percent, Kavango: 42). Selling millet at local markets seems to be only important for Ovambo farmers. In Kavango, millet is also sold to local shops, urban markets or retailers, and to the two competing organizations, the self-help marketing cooperative 'Katemo' located in Rundu and the Namibian Development Corporation, which owns several semi-commercial farms in Kavango. (Table 4-13)

Table 4-13. People or trading locations farmers sell millet, by zone (percent of millet selling households*)

	Millet Selling Households	
	Ovambo (n=53)	Kavango (n=85)
Neighbors	100	89
Traveling traders	22	42
Local markets	17	11
Local shops	4	36
Urban markets/retailers	6	24
Katemo Cooperative/Rundu	0	25
NDC farms in Kavango	0	12
Traders from Windhoek	0	5

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

*Because farmers could indicate several of their millet buyers at the same time, the presented percentages do not add up to 100.

Among neighbors, millet is often bartered for meat. This and similar types of barter occur usually briefly after the grain harvest and involve quantities that range between 1 and 16 kg. Millet is sold to traveling traders mainly in exchange for money or consumer goods. Again, these transactions take place mainly after harvest. However, the quantities sold range from 16 kg up to several 50 kg bags of millet.

4.3.2. Limitations of millet marketing

As mentioned in Chapter 1, the proposal of the Namibian Agronomic Board to implement a millet marketing scheme in northern Namibia was based on the assumption that informal and commercial millet prices are not high enough; i.e., the proposal argued that government-stipulated producer prices are

necessary to encourage more millet production. The following section demonstrates that millet prices are only one of several factors affecting farmers' millet-selling behavior. This section first identifies various limiting factors of millet marketing on the farm level and then addresses the more important of these factors individually.

4.3.2.1. Marketing versus production constraints

The farmers included in the millet subsector household surveys were asked to identify factors that make millet marketing difficult. The responses of the interviewed farmers were analyzed separately for each study zone and for (1) those farmers that 'never sell millet', (2) those who 'sell millet in some years', and (3) those who 'sell millet every year'.

For farmers that never sell millet, 'lack of marketable millet surplus' and 'fear of drought' are the leading constraints on millet marketing.

With increasing millet selling frequencies, farmers mention also more true marketing constraints. In both study zones, over half of the farmers that sell millet in some years mention 'expensive transportation' as an obstacle to millet marketing. In Kavango, over 90 percent of these farmers complain additionally about 'low market prices'. (Table 4-14)

Table 4-14. Millet marketing constraints of rural household, by farmers' selling frequency and zone (percent)

	Ovambo (n = 200)			Kavango (n = 120)		
Households Selling Frequency in Years	**never** 70	**some years** 30	**every year** 0	**never** 28	**some years** 54	**every year** 18
Constraints						
not enough millet	**83**	**68**	n.a.	**94**	**98**	**84**
fear of drought	**79**	**86**	n.a.	**94**	**97**	**88**
expensive transport	22	**56**	n.a.	20	**67**	**77**
no own transport	6	29	n.a.	10	33	**53**
long distances	7	33	n.a.	0	34	**65**
no local market	18	11	n.a.	3	23	**53**
tradition not to sell	15	16	n.a.	32	8	33
search for buyers	12	9	n.a.	0	26	25
low millet prices	7	11	n.a.	0	**94**	29

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

Eventually, over 50 percent of the farmers that sell millet every year state 'lack of their own transportation', 'long trading distances', and 'lack of local markets' as selling constraints.

4.3.2.2. Grain reserves against drought

To analyze the effect that fear of drought has on households' millet-marketing decisions, farmers were asked to state the amount of grain reserves they intend to have in storage before they consider selling larger amounts of

millet. The responses regarding farmers' grain storage/selling-thresholds have been converted into (a) amounts stored per household member and (b) the period of time such reserves would last per household (see Table 4-15).

Table 4-15. Millet reserve targets of rural households, by zone and farmers' millet selling frequency (kg/capita, years/capita)

	Ovambo (n = 200)			Kavango (n = 120)		
Selling Frequency	never	some years	every year	never	some years	every year
Reserve targets						
- kg / capita	540	870	n.a.	260	220	460
- years / capita	4	6 ½	n.a	2	2	3 ½

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

These conversions reveal that Ovambo farmers' fear of drought translates into very high, almost unrealistic millet reserve targets. On average, Ovambo households stated storage targets for millet that would last between 4 and 6 ½ years. These high thresholds imply the following:

(1) The occurrence of drought is imminent and farmers take this into consideration.
(2) Most Ovambo households are not used to selling millet in larger quantities and therefore have the tendency to overestimate their reserve needs.
(3) Because of fear of drought, household reserves have first priority so that even after a good production season, commercial millet sales are not as large as they could be otherwise.

The storage/selling-thresholds of Kavango households seem to be more in line with actual reserve needs. Kavango households that never or only rarely sell millet prefer to have, on average, millet reserves that last 2 years. Kavango households that sell millet every year perceive a need for higher storage/selling-thresholds. Their target grain reserves last, on average, 3½ years. It is assumed that these higher storage/selling-thresholds are related to the social obligations richer farmers have with respect to their extended family and their poor neighbors.

Once the knowledge that those households selling larger amounts of millet also tend to accumulate considerable amounts of millet reserves is pieced together with the information about farmers' storage practices, interesting implications evolve with regard to the prospects of further millet market developments. As already presented in Chapter 3, farmers traditionally store freshly harvested millet as drought reserve and use older grain reserves for consumption. The same is true for marketable surplus, older grain surpluses are offered to the market only when the new harvest arrives and storage containers become scarce.

While the described behavior was justified in the past by household food security considerations, it is not always reasonable under today's circumstances. Contrary to the past, maize meal is today readily available in the food market, even when millet can not be purchased. This means that larger and wealthy farmers might be better off selling their surplus grain soon after harvest and using at least part of it to make investments in non agricultural activities like

education or business, instead of letting their millet sit and rot in their granaries. The commercial millet market currently suffers because even after good harvest years, mostly older and thus lower-quality millet is offered. This prevents consumers that have the cash income to purchase fresh millet from acquiring it. In the middle and long run, such financially-strong customers are lost because they switch to maize meal that is always available, convenient to use, and of consistent quality.

In summary, the above analysis demonstrates that after good production years, farmers ' priority is first to replenish their millet reserves; i.e., at least part of the marketable millet surplus from one production season is not immediately available to consumers in demand and/or areas with production shortfalls. While this behavior is justifiable for farmers who have little access to cash income during periods of drought, the same behavior by wealthier surplus farmers leads to a reduced offer of marketable millet surplus in the commercial food market, and thus to reduced development prospects for the commercial millet market.

4.3.2.3. Transportation limitations

The section about the general limitations to millet marketing at the household level demonstrated that long distances between producers and consumers, as well as lack of transportation and/or high transportation cost, are important constraints for those farmers who sell millet in some years or even every year. To analyze the effect that transportation constraints have on households' millet marketing decisions, sample farmers were asked to indicate

(a) the locations where they would buy and/or sell a 50 kg bag of millet,

(b) whether they needed transportation to reach these locations, and

(c) how much it would cost them to travel to these locations with and without a bag. (see Table 4-16.)

Table 4-16. Marketing locations for larger amounts of millet, by zone and type of transaction (percent)*

	Ovambo Households (n=200)		Kavango Households (n=120)	
Location	**Buying**	**Selling**	**Buying**	**Selling**
neighbors	35	35	32	32
local market	38	30	1	1
distant market	24	23	5	27
local shop	0	8	27	8
distant wholesaler	2	2	8	6
Katemo cooperative	0	0	17	5
FNDC	0	0	6	17
other	1	2	4	4
total	100	100	100	100

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* Farmers were asked to state the locations where they buy and sell at least 50 kg of millet. In case the respondent claimed he/she never buys or sells millet, the question was asked hypothetically.

note: Traveling traders were not mentioned by respondents because the survey question asked specifically for locations, while traveling traders from northern Namibia tend to be unpredictable in the time and the location of their appearance.

In Ovambo, farmers' millet buying and selling locations do not differ from each other. Neighbors and local markets rank first, with each used by more than 30 percent of the survey farmers for millet buying and selling. Distant markets rank third. They are used by roughly a quarter of farmers for marketing and purchasing millet in a 50 kg bag or more. Similar to Ovambo, about a third of all Kavango farmers sell and buy 50 kg bags from their neighbors. Other places differ in their importance for selling and buying. Beside from neighbors 27 percent of Kavango farmers buy millet from local shops and 17 percent buy from the 'Katemo' cooperative in Rundu. Besides to neighbors, Kavango farmers sell millet to the open market in Rundu and to various semi-commercial NDC farms scattered along the Kavango river.

Table 4-17 presents the percentage of households that (a) do not need transportation to trade a bag of millet (buying and selling), (b) use their own transportation, or (c) have to hire transportation service. Because of the low population density in eastern Ovambo and western Kavango, millet buying and selling points are rare. Accordingly, in these two zones, between 80 and 100 percent of all households need transportation for millet trade. In the other subzones, between 30 and 60 percent of households need transportation to buy or sell millet. On average, between 40 and 50 percent of the households from both study zones hire transportation to reach a location where they can sell or buy a larger amount of millet.

Table 4-17. Transportation needs for millet marketing stated by farmers, by subzone, and transaction type (percent)

Zones	Ovambo Households			Kavango Households		
Subzones	West	Central	East	West	Central	East
	(n=80)	(n=40)	(n=80)	(n=40)	(n=40)	(n=40)
	Transportation need for millet purchases					
need no transportation	51	41	1	23	59	63
use own transportation	19	3	50	23	3	3
hire transportation	30	56	49	54	38	34
total	100	100	100	100	100	100
	Transportation need for millet marketing					
need no transportation	51	54	0	8	50	71
use own transportation	17	3	6	12	0	4
hire transportation	32	43	36	80	50	25
total	100	100	100	100	100	100

Data Source: Namibian Millet Subsector Project Surveys 1992/93

Hiring transportation for grain marketing is expensive. (Table 4-18) At the end of the 1992/93 production year, the price for transporting a 50 kg bag of millet to/from the trading place ranged in Ovambo, between N$ 1.20 and N$ 4.00, and in Kavango, between N$ 2.10 and N$ 8.10. The transportation costs for the person that buys or sells a bag of millet are even higher. The

average travel costs for trading individuals ranged, in Ovambo, from N$ 5.50 to N$ 20.00, and in Kavango, from N$ 5.70 to N$ 21.20. Based on an average price of N$ 60 per 50 kg of millet during the 1992/93 production year, total transportation costs ranged, in Ovambo, from 11 to 40 percent of the traded millet value, and in Kavango, from 13 to 59 percent respectively.

Table 4-18. Cost of hiring transportation to sell/purchase millet, by subzone (N$ per 50 kg)

Zones	Ovambo			Kavango		
Subzones	West (n=80)	Central (n=40)	East (n=80)	West (n=40)	Central (n=40)	East (n=40)
Transportation costs to purchase millet						
per 50 kg bag*	1.20	4.20	4.00	4.60	8.10	2.00
for trading person**	5.50	9.20	5.50	12.20	21.20	6.40
total transport cost	6.70	13.40	9.50	16.80	29.30	8.40
Transportation costs to market millet						
per 50 kg bag*	2.30	2.60	3.10	4.50	5.00	2.10
for trading person**	20.00	6.10	9.10	11.00	10.00	5.70
total transport cost	22.30	8.70	12.20	15.50	15.00	7.80

Data Source: Namibian Millet Subsector Project Surveys 1992/93

* cost for one way ** cost for return trip

The above analysis indicates that many rural Ovambo and Kavango households have to hire transportation for millet trade and that their transportation costs are, in some cases, very high. It can be assumed that such high transportation costs reduce the profit expectations of potential millet sellers and ,therefore, lead to reduced millet marketing activities beyond rural farmers' immediate neighborhood.

4.3.2.4. Lack of local markets

Lack of local grain markets is often closely related to the need of traveling far distances to sell or buy millet. In Ovambo and Kavango, between 40 and 60 percent of the surveyed households claimed that there is no local market in their vicinity. (Table 19)

Table 4-19. Percent of farmers lacking access to local grain markets and their attitudes regarding the need of such markets (percent)

Zones	Ovambo Households			Kavango Households		
Subzones	West (n=80)	Centra (n=40)	East (n=80)	West (n=40)	Central (n=40)	East (n=39)
No Market Access:	49	50	59	63	50	51
Expressed Attitudes:						
Yes, need market	26	13	53	63	50	49
Market will not work	13	37	6	0	0	2

Data Source: Namibian Millet Subsector Project Surveys 1992/93

Most of the interviewed farmers who lack access to local grain markets expressed an urgent need for such places. These farmers expect from local markets the following: (a) shorter travel distances (50 percent of all answers); (b) easier trading of grain (30 percent of all answers); and (c) a general improvement of living and income conditions (10 percent of all answers).

A few farmers said that a local grain market would not function (mainly in western and central Ovambo). The two most often mentioned reasons of these farmers are related to the small trade volume in their neighborhood. In western Ovambo, farmers claimed more often that, due to the low purchasing power of their neighbors, potential millet suppliers could not sell much millet and, therefore, could not earn enough profits. In central Ovambo, opponents of local markets claimed that new grain markets in their vicinity would fail because most of their neighbors are not producing enough marketable millet.

The concerns about an insufficient trade volume of local markets bear some validity. Local market places are not necessary in every millet production area, nor is the organization of certain market days promising . However, lack of local grain markets in areas with high demand for millet, or large millet surpluses (or both), increases transaction cost and makes it impossible for individuals to make their needs known to long-distance traders so that they can react. Lack of local grain markets leads surplus producers either to store their millet in their granaries where it is more difficult to access by deficit farmers[1], or to sell their

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[1] As demonstrated in Table 4-12, a significant portion of farmers selling millet (Ovambo: 6 percent, Kavango: 28 percent) claim they only sell if they are

millet at distant marketplaces, which, again, can hardly be reached by poorer deficit farmers in their neighborhood. Consequently, grain deficit farmers, short of local grain markets, have no other alternative than to buy imported maize that is channeled via the urban-based retail system to rural shops.

4.3.3. Regression analysis of farmers' marketing decision

As explained above, data about actual amounts of millet marketed by survey farmers in the past could not be acquired through the conducted millet subsector household surveys. As a result, only farmers' categoric statements about their general millet selling frequencies are available as a basis for the quantitative analysis of household level millet marketing behavior. Of 320 households, 56 percent claimed they 'never sell millet,' while 44 percent stated they sell millet in 'some years' or 'every year'. The following presents, first, an overview of the cross-section probit model that uses the categoric millet selling frequencies as independent variables; second, describe the independent variables employed in this model, and third, discuss the regression results.

When just one observation on each decision maker is available a probit regression model can be used in combination with maximum likelihood methods to predict whether a farm household is selling or not selling millet, given a set of

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approached by potential buyers. This means farmers who are interested in purchasing millet have first to visit potential millet sellers to investigate whether they are willing to sell millet at all, and if so, how much and at what price. In the widely-dispersed communities of northern Namibia this could mean that potential buyers might have to invest significant efforts (search costs) until they identify someone willing to sell his/her millet.

values for the explanatory variables. The measure used to evaluate the estimated coefficients is the percent of successful predictions within the given sample. Due to the nature of the probit model the estimated coefficients of the probit model do not indicate the increase in the probability of farmers millet selling, given a one-unit increase in the corresponding independent variable. Rather, the estimated coefficients reflects the effect of a change in an independent variable from an initial value on the probability of millet selling at this initial value. For this study the initial values of the independent variables are set according to a base (control) case that represents an average farmer in Ovambo and Kavango.

The cross-section probit model encompasses explanatory variables that identify (a) farmers' grain production performance in the past, (b) the use of inputs as indicators that farmers try to increase their millet production to be able to sell at least part of it, (c) farmers' access to grain markets, and (d) household characteristics. Because millet producer prices from the past are neither available on the household level nor on any higher aggregate level, economic price incentives for millet sellers had to be ignored. The variables are all tested for correlation and had met the test.

SELLMIL = f (Q92, SPYRS, ZONE, CEMKT, LOMKT, MANR, OKAS, CASH)

where:

SELLMIL	= farm household tends generally to sell millet (Dummy, 1 = yes)
Q92	= millet production during the 1991/92 drought year (mt)
SPYRS	= millet surplus production years between 1988/92 (No. 1 - 5)
ZONE	= located in Ovambo or Kavango (DUMMY, 1 = Ovambo)
CEMKT	= located close to large center market of zone (DUMMY, 1 = yes)
LOMKT	= have access to local market (DUMMY, 1 = yes)
MANR	= use of cattle manure on all fields (DUMMY, 1 = yes)
OKAS	= experience with Okashana 1 before 1992/93 (DUMMY, 1 = yes)
CASH	= annual cash income from non-cropping activities (N$ '000)

Table 4-20. Characteristics of the variables in the millet selling equation

	Ovambo and Kavango (n = 268)	
VARIABLE	**MEAN**	**S.E.**
SELLMIL (1 = yes)	44 percent = 1	
Q92 (MT)	0.57	2.12
SPYRS (No. 0-5)	0=35%, 1=37 %, 2=16, 3=10, 4=5%,5=0.3%	
ZONE (1 = Ovambo)	63 percent = 1	
CEMKT (1 = yes)	25 percent = 1	
LOMKT (1 = yes)	47 percent = 1	
MANR (1 = yes)	18 percent = 1	
OKAS (1 = yes)	43 percent = 1	
CASH (N$ '000)	7.65	12.10

Data Source: Namibian Millet Subsector Research Project, 1992/93

The independent variables used, and the reasons for their inclusion in the estimated equation, are as follows:

(a) the amount of millet harvested in the 1991/92 production year (Q92). When asked about the limiting factors of millet marketing, the majority of the interviewed sample households responded that low millet yields prevent them from selling millet. From these statements it is concluded that households' overall millet production capacity affects their millet marketing decisions. To account for this effect, households' millet production during the severe drought year of 1991/92 (Q92) has been included in the probit model as a proxy for households' overall millet production capacity. It is hypothesized that the likelihood that a farm household is generally selling millet is positively related to the variable Q92.

(b) the number of years the household was self-sufficient in millet production from 1988 through 1992 (SPYRS). Not only farm households' general millet production capacity affects their millet marketing behavior, but also the fact whether the household is actually capable of producing enough millet over time to cover its grain consumption needs. It is assumed that if a household is not able to produce marketable millet surpluses over a longer time period, the likelihood that this household sells larger amounts of millet is reduced. To account for the effect of grain surplus production on farmers' millet marketing decisions, the variable SPYRS is included in the equation. The SPYRS variable can have six different values, from 0 to 5, reflecting the number of years survey respondents stated they experienced millet self-sufficiency during the period

from 1988 to 1992. Based on the assumption stated above that with an increased number of surplus years farmers are more likely to sell millet, it is hypothesized that the number of grain surplus years experienced by rural households is positively related to the dependent variable SELLMIL.

(c) the production zone in which farm households produce (ZONE). As demonstrated in Chapter 3, the overall millet production potential of Ovambo is lower than that of Kavango. This is mainly caused by lower average rainfall in Ovambo and its significantly higher population density, which leads to the use of more marginal soils for crop production. It is assumed that lower millet yield levels in Ovambo hinder farmers from millet selling, not only through the physical lack of surplus production, but also by creating an attitudinal environment in which millet sales have a much lower priority than household's own millet consumption and its millet reserves against drought-related crop failures. To control for the effect that the lower millet production potential of Ovambo has on farmers' millet marketing behavior, the dummy variable ZONE is included in the estimation. The variable takes the value one if the sample household is located in Ovambo. It takes the value 0 if the sample household is from Kavango. The coefficient of the variable ZONE is expected to be negative as a result of the negative effect that the lower millet production potential of Ovambo has on farmers' millet selling behavior.

(d) the farm location with respect to the central market (CEMKT). Farmers often mention long distances and high transportation costs as constraints to millet marketing. As discussed in Part 2 of this chapter, high transportation costs

reduce profit expectations of potential millet surplus producers, and, therefore, might discourage farmers from commercial millet production. To account for the effect that long distances and high transportation costs have on farmers' decision to produce millet for sale, the dummy variable CEMKT has been included in the regression. The variable has the value one if farmers live in the center region of their zone and are therefore closer to urban grain markets where they can sell larger amounts of grain for cash. Additionally, it is assumed that a closer distance to urban centers increases households' exposure to modern consumer goods which can only be acquired through monetary payments. This again encourages the marketing of grain surpluses. It is therefore hypothesized that households' millet selling is positively related to the variable CEMKT.[1]

(e) farmers' access to a local grain market (LOMKT). Only 44 percent of the interviewed sample farmers have access to local grain markets. The majority of the farmers that have no local market in their vicinity state that they need such a place to reduce their trading distances and to generally ease the exchange of millet and of other goods. It is hypothesized that those farmers who have a local marketplace close to their homestead are more likely to be engaged in millet trade than those without. To test this hypothesis, the dummy variable LOMKT is included in the regression model. The variable takes the value one if farm

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[1] The question whether those millet selling farmers who are located further away from center markets might compensate this fact by selling more millet to their neighbors bears little validity. This is because farmers located closer to center towns have also neighbors to sell to. The center of the above made argument is the additional incentive the close center markets present for millet selling.

households have access to a local grain market; otherwise, the variable is zero. The coefficient of the LOMKT variable is expected to be positive as a result of the positive effect that close by marketing opportunities have on households' millet selling decision.

(f) the use of yield-enhancing production inputs to produce marketable surplus (MANR and OKAS). The regression analyses of millet area and millet hectare yields per household in Chapter 3 demonstrate that (a) the fact that farmers used Okashana 1 before it was distributed for the 1992/93 production season to relieve potential seed shortages, and (b) the use of cattle manure or chemical fertilizer are positively correlated with farm household millet yields. It is hypothesized that those farmers who invest (either financially or through more labor) into productivity enhancing inputs like seed and fertilizer try to recapture at least part of their production costs by marketing millet. To control for the effect that the use of potential yield enhancing inputs has on farmers' millet selling behavior, the two dummy variables MANR and OKAS are included in the model. The variable MANR takes the value one if farmers claimed they fertilized their field either with manure and/or chemical fertilizer. The OKAS variable indicates whether farm households have grown Okashana 1 at least once before the 1992/93 season (one) or not (zero). The coefficients of both variables are expected to be positive due to the positive relation between input use and marketing intention.

(h) the amount of farm households' annual cash income (CASH). Farm households' annual cash income has shown only small positive effects on

farmers' cultivated millet area and on their millet hectare yields. The explanation for this weak relationship between farm household production intensity and annual cash income is based on the argument that households that earn larger amounts of cash income from non-crop production related activities (further called cash income) don't have to balance their consumption needs with grain production. A similar argument is used to hypothesize about the relation between farm households' millet selling behavior and their annual cash income. It is assumed that households that earn cash income are less likely to produce millet for commercial purpose but rather to make use of their labor force bound to the rural homestead. To account for the effect that cash income has on farmers' millet marketing behavior, the amount of cash income earned by sample farmers during the 1992/93 production year (CASH) is included in the equation. Based on the explanations given above, it is hypothesized that household level millet sales are negatively related to the CASH variable.

Table-21 presents the main statistics of the estimated equation. The model's prediction levels indicate that 75 percent of the 268 cases regressed were correctly predicted to be either millet sellers (69 percent) or not (80 percent). All signs of the estimated coefficients are according to expectation and the lowest significance level of the coefficients is 0.07.

For the following interpretation of the probit regression results, the base (control) case represents a farm household during the 1992/93 production year that did not produce millet surplus during any of the last five grain production

periods (SPYRS = 0), lives in Kavango (ZONE = 0), lives in production areas that are far away from commercial centers (CEMKT = 0), has no access to local markets (LOMKT = 0), does not fertilize its fields (MANR = 0), and has not used Okashana 1 before the 1992/93 production season (OKAS = 0).

Holding all other factors constant, the zone in which the sample farmers live (ZONE) affects most the probability that a farm household sells millet. If a farmer is located in Ovambo, the likelihood that he markets millet is reduced by 58.5 percent compared to a Kavango farmer. This result is not surprising, taking Ovambo's marginal grain production potential into account.

Also, under ceteris paribus conditions, the number of grain surplus years (SPYRS) a household experienced between 1988 and 1992 has a significant effect on the probability of millet selling. With each additional year of grain surplus production during the five year period, the likelihood of millet selling increases by 13.8 percent. This conforms with the hypothesis that farmers prefer to first accumulate a certain amount of millet reserves over the course of several production seasons before considering selling larger amounts of it.

Table 4-21. Estimates of the millet selling equation

	Ovambo and Kavango			
VARIABLES	**COEF.**	**S.E.**	**SIGNIF.**	**PROB.***
CONSTANT	- 0.88	0.39	0.03	–
Q92	0.20	0.06	0.00	4.6**
SPYRS	0.65	0.17	0.00	13.8
ZONE	- 3.91	0.61	0.00	58.5
CEMKT	1.34	0.35	0.00	24.3
LOMKT	0.58	0.32	0.07	12.5
MANR	2.28	0.59	0.00	32.4
OKAS	0.84	0.36	0.02	19.7
CASH	- 0.05	0.02	0.02	1.2***

Prediction Levels: Non-Sellers = 80 %, Sellers = 69 %, Overall = 75 %

Case Number = 268, Chi - Square = 106, DF. = 8, SIG. = 0.0000

Data Source: Namibian Millet Subsector Project , 1992/93

* Indicates how the increase of an independent variable by one unit alters the probability that the base case is a millet seller. (in percent)

** Millet production of the 1991/92 drought year is increased by one ton.

*** Annual cash income from non cropping activities is increased by N$ 1000.

Compared to the described relationship between number of surplus years in the past and millet selling, the amount of millet harvested during the severe drought season (Q92) shows little effect on farmers' millet marketing behavior. A large increase of millet production by one ton during the 19991/92 production season increases the likelihood that a farm household sells millet only by 4.6 percent. The high significance level of 0.00 indicates that households' capacity to produce some grain under severe drought conditions has a positive effect on their general millet selling behavior. However, as argued before, other factors that reflect farmers' production capacity over a period longer than one year demonstrate a stronger relation to farmers' millet selling behavior.

As hypothesized, the use of yield enhancing inputs is positively correlated with farmers' millet selling behavior. If farmers fertilize their grain fields with manure (MANR), the probability that they sell millet increases by 32.4 percent. Similarly, farmers who have gained experience with the newly-introduced millet variety Okashana 1 (OKAS) have an increased likelihood to be sellers by 19.7 percent. Having controlled for households' overall millet production capacity (Q92) and the number years farmers were millet self-sufficient since the year 1988 (SPYRS), it can be assumed that those farmers who make investments in production inputs expect and try to recapture their investment costs or efforts by marketing at least part of their millet production.

Both coefficients estimated from variables that represent farmers' closeness to commercial grain markets (CEMKT) and informal millet markets (LOMKT) indicate a positive relation to farmers' millet selling behavior. If millet

producers are living closer to the population centers of Ovambo or Kavango, the likelihood that they are millet sellers increases by 24.3 percent. This can be explained by the fact that farmers who are closer to urban markets are (a) more exposed to commercial ideas, and (b) receive a higher stimulus to buy consumer goods for which they have to earn money through millet sales. If millet producers are located close to a local grain market, the likelihood that they are selling millet is increased by 12.5 percent. The explanation for this is lower transaction cost for millet marketing as well as exposure to the idea to commercially produce millet. However, the closeness of a local grain market might just indicate that the farmers in consideration live in an area with increased millet production, so that the likelihood of having marketable surplus is generally increased.

The coefficient of the CASH variable reflecting households' annual cash income is relatively small and negative, but significant at the 2 percent level. This result indicates that those farm households that earn larger amounts of money from alternative income sources are less likely to sell millet compared to those who have no other employment than to produce millet. An increase of households' annual cash income by N$ 1000 reduces the probability of millet selling by only 1.2 percent. The result confirms the assumption that households that earn cash income are less likely to produce millet for commercial purposes, but rather to make use of their labor force staying at home.

4.4. Chapter summary

The following section summarizes the findings about farm level millet marketing, commercial millet trade, and the price position of millet in the study zones.

4.4.1. Farm level millet marketing

The most important finding about millet marketing on the household level is that about 70 percent of the farmers in Ovambo never sell millet, while the remaining sell millet only in small quantities every other year. In Kavango, millet selling is much more common. About half of Kavango's farmers sell millet every other year, and almost a fifth of them sell millet every year. Also the amounts of millet that Kavango farmers market are larger than those from Ovambo farmers. The differences in household level sales of millet lead to the fact that although Kavango has only a forth of Ovambo's population the amount of its marketable millet surplus from the 1992/93 production was the same as in Ovambo. This is a clear indication that Kavango has a higher potential for commercial millet production in the future than Ovambo.

Most of the farmers that market millet sell it informally to their neighbors. For the farmers that sell millet to commercial intermediaries marketing constraints are a problem. The most important marketing constraints of these farmers are high transportation cost. Farmers from Kavango with marketable surplus indicate that the lack of local markets leads to far distances to the central market in Rundu. The results from the cross-section probit model also confirmed

that the proximity to urban and local grain markets increases the likelihood that farmers engage in the production of millet for the market.

To cope with the large annual yield variations and to reduce the threat to household food security, most farmers try to keep millet reserves that last between one and three years. This means that after good harvest years, most farmers replenish their millet reserves first, and that most of the marketable surplus from such seasons is not immediately available to farmers with grain production shortfalls. Farmers' practice of storing freshly harvested millet as reserves and consuming or offering older millet stocks for sale leads often to older, and thus lower-quality, supplies for the commercial millet market.

4.4.2. Commercial millet trade

In rural areas of Kavango millet dominates the commercial trade of grain. Large farmers that use traditional, low input production methods supply most of the marketable millet surplus in Kavango. In Ovambo, most commercially traded millet is supplied by poor farmers who are in urgent need of cash. In Ovambo commercial millet trade gained importance only since the severe drought in the year 1991/92. During this year the demand for millet was so high that millet imports from Angola were encouraged. During the production year of 1992/93 urban Ovambo traders received up to 80 percent of their millet supply from Angola.

Although it is unclear whether millet imports from Angola will persist in the long run, the fact that millet was imported from neighboring countries changes

the prospects of the Namibian millet sector significantly. So far, only maize imports from South Africa were considered the major competitor of locally produced millet. In the future millet imports from Angola, Zambia, and Zimbabwe might secure commercial traders' grain supply in poor production years. Millet imports from abroad might functions as price cap on farm level millet prices in poor rainfall years and such discourage Namibian producers from investing in new production technologies.

During the marketing season of 1993, most commercial millet traders sold between three and six times more maize meal than millet. However, over 90 percent of them claim that their customers prefer the taste of millet over that of maize. They explain that only those people buy maize meal that can not afford the high prices of commercially traded millet.

Findings about millet traders' profit margins indicate that at least some of them take advantage of local shortages of millet. The net returns of millet traders average 37 percent from their millet retail prices. However, most urban traders pass the cost advantage from cheaper bulk supplies on to their customers. Their profit margins of N$ 380 per ton of traded millet are roughly half of what rural traders earn. On the other hand, most rural millet traders have only small trade volume and face higher risks from millet trade because the invest large portion of their operational funds in millet.

Grain traders identified the following six obstacles to commercial millet trade: (1) lack of marketable millet surplus, (2) lack of transportation equipment, (3) lack of operation funds to purchase millet from producers, (4) lack of market

transparency; (5) lack of an appropriate millet processing technology, and (6) comparatively low maize meal prices.

To increase millet production traders recommended that the government expands its mechanical plowing service, implements an effective agricultural extension service and provides a credit scheme for farm investments. To improve the prospects of the commercial millet market, traders asked for investment credits so that they can improve their transportation capacity and venture into mechanical millet processing. Additionally, traders ask that the government support long-distance trade between areas with marketable millet surplus and millet deficit areas. Commercial millet traders also suggested that the government initiates the organization of local markets.

4.4.3. Price position of millet

The analysis of the formation of millet and maize prices during the year 1993 by zone and by different marketing stages indicates that informally traded millet is the cheapest food staple source for rural households in both study zones. But informal markets are usually bound within the locality of a community, and are therefore very volatile to low millet yields after a poor rainfall season. As a result, millet was only seldom available on the informal millet market.

The second cheapest food grain in the study zones is maize meal sold in urban centers of both zones. Most of the maize is imported from South Africa and is processed by Namibia's two milling corporations south of the study zones.

At present only 25 percent of the rural households in Ovambo and 15 percent of rural Kavango households acquire maize meal from center towns.

In Ovambo, commercially traded millet was the third expensive source during the year 1993, just below the price of maize meal sold in rural areas. Because, during the year 1993 food retailers offered unprocessed millet only for short periods of time, most grain deficit households in Ovambo had no alternatives other than buying expensive maize meal in the nearest shop, or traveling to the next town and buying larger amounts of maize meal at cheaper kg prices.

In Kavango, the drought of 1991/92 had caused millet shortages at the informal millet market and very high millet kg prices at commercial food retailers. Maize meal sold in rural and urban areas was significantly cheaper than unprocessed millet. Because millet imports from Angola had to be shipped via Ovambo to central Kavango, and because the in Rundu concentrated grain traders did not pass the cheaper prices of Angolan millet to their consumers, commercial millet prices continued to stayed above maize meal prices even after the 1992/93 millet harvest. After harvest, informally traded millet was significantly lower priced than the millet and maize offered on the commercial grain market. However, the millet offer on the informal millet market was very thin, so that most of the farmers in need of grain had to acquire one of the more expensive alternatives.

The two lessons learned from the price analysis of millet and maize are:

(1) Locally produced millet is the cheapest calorie source for the rural population in both study zones. However, informal millet trade among farmers is volatile due to production shortages on the household level. Therefore, increased millet production due to improved production technology would probably benefit those households most that depend mainly on informal millet sales from their neighbors.

(2) As long as commercial prices for millet in Kavango are kept so high that only households with income from off-farm employment can afford it, the transportation of Angolan millet to Kavango will continue to be profitable. Households with grain shortages but little cash income will be further forced to purchase maize meal.

5. MILLET CONSUMPTION

The preceeding marketing chapter demonstrated that while informally traded millet constitutes the cheapest calorie source for rural households in Ovambo and Kavango, prices of millet offered at the retail level are considerably higher than those of its main competitor, maize meal. To shed light on the question of why it is possible that grain traders offer millet at prices higher than those of processed and more refined maize meal, Chapter 5 will focus on three grain consumption issues: Section 1 of this chapter describes both the preference structure and consumption habits of rural consumers with respect to major food grains. Section 2 presents findings about the limiting factors on millet consumption and farmers' coping strategies regarding shortages of millet and maize meal. Finally, section 3 employs two cross-section regression models (OLS) to identify the main determinants of farmers' millet and maize meal purchases during the 1992/93 production season.

5.1. Grain preference and consumption structure

Section 1 of this chapter addresses two issues. It first analyzes which staple grain is preferred by rural households in general and by individual household member categories, as well as which factors determine this preference structure. The second issue concentrates on rural households' diet, with special reference to the main food staples, millet and maize, and the consumption shift between the two during the production season 1992/93.

5.1.1. Cereal consumption choices based on preference

During the household surveys of the Millet Subsector Research Project, 1992/93, survey respondents were asked twice to state the type of food staple they prefer. When the question was posed the first time, only a limited choice between the two most commonly consumed food staples, millet and maize, was presented to the respondents. This reduction of choices was based on the fact that a large portion of rural households face cash constraints that limit their consumption choices to the least expensive staple foods available. When household representatives were asked the second time about their most preferred food staple, a larger variety of food grains was given as a choice. The goal of this preference question was to determine whether consumers would eat other food staples if their cash constraints were removed.

5.1.1.1. Preference structure under limited choices

As Table 5-1 demonstrates, under a limited choice between millet and maize, most respondents chose millet over maize. This finding confirms grain traders' statements presented in Chapter 4, that the majority of northern Namibia's population prefers millet over maize. However, the fact that already 20 percent of rural Ovambo households were indifferent in their preference between millet and maize indicates that the traditional preference structure has begun to weaken.

Table 5-1. Consumer preference structure between millet and maize, by zone (percent)

	Prefer Millet	Like Both Equally	Prefer Maize	Total
OVAMBO (n = 200)	77	20	3	100
KAVANGO (n = 120)	94	3	3	100

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

5.1.1.2. Preference structure without limits

To understand whether rural consumers would switch to another food staple if it were offered at the price level of millet or maize, the following six commonly eaten cereal types were offered to choose from, independently from their price: (1) millet meal, (2) maize meal, (3) a mix of millet and maize meal, (4) bread, (5) rice, and (6) macaroni. Except for children, who mostly prefer bread, pure millet meal was most often chosen by all types of household members.

In Ovambo, more than 50 percent of adults prefer pure (non-mixed) millet meal over other staple foods (Table 5-2). Another 20 percent preferred a mix of millet meal and maize meal. Rice and pure maize meal are each preferred by about 10 percent of adults in Ovambo. In Kavango, more than 70 percent of adults favor pure millet meal. Maize meal is preferred by roughly 20 percent.

Contrary to Ovambo, mixing millet with maize seems not to be preferred among Kavango people. Rice, macaroni, or bread were mentioned by the remaining 10 percent of adults from Kavango.

Table 5-2. Household's preference for different cereals, by household member types and zone (percent)

	Elderly	Women	Men	Migrant Worker*	Children
Ovambo (n = 200)					
Millet	66	45	51	61	20
Millet/Maize Mix	11	22	25	11	13
Maize	6	11	12	6	2
Rice	10	13	8	11	12
Macaroni	3	8	4	11	4
Bread	4	2	1	0	50
Total	100	100	100	100	100
Kavango (n= 120)					
Millet/Maize Mix	0	3	0	14	4
Maize	20	18	20	0	10
Rice	0	3	4	0	1
Macaroni	4	7	5	0	5
Bread	0	0	0	0	50
Total	100	100	100	100	100

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* Migrant workers who leave their household for part of the year to work in Windhoek or one of the southern mining towns.

The comparison between the two study zones demonstrates that in Ovambo, people's taste preferences have a much wider range among various cereal types than in Kavango. Besides maize and the mix of it with millet, significant portions of Ovambo people developed, over time, a preference for rice, macaroni, or bread. That taste preferences in Kavango concentrate on millet and maize can mainly be explained by less urban influence in the zone and therefore also less exposure to 'modern food staples'.

Having a much higher population density, Ovambo developed a much stronger urban based retail system that is well-connected by roads and offers a much wider variety of different food items to its urban and rural consumers. In Kavango, cereal imports from other countries are also available at food shops, but the retail system of Kavango reaches to a much lesser extent into rural areas. Accordingly, most of Kavango's farm population had no chance to get acquainted with different cereals and their tastes.

Besides differences in food staple preference by zone, age also seems to be related to food staple preferences of various household members' types. In Ovambo, a clear majority of older people prefer millet among different cereals. The preference data of younger adults indicate that the mix of maize meal with millet or porridge made solely from maize are becoming increasingly popular among younger generations.

That more migrant workers (former and current) prefer millet than men in general can be explained with two reasons: the first reason is again related to age. The proportion of older men that have been raised with millet and therefore

like it better is probably higher among migrant workers than among adult men in general. Second, survey respondents explained that the men working in the south have to eat and are constantly fed with porridge made from maize so that they are eventually longing for the taste difference that millet offers.

Further, in both study zones, about half of all children were said to prefer bread over other non-wheat cereals. This high preference for bread can be explained by children's early exposure to it. After independence in 1991, businessmen from urban Ovambo and Kavango invested in large-scale bakeries in peri-urban areas. At the same time, NGOs like UNICEF promoted the establishment of small-scale bakeries in rural areas to enhance employment and income opportunities of rural women. Survey respondents explained that young children prefer bread because of its sweet taste and because parents often give it to them out of convenience.

Looking at the age pyramid of northern Namibia's population, it becomes obvious that already today young adults and children represent the majority of the communal population in northern Namibia. And it is probably not wrong to assume that tomorrow's household decision makers are the children and adolescents of today. The shift in the food preference structure of this emerging consumer group away from millet towards more refined food products has become evident already. Once the preference structure has changed, the substitution of maize for millet in the traditional, but fairly simple, dishes will be easy.

5.1.1.3. Determinants of cereal preferences

Survey respondents identified five general factors associated with cereal preferences: (1) tradition, (2) availability, (3) low price and easy accessibility, (4) nutritious value, and (5) taste. Surprisingly, the convenience of being able to purchase maize in the form of meal that is ready to cook has not been given as a reason for preferring maize meal over other food types. The convenience of preparation was only mentioned in relation to the 'modern' food types: bread, rice, and macaroni[1] (Table 5-3).

In Ovambo, the preference for millet and the millet/maize mix was mainly determined by tradition and availability. For those who preferred either rice, macaroni, or bread, the main reasons were good taste and the perceived high nutritional value. Reasons for pure maize preference were mainly based on its availability, and secondly, on its low price and easy accessibility. In Kavango, considerations of nutritious value, i.e., the positive effect of a specific food on consumers' health or their perception of hunger, are the most often used explanations for the consumption preference for all cereals.

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[1] The fact that the comparatively easy preparation of maize meal to porridge was not mentioned by the survey respondents can be seen as an indicator that the rural population of the study zones perceives millet still as their main grain staple for which manual processing is normal. It can be assumed that, with the introduction of mechanical processing of millet, opportunity cost considerations for processing will become a more important issue.

Table 5-3. Determinants of staple food preferences stated by farmers (percent)

	Tradition	Availability	Price & Access	Nutritious Value	Good Taste	Total
OVAMBO (n = 200)						
Millet	44	27	7	15	7	100
Maize	44	23	8	10	15	100
Millet/Maize Mix	11	64	14	7	4	100
Bread, Rice, Macaroni	3	2	19*	33	43	100
KAVANGO (n = 120)						
Millet	17	12	0	58	1	100
Maize	0	0	0	100	0	100
Millet/Maize Mix	7	29	10	43	12	100
Bread, Rice, Macaroni	0	5	5*	55	35	100

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* includes convenience and modern lifestyle

The most surprising of these findings is that 'good taste' plays a minor role in determining the preference for the two main staple grains, millet and maize. Only the preference for more 'modern foods' was relatively often guided by considerations of taste.

5.1.2. Food staple consumption pattern

The following section briefly describes what food staples households consume and how the composition of rural households' food diet changes with

the arrival of the local grain harvest.

5.1.2.1. Seasonal staple grain consumption shifts

To gain insights into what rural Ovambo and Kavango households eat during the year, they were asked about their daily diet in April 1993, i.e., eight months after the last grain harvest, and in August 1993, i.e., when threshing of the 1992/93 harvest had just ended. The changes of households' diet that occurred within the period of four months was profound. Especially significant was the consumption shift away from maize towards millet after harvest.

In Ovambo, the percentage of households that ate pure millet porridge increased from 29 percent in April 1993 to 63 percent in August 1993 (Table 5-4). The percentage of households that ate pure maize porridge or a porridge made from a maize/millet mixture declined from a total of 71 percent in April 1993 to 38 percent in August 1993.

In Kavango, the shift from maize towards millet was even more significant. The percentage of households that ate pure millet porridge increased from 8 percent in April 1993 to 69 percent in August 1993. The percentage of households that ate pure maize porridge or a porridge made from a maize/millet mixture declined from a total of 92 percent in April 1993 to 31 percent in August 1993.

Table 5-4. Seasonality in grain consumption during the year 1992/93, by household member types, by zone (percent)

	OVAMBO (n = 200)			KAVANGO (n = 120)		
	before harvest		after harvest	before harvest		after harvest
Millet	29	<	63	8	<	69
Millet/Maize Mix	20	<	34	14	+/-	13
Maize	51	>	4	78	>	18
Total	100		100	100		100

Source: Namibian Millet Subsector Project Surveys, 1992/93

The significant diet change away from maize porridge at a time when millet is available confirms farmers' statements about their consumption preferences. It indicates, additionally, that for the majority of communal households, staple food consumption is mainly supply driven; i.e., as long as millet from their own production is available, it is the preferred food staple. With few exceptions, only when millet stocks decrease notably do households start to stretch millet porridge with maize meal. This continues until no millet from their own production is left and households have to rely entirely on purchased maize until the next harvest.

To make sure that the supply of a certain grain has a major impact on the consumption decision of rural households, farmers were asked before the 1993 grain harvest why they ate one of the two main staples, millet and maize. The answers confirmed the above stated assumption. Of those Ovambo households

that ate pure millet in April 1993, the largest group (46 percent) explained their consumption decision with millet's' exclusive availability (Table 5-5). The term exclusive means that maize meal was either not accessible or not affordable because it had to be purchased with money. The other major determinant for millet consumption given in Ovambo was tradition (43 percent). In Kavango, the determinants for millet consumption were similarly weighted. Forty percent of Kavango households claimed that millet's exclusive availability is the main reason why they eat millet. Another 30 percent claimed they ate millet at that time because of their tradition.

Table 5-5. Determinants of millet and maize consumption during the 1992/93 hungry season, by zone (percent)

	Exclusive Availability	Tradition	Price & Access	Other	Total
			OVAMBO (n = 200)		
Millet	46	43	6	5	100
Maize	93	0	7	0	100
			KAVANGO (n = 120)		
Millet	39	30	0	31*	100
Maize	70	0	22	8	100

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* mainly high nutritious value and good taste of millet

The majority of those households solely consuming maize stated its exclusive availability as the main decision criterion (Ovambo: 93 percent, Kavango: 70 percent). The other factors often mentioned as reasons for maize consumption were its relatively low price and accessibility in the market (Ovambo: 7 percent, Kavango: 22 percent).

5.1.2.2. Other seasonal diet changes

Not only the consumption of millet and maize changes during different phases of one production year. Table 5-6 shows how rural households' diet composition changed from the time period of grain production in April 1993, to the time period after millet harvest in August 1993.

The consumption of goat milk was increased in both zones in April compared to August. In Ovambo, also, the consumption of fresh and dried vegetable leaves was strongly increased during April. In August 1993, after the cropping season, the consumption of beans and of meat was increased in both zones. In the same period of time, cow milk and cabbage were more often consumed in Ovambo, while the consumption of fish and pumpkins was increased in Kavango.

The consumption of more expensive grain staples did change comparably little between April and August. In Ovambo, about 30 percent and in Kavango, 13 percent of all households include bread in their daily diet. Rice is consumed by about 3 percent of households in both zones. Five percent of Ovambo

Table 5-6. Seasonality of farm households' food consumption, by zone (percent, ranked according to change)

OVAMBO (n = 200)				KAVANGO (n = 120)			
Food item	April*	change	August**	Food item	April*	change	August**
Millet	30	33	63	Millet	8	61	69
Millet Drink	57	30	87	Millet Drink	12	25	37
Beans	20	19	38	Fish	0	24	24
Cow Milk	4	17	21	Beans	22	16	38
Cabbage	1	17	18	Pumpkins	3	15	18
Meat	54	10	64	Meat	38	13	51
Fish	0	4	4	Poultry	0	3	3
Bread	28	3	30	Cabbage	0	3	3
Pumpkins	4	2	6	Sorghum Drink	1	2	3
Poultry	0	1	1	Sauce	2	1	3
Maize Drink	2	-2	1	Bread	13	1	13
Tea/Coffee	39	-3	36	Leaves	64	0	64
Rice	5	-4	1	Rice	3	0	3
Sauce	24	-5	19	Eggs	1	0	1
Eggs	6	-5	1	Tea/Coffee	11	-1	10
Macaroni	8	-6	2	Macaroni	2	-2	0
Sorghum Drink	19	-7	11	Millet/Maize Mix	14	-2	12
Maize	20	-16	4	Cow Milk	8	-5	3
Millet/Maize Mix	51	-17	34	Maize Drink	11	-8	3
Goat Milk	22	-22	0	Goat Milk	15	-15	0
Leaves	89	-35	53	Maize	78	-60	18

Data Source: Namibian Millet Subsector Project, 1992/93

* eight months after the last grain harvest
** when threshing of the 1992/93 harvest had just ended

households and one percent of Kavango households included macaroni in their diet.

Even without knowledge about the actual amounts of different food items eaten per household, the comparison of rural households' diet composition, over time, yields three important insights: first, rural households' diet shows quite a variety of food items besides the main food staples, millet and maize. Second, rural households' diet changes significantly within one production year. Third, the consumption of millet and maize are among those diet components that are most affected by the change from food production phase to the post-harvest period.

5.2. Constraints on millet consumption and coping strategies

This section discusses factors that limit the consumption of millet in rural Ovambo and Kavango and presents strategies used by farmers to cope with shortages of millet and of maize.

5.2.1. Limits to millet consumption on the household level

The majority of rural farmers from the study zones do not produce enough millet to reach grain self-sufficiency from one harvest to the next. Recurring scarcity of millet on the informal market at the community level, combined with insufficient links between various production areas, reduces the profitability of commercial millet marketing in rural areas. As a result, only a small portion of

households with considerable off-farm income can afford to travel to, and purchase millet from, urban grain traders.

As described above, the majority of rural households that eat maize instead of millet explain that their consumption decision is based on (1) the non-availability of millet, (2) the relatively low price of maize compared to commercially traded millet, and (3) the easier access to maize than millet.

To provide information about the limits of millet consumption, the following sections will first give a brief overview of the amount of money farm households spend for food, second, describe general problems that grain deficit farmers experience when they want to acquire millet, and third, analyze the problem of non-accessibility of millet in more detail.

5.2.1.3. Household level food expenditures

To understand how large the share of households' food expenditures is of their total financial expenditures, survey respondents were asked after the 1992/93 harvest to state the three types of items for which they spend most money during one month. Households were also asked to estimate the approximate amount they spend on these important expenditure categories. The following two tables show the average distribution of farmers' most important expenditures in August 1993. Table 5-7 demonstrates the expenditure distribution of all interviewed farmers from Ovambo and Kavango. Table 5-8 dis-aggregates the expenditure analysis by grouping households in categories of different total monthly expenditure levels.

As both tables demonstrate, the largest expenditure category on which rural people spend money is food. A surprising result is that the proportion of money spent for food does not decline with increasing household expenditures. This points to the fact that households with higher incomes increase their food expenditures, probably first by increasing the amount of food eaten and then by substituting cheaper staple food categories with more expensive food items.

Table 5-7. Farmers' monthly cash spending across various items in August 1993, by zone (percent)

	OVAMBO (n = 188)	KAVANGO (n = 91)
Food	53	67
Household Goods	23	0*
Clothing	13	15
Transportation	3	6
School	2	1
Other	6	11
Total	100	100

Data Source: Namibian Millet Subsector Project, 1992/93

* As already explained elsewhere in the study, the rural population of Kavango is to a much lesser extent linked to urban biased consumer markets; i.e., they are more subsistence-oriented than Ovambo people and are, therefore, much less used to purchasing household goods.

Table 5-8. Monthly cash spendings across various items by household expenditure categories and zone (percent)

Household Expenditure Level in N$	0	1 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 <	av-er-age
Percent of Households	**6**	**23**	**28**	**24**	**10**	**4**	**1**	**3**	**100**
				OVAMBO (n = 188)					
Expenditures									
Food	-	58	60	47	44	42	49	61	53
Household Goods	-	27	23	24	21	16	17	8	23
Clothes	-	6	11	20	19	24	27	5	13
Transportation	-	3	1	3	3	0	0	3	3
School	-	3	3	3	0	4	0	1	2
Water	-	0	1	2	11	0	0	0	2
Health	-	1	2	2	3	5	0	8	2
Drinks	-	2	0	0	0	0	0	0	1
Rent	-	0	0	1	0	0	6	0	1
Remittances	-	0	0	0	0	0	0	4	0
Hired Labor	-	0	0	0	0	0	0	9	0
Total	-	100	100	100	100	100	100	100	100
Percent of Households	**24**	**7**	**9**	**16**	**23**	**11**	**11**	**0**	**100**
				KAVANGO (n = 91)					
Expenditure									
Food	-	58	84	61	63	70	69	na	67
Household Goods	-	0	0	0	0	0	0	na	0
Clothes	-	3	6	23	17	16	11	na	15
Transportation	-	0	0	0	3	0	0	na	6
School	-	39	5	2	1	3	1	na	1
Water	-	0	0	0	0	0	0	na	0
Health	-	0	0	5	5	4	7	na	4
Drinks	-	0	5	2	5	3	6	na	4
Rent	-	0	0	0	0	3	0	na	0
Remittances	-	0	0	4	2	0	3	na	2
Hired Labor	-	0	0	4	4	0	3	na	1
Total	-	100	100	100	100	100	100	100	100

Data Source: Namibian Millet Subsector Project, 1992/93

In Ovambo, about 75 percent of households spend between 100 and 300 Namibian dollars per month for the three most important expenditure goods. Only 6 percent of all households claimed they have no cash income to spend. Of the money spent per month, the average share spent for food amounts to about 53 percent across all Ovambo households. In Kavango, 24 percent of the interviewed households claimed they have no cash expenditures. But 39 percent spend, on average, between 200 and 400 Namibian dollars a month for the three most important expenditure goods. Those households that have money spent, on average, 67 percent of it for food. The higher levels of food expenditures in Kavango were caused probably by two circumstances: (1) Kavango's relatively poor results of the 1992/93 grain harvest that triggered the need of more food purchases, and (2) low expenditures of Kavango households for household goods.

5.2.1.2. Obstacles to millet purchases

The interviewed households had to indicate factors that limit their buying of millet. In Ovambo, the three most often indicated problems were 'lack of money', 'high transportation cost to and from the place of purchase', and 'high millet prices' (Table 5-9). In Kavango significantly higher proportions of people experienced difficulty purchasing millet. In addition to the problems already identified for Ovambo, in Kavango, cheaper and more easily accessible maize were additional reasons that limit households' millet purchases.

Table 5-9. Household food constraints on millet purchases, by zone and household food buying frequency (percent*)

	Ovambo Households (n=200)				Kavango Households (n=120)			
Food buying frequency	**never**	**some-times**	**often**	**total**	**never**	**some-times**	**often**	**total**
	5	78	17	100	0	73	27	100
Constraints								
not enough money	**100**	**84**	**88**	**85**	-	**91**	**90**	**91**
expensive transport	**50**	**51**	**53**	**51**	-	**76**	**52**	**69**
high millet prices	**57**	49	44	48	-	**90**	**100**	**93**
no transport	**50**	48	38	46	-	41	35	39
long distances	33	43	44	43	-	47	29	42
no local market	33	37	28	36	-	41	26	37
difficult to find seller	33	28	31	29	-	36	35	36
easier access of maize	17	13	44	19	-	**91**	**97**	**92**
unknown price	17	17	28	19	-	24	13	21
cheaper maize	17	11	41	17	-	**91**	**94**	**92**

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

* since several answers were allowed percent figures do not add up to 100

5.2.1.3. Accessibility of millet in comparison

As already demonstrated in Figure 4-1, between February 1993 and January 1994, millet was to a much lesser extent available at rural food retailers than maize meal. When survey households were asked whether millet or maize is generally easier to purchase, responses were clearly in favor of maize. In Ovambo, 57 percent of all households said maize meal is easier to buy than millet. In Kavango, the respective figure was even 91 percent.

Table 5-10. Comparison between farmers' access to millet and maize, by zone (percent)

	OVAMBO (n = 200)	KAVANGO (n = 120)
Millet is more accessible	17	7
Both are equally accessible	26	2
Maize is more accessible	57	91
Total	100	100

Data Source: Namibian Millet Subsector Project, 1992/93

Looking at the figures about the accessibility of various food grains to rural households in April 1993 (Table 5-11), it becomes clear why millet is relatively difficult to buy. In this month, only 44 to 45 percent of all interviewed households claimed that unprocessed millet was available for purchase. Millet meal was only marginally available to rural households.

At the same time, almost 100 percent of the interviewed households indicated that maize meal was available to buy. However, unprocessed maize was in both zones difficult to access. Bread was available to about 86 percent of all Ovambo households and to about 67 percent of all Kavango households, respectively. In both zones, rice was available to the vast majority of all households, while sorghum could only be bought in Ovambo by a quarter of the interviewed households.

Table 5-11. Households' access to various food grains during the 1992/93 hungry season in April 1993, by zone (percent)

	OVAMBO (n = 200)	KAVANGO (n = 120)
Unprocessed Millet	45	44
Millet Meal	2	4
Unprocessed Maize	56	43
Maize Meal	99	100
Bread	99	87
Rice	94	82
Sorghum	24	0

Data Source: Namibian Millet Subsector Project, 1992/93

5.2.2. Coping strategies of farmers in grain shortage

To determine how rural households react to millet and maize shortages and whether this reaction differs between the two grains, sample farmers were asked what they do when the stocks of either grain empty. The results of this inquiry are briefly presented in the following two sections.

5.2.2.1. Strategies to cope with millet shortage

Farmers use mainly four different strategies to cope with declining millet reserves. They first change consumption habits, second, ask others for food, third, work for food or money, and fourth, purchase the food that is out of stock from various sources. However, the composition of these coping strategies differs significantly between Ovambo and Kavango households (Table 5-12).

Table 5-12. Farmers' coping strategies during millet and maize shortages, by zone (percent)

	Millet Shortage		Maize Shortage	
	Ovambo (n = 200)	Kavango (n = 120)	Ovambo (n = 200)	Kavango (n = 120)
Coping Strategy:				
mix millet with maize	43	47	2	5
eat less	17	70	1	26
eat other food	17	60	5	40
ask relatives for grain	38	12	8	9
ask relatives for money	13	6	7	5
ask neighbors for help	26	8	7	13
work for food or money	1	24	2	29
buy the grain in shortage	58	19	92	44

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

In Ovambo, the first reaction to millet shortage is to stretch the existing millet meal with maize meal or eat less millet and change to other food types. The next step is to ask relatives or neighbors that still have millet reserves to give part of it to the household. Relatives with migration income are asked to provide money for the purchase of food. Eventually, 58 percent of all Ovambo households buy millet.

Kavango households mostly reduce millet consumption and shift to other food items of which some, like nuts and fruits, are collected in nature. Also the stretching of millet meal with maize meal is prominent. In comparison to Ovambo, fewer households ask relatives or neighbors for help. Also different is

that about a quarter of the interviewed Kavango households are willing to work for others to receive food or money. Only a fifth of the sample households in Kavango eventually buy millet.

The large difference in the number of Ovambo and Kavango farmers that purchase millet is explained by the much higher proportions of Kavango farmers that indicate obstacles to millet purchases like 'lack of money', 'expensive transportation', and 'high millet prices' in comparison to maize meal prices. Most of the farmers that purchase millet acquire it from various sources (Table 5-13).

Table 5-13. Rural households' purchase sources for millet and maize, by zone (percent)

	Millet Shortage		Maize Shortage	
	Ovambo (n = 200)	Kavango (n = 120)	Ovambo (n = 200)	Kavango (n = 120)
Percent of Households Purchasing Grain	58	19	92	44
Sources:				
Neighbors	22	9	11	11
Local Shop	13	6	66	32
Local Market	5	1	22	2
Urban Market	3	0	8	0
Urban Supermarket	10	6	54	18
Urban Wholesaler	4	4	41	13
Traveling Traders	14	0	8	0
Angolan Traders	14	3	4	2
Angola directly	2	0	2	0

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

In both study zones, the largest group of farmers buys millet from neighbors. Local shops and urban supermarkets are also important sources of millet in both zones. In Ovambo, traveling traders that originate from northern Namibia and from Angola also play an important role for millet supply.

5.2.2.2. Farmer reactions to emptying maize reserves

Of all surveyed households in the study zones, only about one percent stated they do not eat maize meal. In Ovambo, the vast majority of households (92 percent) go and buy maize meal once their own stocks are empty (see Table 5-12 above). In contrast, Kavango households respond to the emptying of their maize meal reserves the same way as they respond to millet shortage. Only about 44 percent of the interviewed Kavango households would buy maize meal to replenish their stocks. A quarter of them reduce their maize meal consumption. Almost half of them switch to other foods. And a third of the sample farmers start to work to be paid in food or money to purchase food.

Table 5-13 above demonstrated that the largest group of farmers acquire maize meal from local shops. But urban supermarkets and wholesalers are also an important source of maize meal, especially in Ovambo. Unlike with millet, traveling traders are a relatively unimportant source of maize.

5.3. Determinants of farm level grain purchases

To make any predictions about the commercialization prospects of the communal millet sector, it is important to know under what circumstances

northern grain consumers would buy locally produced millet rather than maize meal that is imported into the study zones. Accordingly, this final part of Chapter 5 focuses on the main determinants of grain purchases on the household level.

The analysis of household level consumption pattern and obstacles to millet consumption above demonstrated that the grain buying decision of farmers is influenced by a complex set of factors. In the following, the attempt is made to test the significance of the effects of these factors through two OLS regression models. Due to the lack of detailed time series data about farm household grain purchases, both regressions are based on cross-section data of farmers' food purchases madeat a certain point of time. The independent variables are households' purchases during the period of the first household survey in December 1992 of (a) unprocessed millet in the regression model of the following section 5.3.1. and (b) maize meal in the regression model of section 5.3.2..

5.3.1. Regression analysis of millet purchases

The following sections give an overview of the cross-section regression of millet purchases per household in December 1992, discuss the independent variables employed in the equation, and presents the regression results.

The cross-section model of farmers' millet purchases in December 1992 during field preparation encompasses variables that identify (a) households' millet supply from own production, (b) economic determinants of purchasing

behavior like grain prices and cash incomes, and (c) factors that affect farmers' market access to millet.

MILPRCH = f (MILRES, PMIL, PMAZ, CASH, $CASH^2$, CESZ, CEMKT, LOMKT)

where:

MILPRCH	= amount of millet purchased during field preparation in 1992 (kg)
MILRES	= household millet reserves from their own production (DUMMY, 1 = yes)
PMIL	= price of millet quoted by household for December 1992 (N$/kg)
PMAZ	= price of maize meal quoted by household for December 1992 (N$/kg)
CASH	= annual cash income from non cropping activities (N$ '000)
$CASH^2$	= squared annual cash income from non-cropping activities (N$ '000)
CESZ	= resides in a subzone with urban markets (DUMMY, 1 = yes)
DISMKT	= distance to next larger grain market (km '0)
LOMKT	= have access to local market (DUMMY, 1 = yes)

Table 5-14. Characteristics of variables in the millet purchase equation

	Ovambo & Kavango (n=265)	
VARIABLE	**MEAN**	**S.E.**
MILPRCH (kg)	8.92	21.99
MILRES (1 = yes)	40 percent = 1	
PMIL (N$/kg)	1.41	0.73
PMAZ (N$/kg)	1.20	0.16
CASH (N$ '000)	6.70	9.67
$CASH^2$ (N$ '000 ^{2})	1.38	4.60
CESZ (1 = yes)	25 percent = 1	
DISMKT (km '0)	81.55	62.49
LOMKT (1 = yes)	48 percent = 1	

Data Source: Namibian Millet Subsector Research Project, 1992/93

The independent variables used and the reasons for their inclusion in the estimated equation are as follows:

(a) the availability of millet reserves from their own production at the time of grain purchases during field preparation in December 1992 (MILRES). After the severe drought of the production year 1992/93, food aid in the form of maize meal and canned food was distributed in the communal north of Namibia. Farmers that tried to be classified as 'in need of handouts' were therefore very reluctant to reveal their actual status of grain reserves. Due to the sensitivity of the topic, questions in the direction of grain reserves had to be omitted in all three household surveys during the 1992/93 production season. However, during the April 1993 household survey, two months before the start of the millet harvest, household representatives were asked what food items they were currently eating. If millet was mentioned, it was inquired whether this millet came from their own production or whether it was bought somewhere else. It is hypothesized that those farmers that ate in April 1993 millet that was produced on their own fields were less likely buyers of millet in December 1992 than those who either ate purchased millet or purchased maize meal. To account for this effect, the dummy variable MILRES was included in the regression model to distinguish between those households that were probably in grain shortage in December 1992 (MILRES = 0) and thus more likely to buy millet or maize, and those households that had enough millet from their own production still in April 1993 (MILRES = 1). According to this reasoning, it is expected that the

coefficient of the MILRES variable is negatively correlated with household level millet purchases.

(b) the price of millet and of maize meal that farmers faced during December 1992 (PMIL and PMAZ). Not only the absolute price of millet, but also the discrepancy between the price of millet and maize meal affects farmers' decision whether to buy millet at all, and if so, how much. As discussed in the first section of this chapter, the majority of the rural population prefer millet over maize. From this preference structure, one can expect that households with considerable amounts of cash income are willing to pay a premium for millet, although it is not available in processed form as is the case with maize. However, the larger the price gap between millet and maize is, the more likely is it that consumers choose to buy the cheaper maize meal.

It is also assumed that the purchase decision of households with very scarce cash sources will almost always be made in favor of the absolute cheaper grain. Poor farmers probably take less into consideration that millet still has to be processed manually. For them, money is the main constraint, while they value their opportunity cost of labor close to zero.

The hypotheses that millet purchases are both negatively affected by increases of millet prices and positively affected by a decline of maize meal prices are not solely based on economic theory. As demonstrated in the second section of this chapter, 'lack of money', 'high millet prices', and 'comparatively low maize meal prices' have been ranked among the most limiting factors for millet purchases.

To control the effects that millet and maize meal prices have on the decision to purchase millet, two variables are included in the model. These variables reflect the local price of millet (PMIL) and of maize meal (PMAZ) the farmers faced in December 1992.

(c) the amount of farm households' annual cash income and the squared value of it (CASH and $CASH^2$). As demonstrated in Table 5-9, farmers mention 'lack of money' most often as an obstacle to millet purchases. This is not surprising. In both study zones, more than 50 percent of rural households do not earn cash income from local or migration employment. The average annual cash income per capita of these households is about N$ 100 or US$ 33 at the exchange rate of 1993. Based on this information, it is hypothesized that millet purchases are positively correlated with annual cash income represented by the variable CASH.

Since the per capita consumption of food staples is naturally limited, and because higher income households tend to substitute food staples with higher value food like meat, the relation between annual cash income and grain purchases is probably not linear. To enable the model to capture the fact that the marginal increase of millet purchases is diminishing, while cash income increases, the variable $CASH^2$ is included. It is expected that the estimated coefficient of the $CASH^2$ variable is negative.

(d) the location in a center subzone with urban grain markets (CESZ). The independent variables discussed so far concerned household level millet supply and economic decision factors. The following three variables discussed

and included in the model focus on the accessibility of millet for purchase. The dummy variable CESZ distinguishes between households that live in the area near the urban trading centers of Ovambo and Kavango (value one) and households that live in the periphery of the study zones (value zero). As presented in the marketing Chapter 4, many local/informal millet markets collapse within a few of months after harvest due to lack of local supply. Therefore, most commercially offered millet is available in urban centers like Oshakati / Ovambo, originating from Angola, and in Rundu / Kavango, coming from a few larger Kavango farmers producing millet surplus.

It is assumed that farmers living close to the urban centers are more knowledgeable about the millet offered at center markets and face lower transportation costs to reach millet suppliers than farmers from the periphery. Accordingly, it is hypothesized that farmers from subzones close to urban population centers are more likely to buy millet. Therefore, the coefficient of the CESZ variable is expected to be positive.

(e) the distance to the next larger grain market (DISMKT). As data about staple grain sources of rural households have shown (Table 5-13 above), farmers who are in millet deficit do not rely solely on local/informal millet sources but also purchase grain from urban supermarkets and wholesalers. However, as price data have shown, maize meal available at these market outlets is usually significantly cheaper than unprocessed millet. From this, the hypothesis is derived that price-conscious farmers that live closer to larger sources of millet and maize meal are less likely buying millet, but maize. The latter part of this

hypothesis will be tested in the regression model that estimates household level maize meal purchases. The first part will be tested in this model through the DISMKT variable. This variable contains the kilometer distances (measured in 10 kilometers per unit) between individual sample farmers and the nearest point where they can purchase larger amounts of millet or maize. It is expected that the coefficient of the DISMKT variable is positively related to the amount of millet purchased. Again, the main reason for this hypothesis is that farmers who are further away from urban grain traders often have less opportunity to buy cheaper maize meal.

(f) the access to a local grain market (LOMKT). In both study zones, about a third of the survey respondents pointed to missing local grain markets as an obstacle to purchasing millet. As discussed in the millet marketing Chapter 4, in communities without locally organized grain trade surplus, producers might develop the tendency to bypass poor deficit farmers that can only afford to buy grain in small quantities. The millet surplus producers tend to sell their produce in bulk to distant grain traders in urban centers. Often, such a pattern leaves deficit farmers no other choice than to purchase relatively high-priced maize meal at local shops. To estimate the effect that the existence of a local grain market has on millet purchases, the dummy variable LOMKT is included in the model. If the surveyed farmers had access to a local grain market, the LOMKT takes value one; otherwise, its value is zero. It is hypothesized that the MILPRCH variable is positively related to the existence of local markets.

Table 5-15 presents the main statistics of the estimated equations for millet purchases. The level of the adjusted R-Square indicates that the model explains 30 percent of the variability of household level millet purchases. This level of explanation, which is not bad for household level surveys, is mainly attributable to the rough information about farm level millet purchases based on a one-time interview. However, despite the low R-Square value, the signs of all regression results are consistent with expectations, and all considered explanatory factors demonstrate a significant relation to the amount of millet purchased.

Table 5-15. Estimates of the millet purchase equation

	Ovambo & Kavango		
VARIABLES	**COEF.**	**S.E.**	**SIGNIF.**
CONSTANT	-14.87	6.15	0.01
MILRES	-3.70	1.48	0.01
PMIL	-3.32	1.04	0.00
PMAZ	13.97	4.88	0.00
CASH	0.48	0.15	0.00
$CASH^2$	-0.007	0.003	0.02
CESZ	14.60	1.79	0.00
DISMKT	3.20	0.01	0.01
LOMKT	5.41	1.52	0.00
Adjusted R-		0.30	
Case Number		256	

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

In the following interpretation of the regression results, the base case represents a farm household that had no millet reserves from its own production available in April 1993 (MILRES = 0), is located on the periphery rather than close to the population centers of the zone (CESZ = 0), and has no access to a local grain market (LOMKT = 0).

Holding all other factors constant, a rise of local prices of millet (PMIL) by one Namibian dollar per kg leads to a decrease of farmers' monthly millet purchases by 3.3 kg. This is a reduction of about 30 percent of the average amount households bought during December 1992. A price decline of millet's closest substitute, maize meal, by one Namibian dollar triggers, on average, a decline of millet purchases by 14 kg. Both results are statistically significant and conform with economic theory. The fact that farmers buy, on average, three times more maize meal than millet probably explains why they react more strongly to price changes of maize meal than to changes of millet.

The variable that also influences strongly household level millet purchases is CESZ. Those farmers living in a subzone close to a large center market of their zone buy, on average, 14.6 kg more millet than those who live on the periphery. This result reaches a significant level of 0.00 percent. It confirms the assumption that living close to a market source where millet is available most times of the year has a positive effect on the purchases of staple food that consumers prefer. The other two explanations for this outcome are: first, closeness to the urban center markets reduces farmers' transaction cost for grain purchases significantly. Second, households living close to urban centers more

likely have household members that generate enough cash income from off-farm employment, allowing the purchase of millet even if it is more expensive than maize meal.

Another factor that shows larger effects on farm level millet purchases is local grain markets. The marginal effect of a nearby market is a 5.4 kg increase in households' millet purchase per month. This finding is especially important because disseminating the idea of locally organized grain marketdays among rural communities is a relatively simple measure, compared to changing factors like grain market prices.

The hypothesis that farmers living further away from larger grain markets are buying more millet but less maize is confirmed with respect to millet at a significant level of 0.01 percent. With every 10 kilometer distance, farmers purchase about 0.32 kg more millet per month.

Finally, cash income from activities other than crop production does not seem to be closely related to households' millet purchasing behavior. Although significant at 0.00 percent, the estimation results show that with every additional N$ 1,000 annual cash earnings, farm households buy only half a kilogram more of millet per month. But this result shows that the communal population doesn't perceive millet as an inferior good whose consumption is automatically reduced with increasing income.

5.3.2. Regression analysis of maize meal purchases

This section gives first an overview of the cross-section regression model of maize meal purchases per household in December 1992. Then it describes the independent variables employed in the equation. Finally, regression results are presented and discussed.

The cross-section model of rural households' maize meal purchases in December 1992 during field preparation[1] incorporates one additional variable compared to the model estimating millet purchases. Besides variables that reflect (a) households' millet supply from their own production, (b) economic factors like grain prices and cash incomes, and (c) farmers' access to millet, a fourth variable type (d) was added, mirroring farmers' exposure to more 'modern' or urban-biased attitudes that might influence their grain purchase decision.

$$MAZPRCH = f(MIL92, PMIL, PMAZ, CASH, CASH^2, MILAV, WEEA, DISMKT, LOMKT, READ)$$

where:

MAZPRCH	= amount of maize meal purchased during December 1992 (kg)
MIL92	= millet produced during the 1991/92 production season (mt)
PMIL	= price of millet quoted by household for December 1992 (N$/kg)
PMAZ	= price of maize meal quoted by household for December 1992 (N$/kg)
CASH	= annual cash income from non-cropping activities (N$ '000)
CASH2	= squared annual cash income from non-cropping activities (N$ '000)

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[1] These purchases also include maize meal purchases brought by migrant workers returning to their home. These usually buy maize meal in the center town of their zone before they organize their transportation to their homestead in the bush.

MILAV = household stated 'millet is available for purchase' (DUMMY, 1 = yes)
WEEA = geographic west/east location (No. 1 - 6, 1= West, 6 =East)
DISMKT = distance to next larger grain market (km '0)
LOMKT = have access to local market (DUMMY, 1 = yes)
READ = number of household members that can read (persons)

Table 5-16. Variables in the maize meal purchasing equation

	Ovambo & Kavango (n=265)	
VARIABLE	**MEAN**	**S.E.**
MILPRCH (kg)	24.98	43.63
MIL92 (mt)	0.77	3.99
PMIL (N$/kg)	1.41	0.73
PMAZ (N$/kg)	1.20	0.16
CASH (N$ '000)	6.70	9.67
CASH2 (N$ '000 2)	1.38	4.60
MILAV (1 = yes)	53 percent = 1	
WEEA (No. 1-6)	1, 3 =25 % and 2, 4, 5, 6, =12.5 %	
DISMKT (km '0)	81.55	62.49
LOMKT (1 = yes)	48 percent = 1	
READ (persons)	5.52	4.30

Data Source: Namibian Millet Subsector Research Project, 1992/93

The independent variables used and the reasons for their inclusion in the estimated equation are as follows:

(a) the amount of millet produced during the production year 1991/92 (MIL92). As for the regression model estimating millet purchases, it is hypothesized that farmers buy less grain on the informal and commercial market

the more millet they have in stock from their own grain production. Lack of data about farmers' actual grain storage levels in December 1992 make it necessary to use a variable closely related to farm level millet reserves. For this cross-section regression, farmers' harvest results from May/June 1992 were used as a proxy for farmers' supply of millet from their own production in December 1992 (MIL92). It is assumed that the coefficient estimated for MIL92 is negative.

(b) the price of millet and of maize meal that farmers faced during December 1992 (PMIL and PMAZ). According to economic theory, both maize meal and millet prices are supposed to affect farmers' grain purchasing decision. To control for these effects, the price variables PMIL and PMAZ are included in the model. Each variable reflects the respective grain price farmers faced in December 1992. It is hypothesized that PMIL is positively and PMAZ is negatively correlated with maize meal purchases.

(c) the amount of farm households' annual cash income and the squared value of it (CASH and CASH2). Economic theory predicts that disposable cash income affects household food consumption. It is believed that 'lack of money' does not only limit household level millet purchases (see Table 5-9 above), but also the purchase of maize meal. It is assumed that maize meal purchases are positively correlated with annual cash income (CASH). Since grain consumption per capita is naturally limited and because higher income households tend to substitute higher value food for staple food, the variable $CASH^2$ of the squared annual cash income is added to enable the model to estimate the fact that the

marginal increase of millet purchases are diminishing with cash income increases.

The next four variables included in the model focus on the accessibility of maize meal or its substitute, millet:

(d) the availability of millet to farmers (MILAV). Not only the price of maize meal's major substitute, millet, affects households' grain purchasing decision. The availability or accessibility of millet to individual households is also an important decision factor. Only about half of all interviewed farmers stated they had access to millet for purchase in December 1992. This implies that many of the households in grain deficit had no alternative other than buying maize meal to cover their food staple needs. To estimate the effect that the general accessibility of millet has on farmers' maize meal purchases, the variable MILAV was included in the model. If households stated in December 1992 'they had access to millet' the value of MILAV is one; otherwise, it is zero. It is hypothesized that the coefficient of the MILAV variable is negative.

(e) the geographic west/east location of farmers within the study zones (WEEA). Infrastructure like roads and communication services are better developed in western than in eastern parts of the study zones. A similar distribution exists for farm households' levels of formal education and annual cash income. It is difficult to determine what exactly caused these imbalances in development. However, it can be speculated that several factors, like cultural, historical and political events, as well as different levels of population density led

to this situation. Nevertheless, it is assumed that differences in infrastructure affect marketing of locally produced millet and imported maize meal differently.

In areas with less technical infrastructure, the collection, advertising, and eventual transporting of marketable millet surplus is more difficult than distributing well- packaged maize meal that is shipped together with other goods from urban centers to rural shops. From this, it is hypothesized that as maize meal's comparative advantage over millet in marketing increases, the less market infrastructure exists. To account for the fact that toward eastern areas of the study zones market infrastructure worsens, the variable WEEA was included. The variable uses ordinal numbers from 1 to 6 to reflect the west/east location of the six subzones within the study zones, i.e., between the neighboring regions Kaukofeld and Caprivi. It is hypothesized that the coefficient of the WEEA variable is positively correlated with household level maize meal purchases.

(f) the distance to the next large grain market (DISMKT). Not only the general level of market infrastructure, but also the distance to larger grain markets affects the purchasing decision of farmers in grain deficit. As the regression results about household level millet purchases demonstrate, the further farmers have to travel to a larger market where they can buy relatively cheaper maize meal, the more millet they buy. To test whether farmers who live closer to grain markets buy more maize meal, the variable DISMKT used in the regression model above is again included. The variable contains the kilometer distances (measured in 10 kilometers per unit) between individual sample farmers and the nearest point where they can purchase larger amounts of millet

or maize. It is expected that the coefficient of the DISMKT variable is negatively related to the amount of maize meal purchased.

(g) the access to a local grain market (LOMKT). The existence of local grain markets usually improves access to maize meal's main substitute, locally produced millet. It is assumed that improved access to millet reduces farmers' maize meal purchases. To test this hypothesis, the dummy variable LOMKT is included in the model. If the surveyed farmers stated they have access to a local grain market, the LOMKT takes value one; otherwise, its value is zero.

(h) the number of household members that can read. (READ). Grain traders interviewed during the millet marketing season emphasized that most of their customers buying maize meal do this because they can not afford to purchase the more expensive millet. However, some traders indicated that urbanized people or people with more 'modern' attitudes are the only ones who actually prefer the taste of maize meal over that of millet. To test whether the level of urbanization effects maize meal purchases on the household level, the proxy variable READ has been chosen to reflect farm households' exposure to modern, i.e., non-rural, attitudes.

The READ variable contains the number of household members that can read. The knowledge of reading can be gained either through formal school education or through informal training in later life phases. It is hypothesized that the number of household members that can read is positively correlated with maize meal purchases.

The results of the regression of maize meal purchases are presented in Table 5-16. The level of the adjusted R-Square indicates that the model explains 24 percent of the variability of household level maize meal purchases. The relatively low level of explanation can be explained by information gaps about farm level maize meal purchases gained from a one-time interview and the use of two categorical and two proxy variables. However, with one exception, the signs of all regression results are consistent to expectation, and most explanatory factors included in the model demonstrate a significant relation to the maize meal amount purchased. The control case underlying the interpretation of the regression results is a farm household that has no access to a local grain market (LOMKT = 0).

The most unexpected result of the regression model is the large and positive correlation between maize meal prices and maize meal purchases. The increase of the maize meal price by one Namibian dollar per kg seems to increase maize meal purchases by almost 30 kg per month and household (significant at 1 percent). This result is contrary to economic theory but can be explained by the monopolistic pricing behavior of grain traders in rural areas.

Table 5-17. Estimates of the maize meal purchase equation

	Ovambo & Kavango		
VARIABLES	**COEF.**	**S.E.**	**SIGNIF.**
CONSTANT	-21.01	11.94	0.08
MIL92	-0.40	0.28	0.16
PMIL	0.74	1.79	0.67
PMAZ	29.85	10.68	0.01
CASH	0.28	0.26	0.28
$CASH^2$	-0.001	0.005	0.83
MILAV	- 3.65	2.60	0.16
WEEA	2.79	0.85	0.00
DISMKT	- 0.85	0.24	0.00
LOMKT	- 6.42	2.68	0.02
READ	0.73	0.29	0.01
Adjusted R-		0.24	
Case Number		223	

Data Source: Namibian Millet Subsector Project Surveys, 1992/93

When farmers' millet reserves from their own production empty, they usually turn to their neighbors to buy millet. However, after poor rainfall seasons in one locality, most farmers face millet shortage, and informal millet markets collapse soon after harvest. In such cases, the majority of farmers that can not afford the high travel cost to distant grain markets have no other choice than to buy maize meal at rural shops. There, rural traders tent to exploit their quasi-monopolistic position by adjusting their prices upward.

Three other regression results confirm the above stated arguments. First, maize meal purchases are reduced by 6.4 kg if farmers have access to local grain markets. Second, maize meal purchases are reduced by 3.6 kg if farmers stated that millet is generally available for purchase. Third, with each subzone further to the east, i.e., the less infrastructure is available to support local millet trade, 2.7 kg more maize meal is bought per household and month. Although the second result is only significant at 16 percent, all three results point in the same direction: maize meal purchases are increased when millet is not available or difficult to access.

If the distance to larger grain markets with cheaper maize meal offerings is increased by ten kilometers, maize meal purchases decline at about 0.8 kg per month.

The number of household members that can read was used as a proxy variable for households' urbanization level. The variable demonstrates a small but significant effect on maize meal consumption. With each additional literate per household, 0.72 kg more maize meal are purchased per month.

Both households' millet harvest results of the 1991/92 production season and millet prices affect maize meal purchase relatively little. The increase of the 1991/92 millet harvest by one ton reduces maize meal purchases only by 0.4 kg. The increase of the millet price by one dollar per kg increases maize meal purchases only by 0.7 kg. While the statistical significance is weak for the first result, the second is definitely insignificant.

Although the coefficient estimates of the CASH and $CASH^2$ variables have the predicted significance, the effect of considerable cash increases are very small and statistically insignificant.

5.4. Chapter summary

This section summarizes findings about rural households grain consumption pattern and their limitations to purchase millet in the commercial food market.

5.4.1. Grain consumption pattern

Millet is the most preferred grain of the rural people in Ovambo and Kavango. Given a choice between pure millet and pure maize, 77 percent of the interviewed households in Ovambo and 94 percent in Kavango stated they prefer millet over maize. With more options to chose from only 50 percent of the respondents from Ovambo and 70 percent in Kavango favored pure millet over other staple grains. A mix of millet and maize was chosen by 25 percent of the respondents from Ovambo and pure maize was chosen by 20 percent of the respondents from Kavango.

The portion of adults preferring one of the more 'modern' grains, such as rice, macaroni or wheat in the form of bread, was significantly higher in Ovambo (17 percent) than in Kavango (10 percent). In both zones, bread is the number one choice for rural children. Survey respondents explained that young children get used to bread because it is often given to them for convenience.

'Tradition', 'availability' and the 'nutritious value' were the most often characteristics that led consumer preference either towards millet or maize. 'Good taste' played only a minor role in farmers' decision to choose millet or maize as their most preferred grain. Taste was only an important decision criteria for respondents who favored either bread, rice, or macaroni over millet and maize.

The investigation into the actual composition of rural households' diet revealed that farmers' grain consumption is mostly supply driven; i.e., as long as millet from their own production is available, it is the preferred food staple. Households begin to purchase and consume maize meal only when millet reserves are empty and millet is not available in the local market. Differences of households' diet before and after grain harvest confirm this finding. Two months before the 1992/93 millet harvest, most farm households included maize in their diet (Ovambo: 71 percent, Kavango: 92 percent). Two months after the millet harvest only 37 percent of the households in Ovambo and 31 percent in Kavango included maize in their diet.

5.4.2. Limitations to millet purchases

In 1992/93 rural household spent roughly 50 percent of their cash expenditures on food in Ovambo and 70 percent in Kavango. Household respondents from both zones stated that 'lack of money', 'expensive transportation', and 'high millet prices' are the main limiting factors for purchasing millet. Ninety percent of the respondents from Kavango mentioned 'better

access to maize meal' and 'cheaper maize meal prices' as an additional reasons for not purchasing millet.

In Ovambo 57 percent and in Kavango 91 percent of the respondents claimed that maize is more accessible than millet. These result are in line with survey findings indicating that only 45 percent of the respondents could buy millet around planting time while maize was accessible to most of the survey participant.

In Ovambo, most farmers who run out of millet reserves from own production purchase millet (57 percent) or stretch their remaining millet with maize meal (43 percent). In contrast, Kavango farmers respond to depleting millet reserves by eating less millet (70 percent) and switching to other food sources (60 percent). Only 19 percent of Kavango households would eventually buy millet to replenish their food stocks. The fact that millet deficit households in Kavango are less likely purchasing millet than households from Ovambo seems to be in contradiction to the fact that a larger share of the survey respondents in Kavango expressed preference for millet than those in Ovambo, and, that Kavango farmers produce comparatively more marketable millet surplus than Ovambo farmers. The results from the OLS cross-section regressions indicated that factors such as 'the relative price of millet' and ' the accessibility of millet on the food market' affect households millet purchasing decision more than (a) the their food staple preference or the millet production capacity of their area.

The regression results reveal also that the existence of local grain markets leads to a significant reduction of household level maize meal

purchases. i.e., Once local markets are available, farmers can more easily exchange locally produced millet or millet supplied by traveling traders and thus reduce the need to purchase expensive maize meal at local shops.

Finally, the finding that increased literacy at the household level is positively correlated with maize meal purchases confirms the argument that increased exposure to 'modern' lifestyles or attitudes will lead consumers to an increased purchase of maize meal. It is therefore to fear that with continued supply shortages of millet and increased exposure to urban life styles consumers become used to the consumption of maize meal so that millet's advantage of being the most preferred grain staple declines and millet surplus farmers start loosing their market.

6. SIMULATION OF MILLET PRODUCTION AND MARKET IMPROVEMENTS

The purpose of this chapter is to determine whether millet subsector improvements can contribute to the fulfillment of policymakers' expectations; i.e., can agricultural policies and programs, aiming to increase farmers' millet yields and to reduce farmers' millet marketing costs, lead to (a) millet that is price competitive with maize imports, (b) increased household food security, and (c) reduced grain imports?

To answer these questions, we shall analyze the prospects of the millet subsector, assuming that millet yield levels could be increased and marketing cost of millet could be reduced within the coming years. The assumptions about how much millet yields will increase in the future are based on findings from on-farm yield trials conducted during the production season 1992/93. The assumptions about how much millet marketing costs of farmers could be reduced in the future are based on survey findings about marketing costs of farmers that are already well connected to commercial grain markets. To estimate what impact the assumed millet subsector improvements might have three spreadsheet models that are based on data from the Millet Subsector Research Project, 1992/93 were developed.

The first model calculates relative supply prices of millet for various millet market channels and processing technologies under current conditions and under conditions that simulate potential yield increases and cost reductions for

millet marketing. The second model estimates the percent of rural households in the study zones that are food insecure[1] under current millet subsector conditions and under the assumption that millet production and marketing conditions are improved. The third spreadsheet model estimates current import requirements of grain in the study zones and the effect that millet yield increases and marketing cost reductions will have on future grain imports.

Before the study focuses on each model individually the procedures and the limits of estimating potential millet production and marketing improvements are presented in the following section.

6.1. Simulation of potential millet sector improvements

In accordance with the first and second objectives of this study, the preceding chapters analyzed both the current pattern of millet production, marketing, and consumption and the main determinants of household behavior at these sector stages. Important findings of these chapters are as follows:

(1) No other cereal is as well adapted to the climate and soil conditions of the study zone as millet. However, most study zone farmers do not reach millet self-sufficiency. Only very few farmers produce marketable millet surplus in Ovambo, while a fifth of the farmers in Kavango sell millet regularly on the commercial grain market. Because Kavango has usually better rainfall and less scarcity of

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[1] For this study, farm households are defined as "Food Insecure Households" (FIHs) if they neither produce enough grain to cover their annual household grain requirements nor earn enough cash income to purchase enough grain to balance their grain production deficit.

arable land than Ovambo its potential to produce a marketable millet surplus in the future is also higher than Ovambo.

(2) The marketing system for locally produced millet is insufficiently developed. Local millet markets are missing and the costs to transport millet to the central markets are especially high in Kavango where the population density is lower and distances between communities are further than in Ovambo.

(3) Most consumers in the rural areas of the study zones prefer millet over imported maize. However, millet is often not available in local markets so that households that are net grain buyers have often to purchase maize that is imported from South Africa. The continued exposure to maize show already effects on consumers preferences for food staples. In Ovambo where millet shortages are frequent and maize is more often consumed than in Kavango, roughly 20 percent of the survey respondents claimed they are indifferent between millet and maize.

Based on these finding it seems logical to propose that the Namibian government should foster its efforts to increase farmers' millet yields and improve the local millet markets in order to make marketable millet surplus available to the many net grain buyers in the study zones and to reduce the trend towards the consumption of imported grains. However, before designing policies and programmes to improve Namibia's millet subsector decision makers should know how much millet yield can potentially increase and by how much can current millet marketing cost decline in the future. Only when these questions are answered an analysis can be made to determine the effects of

these improvements on important issues such as: competitiveness of local millet with imported maize, household food security, and requirements to import grain.

It is obvious that each of the addressed issues is worth a comprehensive study by itself. However, it seems very unlikely that within the near future Namibian policymakers will have access to sufficient research capacity to address these questions in a comprehensive manner. Since policymakers need at least some information about expected gains from millet sector investments, the attempt is made to predict on the basis of the available cross-section data what can, and what can not, be expected from millet sector improvements.

One major limitation of using cross-section data from the production season 1992/93 is that they are not suitable to estimate price elasticities. To circumvent this problem, simple cost accounting will be used to determine the prices at which millet could be offered under current and improved sector scenarios. The underlying assumption of this approach is that market competition is strong enough to keep prices close to actual costs, i.e., to keep profit margins of farmers, processors, and traders low.

It is also necessary to emphasize that up to now, neither improved millet production technologies have been developed for northern Namibia, nor has any policy decision been made regarding the structure or organization of the communal millet market in the future. Of course, without specific information about the type of improvements to expect, it is even more difficult to make assumptions about the magnitude of change to expect from such improvements.

The following two sections discuss briefly how the study deals with these dilemmas.

6.1.1. Simulation of increases in millet yields

The task of developing, testing, and disseminating an improved production technology for millet lies in the hands of both Namibian and international crop researchers,[1] as well as the extension service. The 1992/93 farm survey revealed that locally produced millet becomes competitive with imported maize only if the introduction of improved production technologies increases millet yields and reduces the average unit cost of millet production. Only under such conditions is it possible that millet out-competes imported maize.

Chapter three demonstrates that the widely publicized millet variety Okashana 1 has not significantly increased farm yields. The results from the 1992/93 on-farm trials reveal that relative large yield gains are possible due to agronomic field management changes compared to small grain yield gains realized by cultivar change. (Matanyaire, 1994, p. 9). The household survey reveals that an improved technology will include several components, such as: improved seed, cheaper draft power, better field preparation equipment, better

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[1] Since 1988, the international agricultural research institute ICRISAT has collaborated with government and non-government institutions in the testing and development of suitable millet cultivars for northern Namibia.

field management practices, chemical fertilizer, improved storage protection, mechanical threshing and processing equipment.

Since the components for an improved technology package have not yet been confirmed by researchers and extension workers, it is difficult to predict whether or to what extent hectare yields might increase in the future and how much unit costs might decline within the coming years. However, one can assume that average hectare yields of communal farmers will be significantly below the yield levels of Namibian crop research stations like "Mahanene" in Ovambo and "Mashari" in Kavango. It is well known in neighboring countries that communal farmer are unlikely to have similar soil fertility conditions as maintained under controlled research conditions. Communal farmers also lack irrigation and other farmer support services.

The yield increase eventually used to simulate the application of an improved technology package in the three spreadsheet models are based on the regression findings from this study and research results from on-farm trails. The regression analysis of millet yields indicated that the use of manure or chemical fertilizer increases millet yields by 157 kilogram per hectare on average. Matanyaire, ICRISAT advisor to the Namibian government reported from his on-farm trails:

> " ... a quarter of the pearl millet farmers already using fertilizer (mainly manure) may, if their management is improved and the fertilizer used in line with the up-coming guidelines, result in their pearl millet grain yields being increased by at least 66 %. Yield gains of up to 200 % are also possible" (Matanyaire, 1994, p. 9).

Based on these results the yield increases used in the simulation models are 66 percent for farmers that had above average millet yields during the production year 1992/93. Farmers with yield levels below the 1992/93 yield levels are assumed to rise between 10 to 30 percent to the 1993 yield average of their zone. Weighing the fact that due to late rains in the production year 1992/93 millet yields were fairly depressed in the production areas east of central Ovambo and that most farmers had yields below the zone average the simulated millet yield increase was determined at 20 percent for Ovambo and 30 percent for Kavango.

6.1.2. Simulation of improved marketing conditions

Another difficulty stems from the attempt to estimate potential decreases in millet marketing costs resulting from better market organization in rural areas. Chapter 4 concluded that an increase in rural markets will reduce transportation costs. In addition, the improvement or construction of feeder roads is likely to reduce farmers' marketing costs, first, because traveling traders might more easily and, therefore, more often reach into the rural periphery, and second, because more private entrepreneurs might invest into vehicles to provide transportation service to farmers. The increase of price competition among transporters might also lead to significant transportation cost reductions.

Eventually, more markets and better roads, combined with market and price information via public radio, might allow farmers and traders to better locate centers of high millet demand or high millet surplus production. Although

traditional communication systems prove to be very efficient on the community or even district level, they often fail over long distances. A reliable price information network that does not discriminate between small and large-scale traders and even informs consumers about price discrepancies between production areas increases transparency and stimulates efficiency and faster price adjustments in rural markets.

Despite the above mentioned options to improve millet marketing in communal areas of Namibia, there are few indications of which measures the MAWRD will eventually choose to ease the marketing of locally produced millet. At present, it seems unlikely that the government will agree to the original NBA proposal that includes the announcement of producer prices every year and the mandate that marketable millet surpluses have to be delivered to large-scale processing units in the major towns.

Nevertheless, to simulate potential improvements in the local grain marketing structure, grain marketing costs obtained from survey farmers (mainly transportation costs) will be reduced by 55 percent for Ovambo and by 45 percent for Kavango. The resulting transportation costs come close to those observed in the peri-urban areas of northern Namibia, where the market infrastructure is generally better.

The reductions seem feasible because marketing costs for locally produced grain are relatively high compared to production costs, and because changes in the current market system, like the introduction of better grain market information and organization, seems neither difficult to introduce nor extremely

costly. In some cases, even improvements in the physical market infrastructure could be achieved with relatively low cost solutions. Zone differences in marketing cost reductions are based on Ovambo's natural marketing advantage. It has a higher population density and a better road net that has led to the establishment of more rural markets than in Kavango.

6.1.3. Other factors influencing the millet sector performance

Simulating changes only within the millet subsector might lead to the wrong perception that issues like grain price competitions, household food security, and national grain imports are only influenced by factors that fall in the realm of the Namibian Ministry of Agriculture. To avoid this perception, each of the developed models is exposed to some exogenous changes as well. For the "Millet Procurement Model", presented in the next section, the possibility of a significant reduction in maize import prices will be considered. This is meant to test the robustness of millet procurement cost reduction in the long run and to simulate potential reductions of maize prices on the world market. The simulations of the "Household Grain Balance Model" include a scenario testing the effects of increased household income from off-farm employment without simulating any improvements in the millet subsector. Finally, the simulations of millet sector improvements in the "Grain Import Substitution Model" are carried out twice. First, using the population estimates of the year 1995 to calculate food grain requirements, and second, using population estimates of the year

2005. The second simulation demonstrates how population growth influences grain imports.

6.2. Millet procurement model

This section tries to determine whether improvements of the millet production, marketing, and processing can enable millet to become competitive with maize. To investigate this question, a simple cost accounting model is established that calculates procurement costs for millet meal on the village and urban center level and under different cost scenarios for millet production, marketing, and processing in the study zones. To test whether millet will be competitive with maize in the long run, millet procurement costs will be compared with maize meal prices that are 20 percent lower than current prices. From the results of these price comparisons, conclusions are drawn regarding (a) the effectiveness of production and marketing improvements on the price competitiveness of millet, and (b) the appropriate choice of millet processing technology.

The production and transportation costs data used in the model are from the Namibian Millet Subsector Household Surveys, 1992/93. The processing cost calculations are from a 1992 feasibility study of the Namibian Agronomic Board (NAB) and Likwama Farmers' Cooperative from Caprivi.

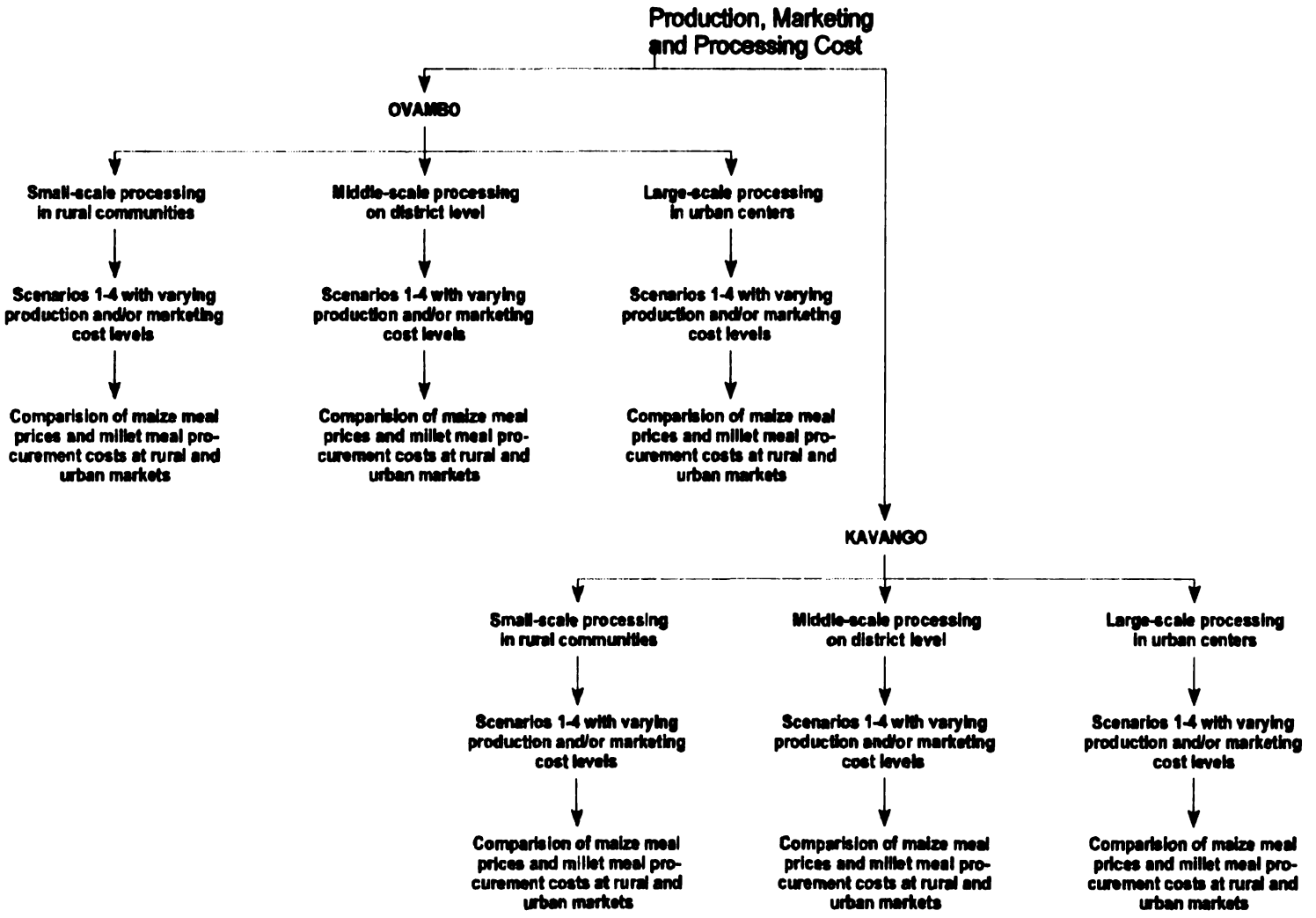
6.2.1. Model description

The base or control Scenario 1 of the Procurement Model starts out by adding today's main cost components of millet meal procurement to rural and urban consumers: production, marketing, and processing cost. Production costs are mainly based on labor input valued at current agricultural wage rates, expenses for seed, and received services, like plowing or weeding. Marketing costs are mainly transportation costs to the prossing location and from there to consumers, either in urban centers or rural communities. Some grain handling costs are included in the marketing costs. Processing costs include the actual processing cost of the simulated processing technology and extraction losses calculated from the cost accrued so far.

The calculations will be done separately for the study zones due to the differences in natural grain production potential and differences of distances between the locations of production, processing, and point of retailing (Figure 6-1).

Millet meal procurement costs will be separately calculated for the four millet processing technologies currently available in Namibia: (1) large-scale, (2) middle-scale, (3) small-scale full mechanical, and (4) small-scale semi-mechanical. Each type of processing technology assumed influences the location of processing. Large-scale processing units are more likely established close to urban centers, while middle-scale technology is more suitable to rural sub-centers. Small-scale processing units are assumed to operate only on the community level. Because the location of processing and its distance to

Figure 6-1. Overview of the millet procurement model



consumers affects marketing costs, millet meal procurement costs have to be calculated individually for rural and urban consumer markets.

Once the procurement costs for millet meal are calculated for each procurement/processing channel, they are compared with average maize meal prices observed in 1993. The comparison is based on the nominal costs of millet meal procurement and nominal maize meal prices, assuming inflated prices of both will rise together in the future. Eventually, those procurement /processing scenarios are identified where millet meal procurement costs are lower than 1993 maize meal prices.

To test whether solutions where millet meal can be more cheaply offered than maize meal are robust enough in the long run, it is assumed that maize meal prices observed in 1993 could decline up to 20 percent over the next years. This assumption is based on potential price reductions due to increased competition in the Namibian milling industry and possible reductions of grain import prices due to improved production conditions in South Africa.

The following paragraphs describe how various procurement cost components are derived. Table 6-1 summarizes the simulations of costs under current and improved millet production and marketing conditions and various processing technologies.

Millet production costs:

The three main components of the millet meal procurement cost calculation are production, marketing, and processing costs. Because it can be

assumed that surplus producers sell millet commercially, production cost are derived only from sample farmers that produced a marketable millet surplus during the 1992/93 production year.

The main inputs used by communal farmers for millet production are land, labor, draft power, manure, and seed. The use of communal land was not valued as a cost factor. Manure was also valued at zero cost because it has no market value and it comes from producers' own livestock. Labor input is measured in workdays for field preparation, weeding, fertilization, bird chasing, harvesting, and threshing. The calculation of workday equivalents was already described in the production Chapter 3. One workday was valued at the 1992/93 average wage rate of N$ 5 for agricultural laborers. If farmers used only the hoe and/or their own span of draft animals for field preparation, only the time they spent in the fields was valued as cost. If households hired draft power, cash payments made for this service were included in the cost calculation.

It is assumed that roughly 2.5 kg of millet seed are necessary to plant one hectare of millet. One kilogram of millet seed is valued at N$ 1.10, the average price for millet in 1992/93 on informal millet markets.

Based on these production cost and average yields of millet during the year 1992/93 production costs per ton of millet are estimated at N$ 670 for Ovambo and N$ 620 for Kavango. Since on-farm trials demonstrated that for farmers that are already using fertilizer the introduction of improved seed and production technology could lead to a yield increase of 66 percent it is simulated that farmers that are currently producing a marketable surplus of millet have a

Table 6-1. Millet meal procurement costs under current and improved technology conditions, by zone (N$ per metric procured millet meal)

Zone	Ovambo			Kavango		
Sector Conditions	**base year 1993 N$/MT**	**improved conditions N$/MT**	**differ-ence %**	**base year 1993 N$/MT**	**improved conditions N$/MT**	**differ-ence %**
Production costs	670	420	-37%	620	370	- 40%
Transportation to processors						
- large-scale/zone center	210	105	- 50%	300	150	- 50%
- middle-scale/subzones centers	105	60	- 57%	165	83	- 50%
- small-scale/community level	0	0	–	0	0	–
Extraction losses			20 percent of accrued cost*			
Processing						
- large-scale full-mechanical	333	333	–	333	333	–
- middle-scale full-mechanical	440	440	–	440	440	–
- small-scale semi-mechanical	500	400	- 20%	500	400	- 20%
- small-scale full mechanical	1000	800	- 20%	1000	800	- 20%
Mark-ups			15 percent of accrued cost*			
Transportation to consumers						
- from urban centers	210	70	-66%	30	100	-66%
- within rural community	0	0	–	0	0	–

Data Source: Namibian Millet Subsector Project, 1992/93; Namibian Agronomic Board;

yield increase of 66 percent. It is estimated that this yield increase reduces millet production costs by about 40 percent to N$ 420 per ton in Ovambo and to N$ 370 per ton in Kavango.

Millet marketing costs:

The analysis of transportation cost data acquired during the 1992/93 farm household surveys indicates that farmers who sell their grain outside of their own community are facing marketing costs of N$ 200 per ton in Ovambo and N$ 300 per ton in Kavango. However, most farmers selling their millet within their community have no explicit transportation or other marketing costs.

Those farmers that marketed millet at urban centers like Oshakati in Ovambo or Rundu in Kavango faced, on average, 40 percent higher marketing costs than those who traded millet at nearer sub-centers of their zone.

The average transportation costs identified for the production year 1992/93 are used directly for the base Scenario 1 of the accounting model. To simulate improved marketing conditions in terms of reduced marketing costs, it is assumed that current transportation costs can be reduced by 55 percent in Ovambo and 45 percent in Kavango. As explained in the introduction of this chapter, such high reductions seem to be feasible because the current situation suffers under a poor market infrastructure and low competitive pressure on transporters' price demands.

Processing costs:

The Namibian Agronomic Board estimated the cost of millet processing with large scale processing equipment at N$ 333 per ton. The Likwama farmers' cooperative calculates the millet processing costs of its middle scale processing operation at N$ 440 per ton. The costs for small-scale processing of millet with a hammermill and with a dehuller (full mechanical) or without a dehuller (semi-mechanical) at the community level have to be inferred from observed service fees of private operators. The costs for semi-mechanical processing are estimated at N$ 500 per ton, assuming zero opportunity cost for farmers' manual dehulling. For full-mechanical processing the cost to process one ton of millet is calculated at N$ 1000.

For the scenarios of improved marketing conditions, it is estimated that increased competition among small scale processors will lead to the decline of fees for milling and dehulling by 20 percent. This leads to estimated fees for small-scale processing at the semi-mechanical level of N$ 400 and at the full-mechanical level of N$ 800 under improved marketing conditions.

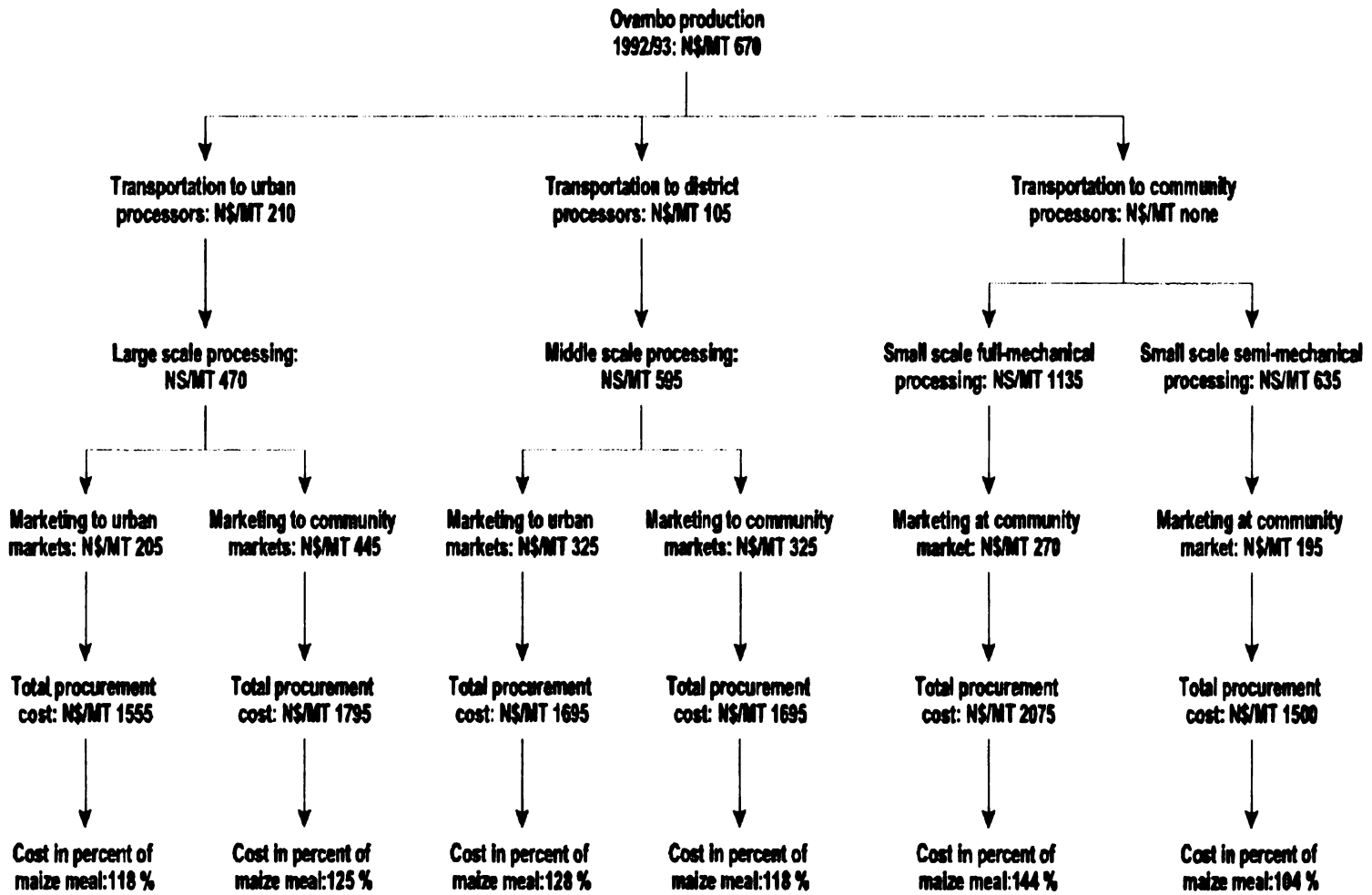
A study about mechanical millet processing in northern Namibia reported that the extraction losses of used dehullers are close to 30 percent, but that this could be reduced to about 20 percent if the extracted bran is recycled through the dehulling process for a second time. (Dendy, 1993) This leads to the simulation of extraction losses of 20 percent for both large and middle scale

millet processing. For small scale processing operations it is assumed that the bran is returned to the customers who can use it for beer brewing or animal feed.

Example of procurement cost calculation:

Having described how individual components of the Procurement Model are determined, Figure 6-2 demonstrates an example of how these costs are combined for a particular zone and a particular scenario. The actual calculations under different scenarios are done by a standard PC-spreadsheet program and the results are obtained in table form. The main advantages of using this type of software are its flexibility in adjusting calculations to specific cases and its capacity to repeat calculations of various scenarios without high programming and calculation costs.

Figure 6-2. Millet procurement cost calculations for Ovambo / Scenario 1



6.2.2. Model results

The results from the simulation models are presented for four different sector scenarios: the base Scenario 1, which is based on current production and marketing costs; scenario 2, that *ceteris paribus* is based on reduced production costs; scenario 3, that *ceteris paribus* is based on reduced marketing costs; and scenario 4, that *ceteris paribus* is based on reduced production and marketing costs. For each scenario mentioned, the cost of six alternative procurement channels is estimated separately for Ovambo and Kavango. Through these procurement channels millet meal reaches the following:

(1) urban markets via large-scale processing operations located at urban centers;
(2) urban markets via middle-scale processing operations located at subzone centers;
(3) rural markets via large-scale processing operations located at urban centers;
(4) rural markets via middle-scale processing operations located at subzone centers;
(5) rural markets via small-scale semi-mechanical processing operations located in communities;
(6) rural markets via small-scale full-mechanical processing operations located at communities.

Table 6-2 presents the model results in two forms: first, as absolute values of millet meal procurement cost per ton, and second, as percent deviation from 1993 maize meal prices. Solutions that display negative percent values can be considered as price-competitive against maize meal, assuming that both millet and maize meal prices undergo the same rate of inflation. The most cost effective solution within a scenario is printed **bold** if the millet procurement costs

Table 6-2. Comparison of millet meal procurement costs and prices of maize meal, by zone, location, processing technology, and development scenario (N$ per ton, percent of 1993 maize meal price)

	OVAMBO						KAVANGO					
	Rural Markets			Urban Markets			Rural Markets			Urban Markets		
Scenario, Location of/and Processing Technology	**Millet Meal**	**Maize Meal**	**Differ -ence**	**Millet Meal**	**Maize Meal**	**Differ -ence**	**Millet Meal**	**Maize Meal**	**Differ -ence**	**Millet Meal**	**Maize Meal**	**Differ -ence**
Scenario 1 (Base)												
local / small / full-mech.	1670	1440	16 %	--	--	--	1620	1600	1 %	--	--	--
local / small / semi-mech.	1170	1440	-19 %	--	--	--	1120	1600	-30 %	--	--	--
subzone / middle / full-mech.	1475	1440	2 %	1370	1320	4 %	1547	1600	- 3 %	1382	1480	- 7 %
zone center / large / full-mech.	1599	1440	11 %	1389	1320	6 %	1737	1600	9 %	1437	1480	- 3 %
Scenario 2 (+Production)												
local / small / full-mech.	1420	1440	- 1 %	--	--	--	1370	1600	-14 %	--	--	--
local / small / semi-mech.	920	1440	-36 %	--	--	--	870	1600	-46 %	--	--	--
subzone / middle / full-mech.	1175	1440	-18 %	1070	1320	-19 %	1247	1600	-22 %	1082	1480	-27%
zone center / large / full-mech.	1299	1440	-10 %	1089	1320	- 8 %	1437	1600	-10 %	1137	1480	-23%
Scenario 3 (+ Marketing)												
local / small / full-mech.	1470	1440	2 %	--	--	--	1420	1600	-11 %	--	--	--
local / small / semi-mech.	1070	1440	-26 %	--	--	--	1020	1600	-36 %	--	--	--
subzone / middle / full-mech.	1356	1440	- 6 %	1316	1320	- 0 %	1338	1600	-16 %	1257	1480	-13 %
zone center / large / full-mech.	1333	1440	- 7 %	1263	1320	- 4 %	1357	1600	-15 %	1283	1480	-15 %
Scenario 4 (+ Prod. & Mrkt.)												
local / small / full-mech.	1220	1440	-15 %	--	--	--	1170	1600	-19 %	--	--	--
local / small / semi-mech.	820	1440	-43 %	--	--	--	770	1600	-47 %	--	--	--
subzone / middle / full-mech.	1056	1440	-27 %	1016	1320	-23 %	1036	1600	-28 %	983	1480	-34 %
zone center / large / full-mech.	1033	1440	-28 %	963	1320	-27 %	1057	1600	-34 %	957	1480	-35 %

are 20 percent less than the 1993 maize meal prices, i.e., the solution would still be competitive if maize meal prices decline by 20 percent in the long-term.

6.2.2.1. Current competitiveness (Base Scenario 1)

Scenario 1 estimates millet meal procurement costs under 1993's production, marketing, and processing conditions. The model estimates that packaged millet meal could be offered at prices ranging between N$ 1120 and N$ 1737 per ton, depending on the study zone and the type of processing technology used. The cheapest procurement options are (a) for rural consumers in both zones, semi-mechanically processed millet meal (small-scale hammermills) with N$ 1170 per ton in Ovambo and N$ 1120 per ton in Kavango, and (b) for urban consumers of both zones, middle-scale processing operations (Ovambo: N$ 1370, Kavango N$ 1382).

The comparison of millet meal procurement costs with prices of 25 kg bags of maize meal in local markets in 1992/93 reveals that under 1993's conditions, millet meal could be offered to rural consumers at lower prices than those of maize meal if semi-mechanical processing technology is used.

For Ovambo, estimated millet meal prices for semi-mechanically processed millet are 19 percent below maize meal prices in rural communities. However, while in Ovambo none of the remaining procurement options can out-compete maize meal prices, some estimates come very close. Large and

middle-scale processing for urban consumers and middle-scale processing for rural consumers come within a 5 percent difference of maize meal prices.

In rural Kavango, estimated prices for millet meal from semi-mechanical processing with small-scale hammermills are 30 percent below maize meal prices in rural communities. This large price advantage guarantees millet meal a long-term competitive position versus maize.

The main conclusion is that if rural consumers continue to prefer millet over maize and buy the cheapest grain available, the introduction of small-scale hammermills will be economic viable in rural Ovambo and Kavango.

Small-scale milling services in rural communities will give rural farmers the option to purchase semi-mechanically processed millet meal at prices that are lower than current maize meal prices. Additionally, rural employment and income opportunities could be created through the use of small-scale processing technology. It is also possible that local grain markets, if not yet existent, will emerge close to small-scale hammermill operations.

6.2.2.2. After sector improvements (Scenarios 2 - 4)

Scenario 2 simulates the impact of the introduction of an improved millet production technology which reduces production costs in Ovambo by 37 percent

and 40 percent in Kavango. The reduction in production costs reduces the cost of millet meal by roughly 20 percent for both urban and rural consumers. However, under the restriction that millet meal prices have to remain competitive even if maize meal prices decline in the long run by 20 percent, the outcome is more diverse. In Ovambo, only semi-mechanical small-scale processing in rural communities reaches prices 36 percent lower than maize meal prices, and are therefore, far beyond the required 20 percent. Middle-scale processing at the subzone level still achieves cost advantages over maize meal that come very close to the 20 percent threshold (rural markets: -18 percent, urban markets: -19 percent).

In urban areas of Kavango, both middle and large-scale processing units would reach long-term price competitiveness, while in rural Kavango, only middle-scale millet processing and semi-mechanical small-scale processing would provide millet meal at costs that are competitive in the long run. As in Ovambo, cost advantages of semi-mechanical processed millet over maize meal are very high.

The three most important findings from Scenario 2 are as follows: First, local semi-mechanical millet processing with small-scale hammermills will increase millet meal's price advantage in rural areas significantly once an improved production technology is identified and implemented. Second, once farmers' production costs are reduced, middle-scale processing operations at subzone level have the potential to serve both rural and urban grain consumers

with price-competitive millet meal. Third, procurement of millet meal on the basis of full mechanical small-scale processing with a small-scale dehuller and hammermill is too costly for local markets.

In Scenario 3, millet transportation costs to processing facilities and consumers are reduced between 50 and 66 percent to reflect potential improvements in the millet marketing system of Ovambo and Kavango, respectively. Since reducing transportation costs benefits millet procurement options that are transportation intensive, procurement of millet meal via large-scale processing in urban centers with retailing in rural communities was most affected (Ovambo: 17 percent; Kavango: 22 percent).

The reduction of millet transportation costs makes 5 of the 6 millet meal procurement channels in Ovambo competitive against maize meal prices and all 6 channels in Kavango. However, the introduction of the condition of a 20 percent cost advantage over maize meal leaves, in both study zones, only semi-mechanical millet processing as a competitive option.

The results from the improved market system simulated in Scenario 3 lead to similar conclusions as previous scenarios. The competitive position of local semi-mechanical millet processing with small-scale hammermills can hardly be challenged by other alternatives. Middle and large-scale processing operations might not yield competitive millet meal prices if only marketing condition are improved.

Scenario 4 simulates the joint impact of reducing millet production and marketing costs. The result reveal that procurement costs are between 26 to 39 percent less than under cost conditions in 1993. The estimated cost for one ton of millet meal from middle and large-scale processing units range between N$ 957 and N$ 1057 in both zones. The cost for millet meal processed semi-mechanically by small-scale hammermills leveled at around N$ 800 per ton of meal. The cost for fully-mechanical small-scale processed millet at local market level is about N$ 1200 per ton.

Except for full mechanical small-scale milling on the community level, all other procurement options provide millet meal at costs that are 20 percent less of what rural and urban consumers have to pay for maize meal today. Millet meal that is dehulled manually by producers and milled by small-scale hammermills can be competitive in both zones if maize meal prices decline by even 40 percent. Under the conditions of combined improvement in millet production and marketing, large-scale processing in urban centers becomes slightly more cost effective than middle-scale processing at subzone level.

The outcome of Scenario 4 eventually confirms findings from all previous scenarios. The dissemination of small-scale hammermills in rural areas is the most competitive solution for millet meal procurement in rural areas. In the case that aggregate millet production levels increase to such an extent that also urban consumer markets can be catered, both middle and large-scale processing operations seem to be suitable.

6.3. Household grain balance model

This section investigates how household food security in the study zones will be affected by the introduction of an improved production technology and improved grain marketing. A Household Grain Balance Model is used to relate millet production and marketing parameters with household food security.

Current definitions of "household food security" emphasize both farm households' food production capacity and their capability to purchase food to meet household needs. "Food Insecure Households" (FIHs) are defined as those who neither produce enough grain nor acquire enough income to meet household grain requirements.

To be able to identify food insecure sample households the potential grain balance was calculated in the base or control Scenario 1. The calculation includes the following three figures: (a) households' grain consumption needs, (b) households' subsistence production, and (c) potential grain purchases from off-farm cash income.

Households' current food security levels are expressed in percent of households' grain consumption needs covered through staple grain production and potential staple grain purchases. It is assumed that the acquired average percent figures from the survey sample reflect general food security conditions in Ovambo and Kavango.[1]

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[1] Due to lack of historical data and to simplify modeling, it is necessary to assume that the FIHs identified during the 1992/93 surveys are a fair

Three further scenarios simulate improvements (1) in millet production technology, (2) in northern Namibia's grain marketing structure, and (3) in improvements 1 and 2 together. The improvements are simulated by using increased grain yields, reduced unit production costs, and reduced unit marketing costs.

These simulations can help inform agricultural policymakers about the potential reduction in household food insecurity through programs geared towards improving grain production and marketing conditions in the principle millet production zones. To provide policymakers with a comparison between the reduction of FIHs through grain sector improvements and potential improvements in non-agricultural sectors Scenario 5 shows how improved access to off-farm employment can increase rural incomes and reduce food insecurity.

The rest of this section is divided in two parts. The first part describes the Household Grain Balance Model. Part two presents and discusses the model results.

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representation of grain deficit households in recent years in the study zones. This assumption is supported by aggregate grain production estimates from the Namibian Early Warning & Food Information System Unit. As Table 3-5 of Chapter 3 already demonstrated, the harvest results of the 1992/93 production year are not significantly different from other recent production years.

6.3.1. Model description

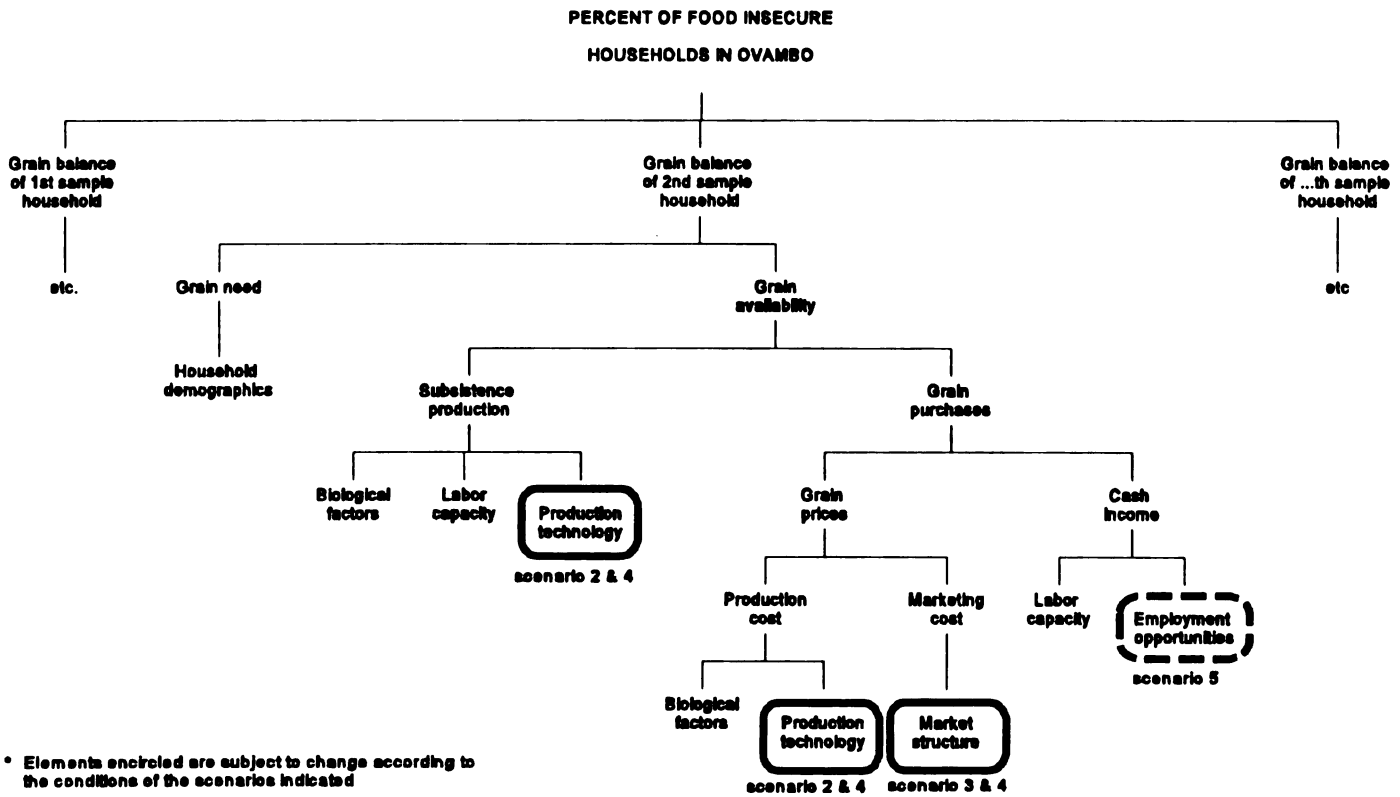
The base or control Scenario 1 identifies the food insecure farmers of the 320 households surveyed in the 1992/93. These farmers did not produce enough grain to cover the grain needs for the following year or earn insufficient cash income to meet their household food security needs.

Figure 6-3 presents the information used to calculate the percentage of FIHs in Ovambo. For each sample household, the difference between annual grain need and grain availability is estimated. The calculation of households' annual grain needs is based on FAO recommendations regarding energy requirements for different gender and age groups. The amount of grain available per household is estimated by adding to households' 1992/93 grain production the amount of grain possibly bought with households' annual cash income.

The grain prices used to calculate potential purchases were the cheapest grain prices mentioned by individual survey households during the April 1993 household surveys (maize meal was the cheapest calorie source during most at that time).

The amount of cash income available for the purchases of staple grain is based on the finding that, on average, 50 percent of Ovambo households' available cash income and 60 percent of Kavango households' available cash income is used to buy food (see Tables 5-8 and 5-9 above) and 80 percent of the money spent on food is used to purchase grain.

Figure 6-3. The household grain balance model for Ovambo*



* Elements encircled are subject to change according to the conditions of the scenarios indicated

Data Source: Namibian Millet Subsector Research Project, 1992-93

After the base conditions are established and the percent figures of FIHs in Ovambo and Kavango are estimated, the following assumptions are made for Scenarios 2, 3, 4 and 5:

(a) Household millet production can be increased by the implementation of an improved technology package (Scenario 2);

(b) More and cheaper surplus millet is available to buy after the communal marketing system has been improved (Scenario 3);

(c) Production and market improvements estimated in Scenarios 2 and 3 can be achieved at the same time (Scenario 3);

(d) Improvements in non-agricultural sectors that lead to increased off-farm employment opportunities for rural households can be simulated by adding to each household an average annual income from non-agricultural employment.

Scenario 2 assumes that improved millet production technologies can be identified that increase the average millet yield in Ovambo 20 percent and in Kavango 30 percent. The average increase was calculated on the assumption, that (a) yields of farmers that produce below zone average can increase their yields up to this zone average, and (b) farmers that are currently operating at levels higher than zone average can increase their yields by two thirds, the potential yield increase derived from on-farm trails conducted by agronomists during the production year 1992/93.

In Scenario 3, improvements of the communal grain marketing system are assumed to lead to lower marketing costs and cheaper millet prices for consumers. Transportation costs constitute the lion's share of total grain marketing costs. Under current market conditions, transportation of millet from producers to markets amounts, on average, to 30 and 50 percent of the original production cost, i.e., 200 Rand per ton in Ovambo and 300 Rand in Kavango.

We assume improvements in the grain market structure will reduce the marketing costs of farmers by 45 percent in Kavango and 55 percent in Ovambo. Under the improved market conditions, a higher percentage of grain deficient farmers are now enabled to purchase millet locally that is cheaper than maize meal. The millet prices used to simulate the new conditions are taken from the Millet Procurement Model developed in the previous section. In cases where maize meal remains cheaper than millet, maize prices will be used.

Scenario 4 simulates both improvements simultaneously, production is increased due to the adoption of improved production technologies and grain purchases are increased because of improved grain marketing conditions.

Scenario 5 assumes that improvements in the manufacturing and service sectors will generate more non-farm employment opportunities to the rural population of Ovambo and Kavango. Under this assumption, the cash income of each household is increased by N$ 6000 per year.

This figure represents the current average annual salary of unskilled men and women in occupations such as laborer, sales person, food processor, security personnel, assistant clerk, and assistant nurse, that were reported in the household surveys in 1992/93.

6.3.2. Model results

As described, the Household Grain Balance Model generates results for five different scenarios: the base Scenario 1, representing today's conditions, Scenarios 2, 3, and 4, simulating potential improvements in millet production and/or marketing, and Scenario 5, simulating increased cash income from more employment opportunities in non-agricultural sectors. The results of these scenarios are summarized in Table 6-3. Figures 6-4 through 6-13 present the simulation results graphically.

6.3.2.1. Current food security conditions (Base Scenario 1)

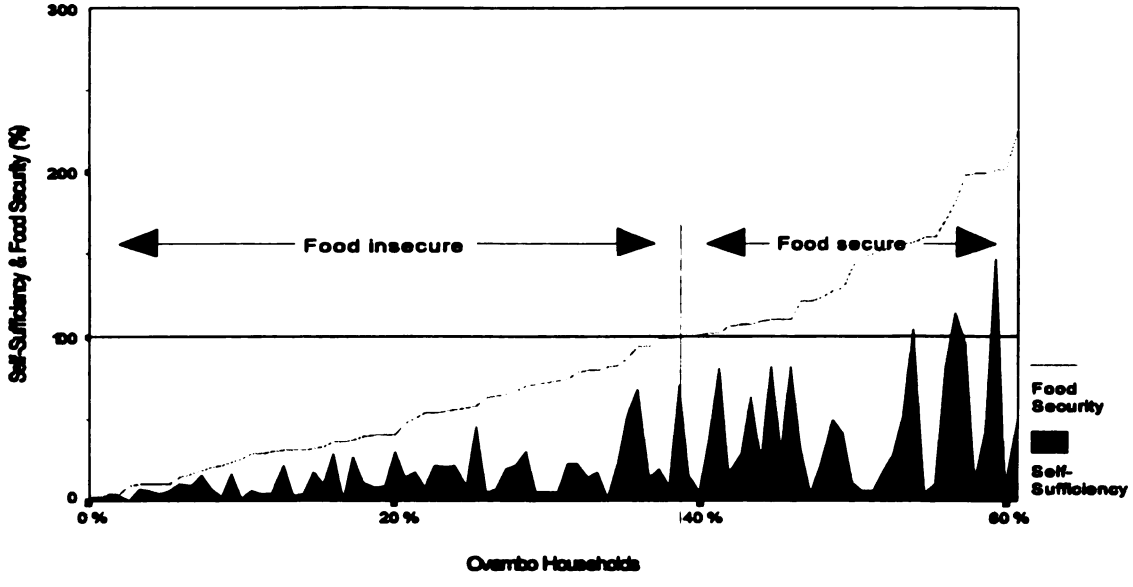
In Table 6-3 the results of the base Scenario 1 show that the share of food insecure households is 38 percent (230,000 people) in Ovambo and 43 percent (56,000 people) in Kavango.

Table 6-3. Model Results: Percent of food insecure farm households, by zone and scenario

Zones	Ovambo		Kavango	
	percent of rural HHS	'000 of people	percent of rural HHS	'000 of people
Scenario 1: current production, current marketing, current income	38 %	229	43 %	56
Scenario 2: improved production, current marketing, current income	29 %	175	32 %	41
Scenario 3: current production, improved marketing, current income	35 %	211	42 %	54
Scenario 4: improved production, improved marketing, current income	23 %	139	27 %	35
Scenario 5: current production, current marketing, improved income	3 %	18	0 %	0

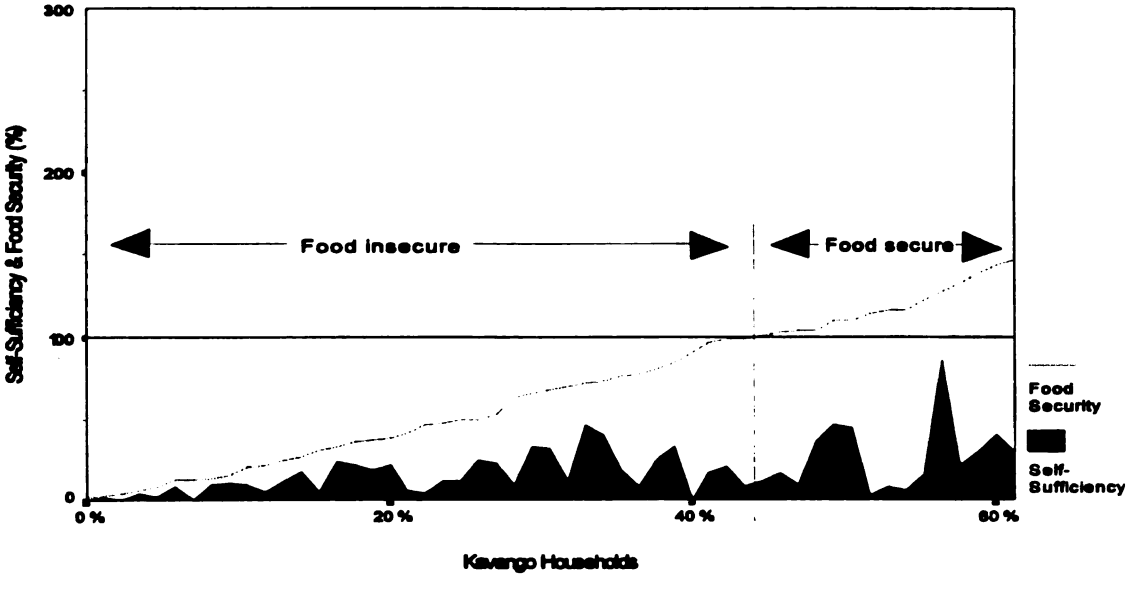
Data Source: Namibian Millet Subsector Project Surveys, 1992/93

Figure 6-4. Scenario 1/Ovambo: Food insecure households under 1992/93 production and marketing costs



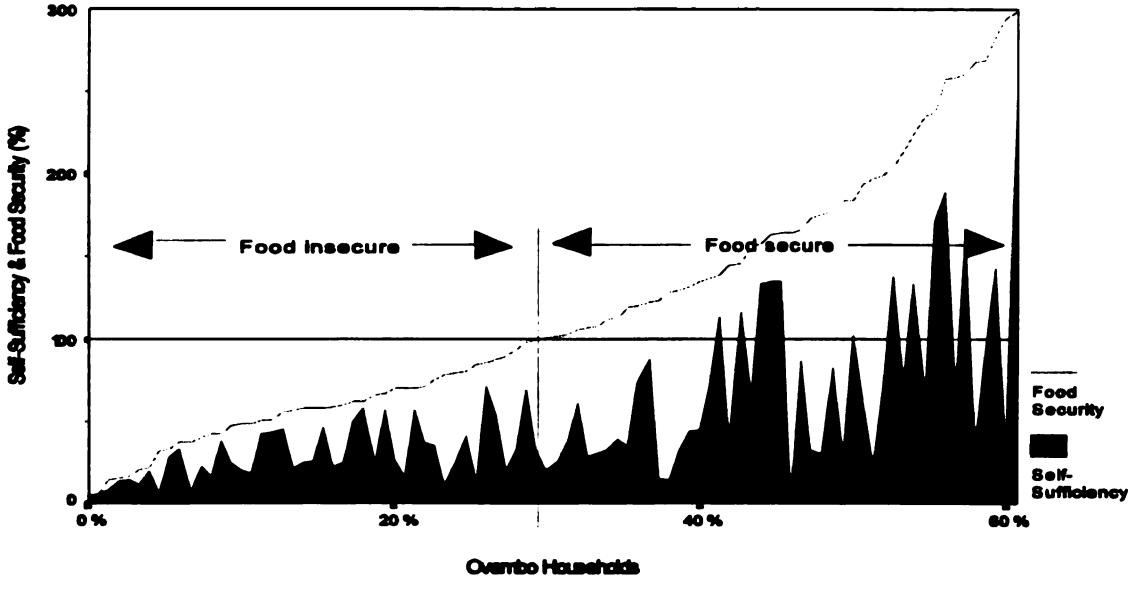
Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-5. Scenario 1/Kavango: Food insecure households under 1992/93 production and marketing costs



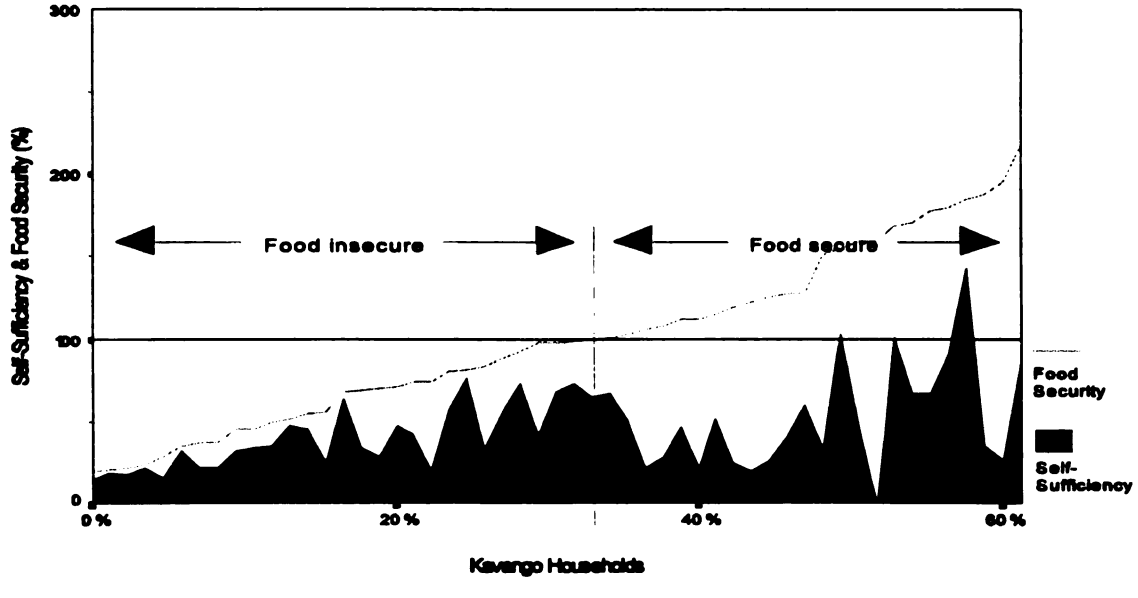
Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-6. Scenario 2/Ovambo: Food insecure households under reduced production and 1992/93 marketing costs



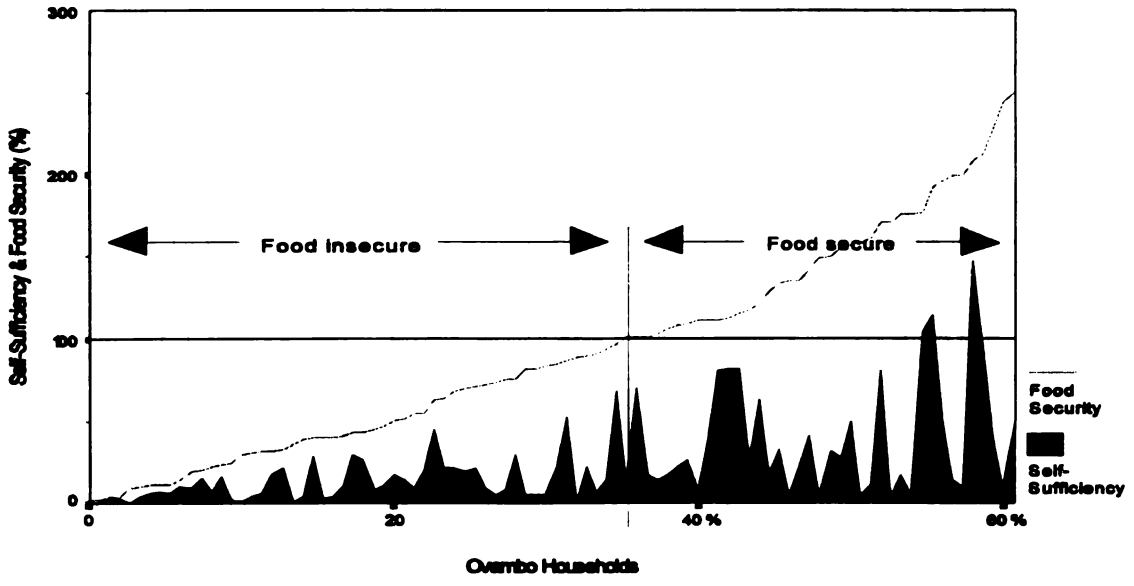
Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-7. Scenario 2/Kavango: Food insecure households under reduced production and 1992/93 marketing costs



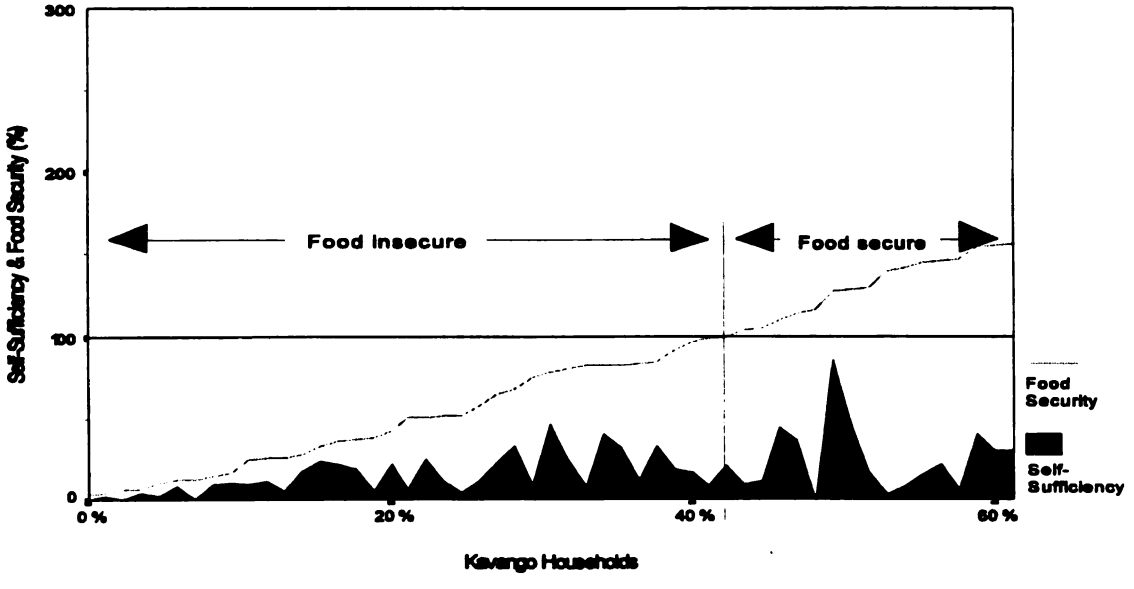
Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-8. Scenario 3/Ovambo: Food insecure households under 1992/93 production and reduced marketing costs



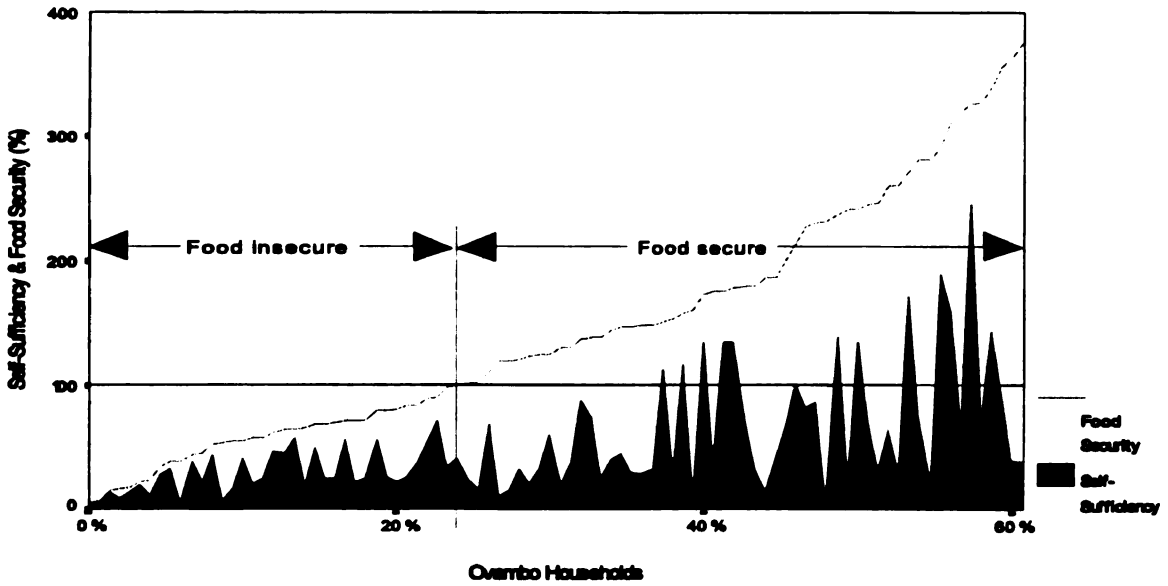
Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-9. Scenario 3/Kavango: Food insecure households under 1992/93 production and reduced marketing costs



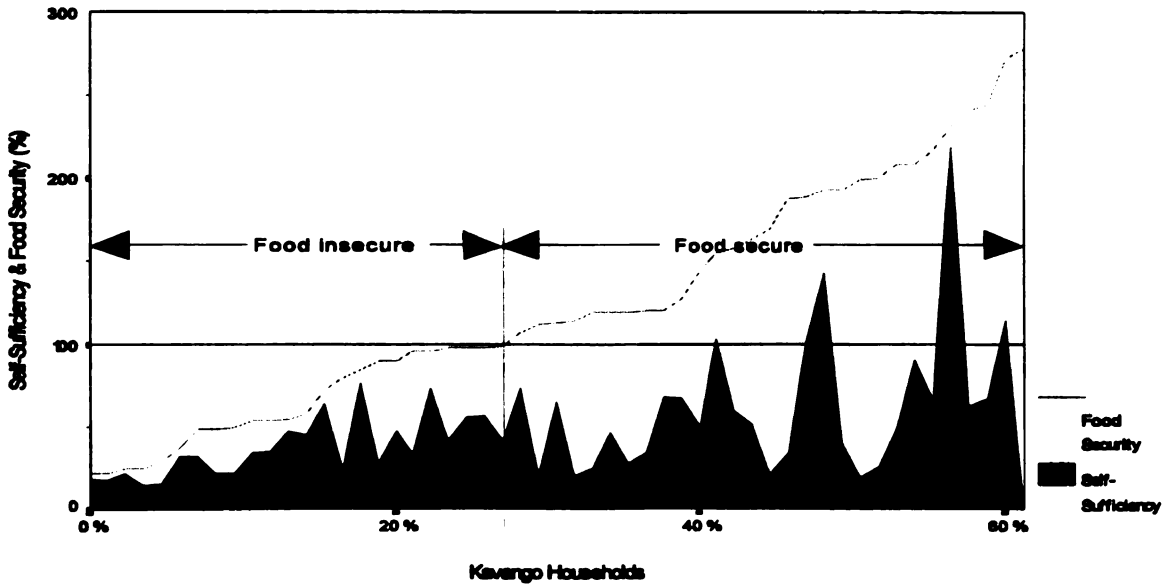
Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-10. Scenario 4/Ovambo: Food insecure households under reduced production and marketing costs



Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-11. Scenario 4/Kavango: Food insecure households under reduced production and marketing costs



Data Source: Namibian Millet Subsector Research Project and my own calculations

6.3.2.2. Effects of sector improvements (Scenarios 2 - 4)

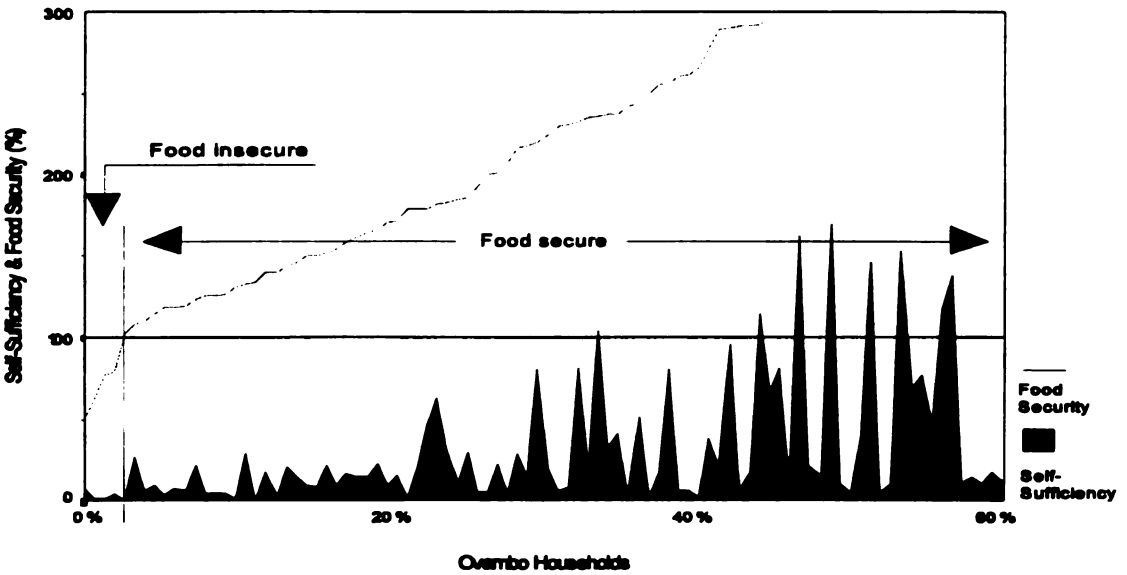
The results of Scenario 2 and 3 show that improvements in millet production or marketing can reduce the number of FIHs. However, these reductions cannot eradicate all food security problems. Estimations from Scenario 4 indicate that even with simultaneous improvements in millet production and marketing, still a quarter of all rural households remain food insecure.

The results of these scenarios are important for Namibian decision makers because they show that policies designed to improve the food grain sector in northern Namibia could have a considerable impact on the incidence of FIHs. However, Scenarios 2 to 4 also show that improvements in the agricultural sector alone cannot overcome severe rural poverty that is the product of policies of the colonial government. The results show that political empowerment and economic development of Namibia's rural majority, has to be pursued in agriculture and non agricultural sector because grain production accounts for less than 40 percent of total food security requirements (Ovambo: 38 percent and 32 percent in Kavango).

6.3.2.3. Effect of non-farm employment (Scenario 5)

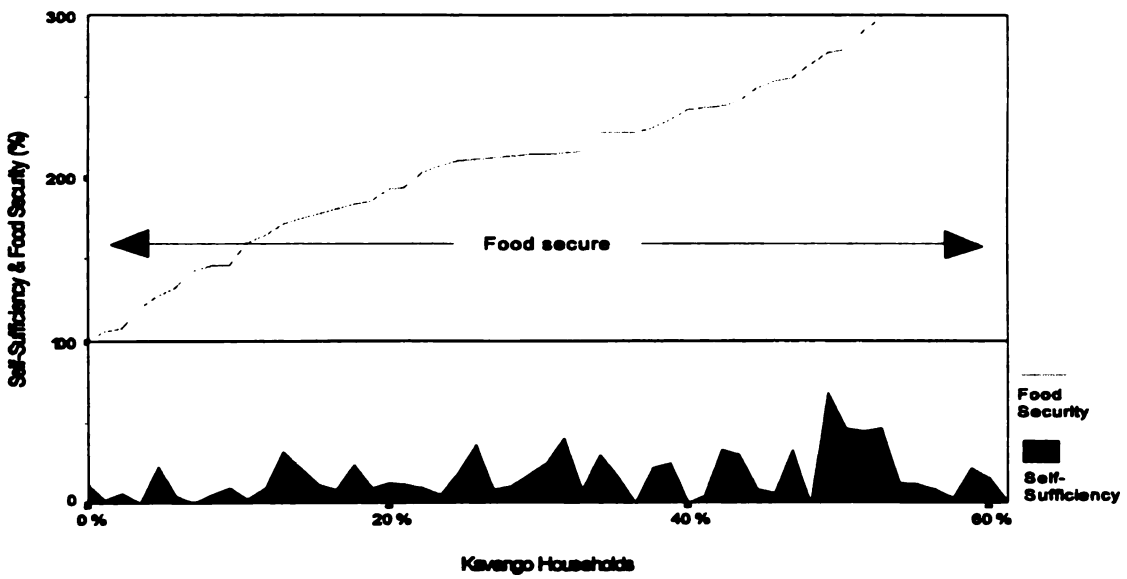
A surprisingly large reduction in the number of FIHs stems from an increase in cash income in Scenario 5. (Figure 6-12 and 6-13) The cash income of each sample household is increased by the average wage of an

Figure 6-12. Scenario 5/Ovambo: Food insecure households under increased income from off-farm employment



Data Source: Namibian Millet Subsector Research Project and my own calculations

Figure 6-13. Scenario 5/Kavango: Food insecure households under increased income from off-farm employment



Data Source: Namibian Millet Subsector Research Project and my own calculations

unskilled laborer (N$ 6000 per year that allows at 1992/93 prices the purchase of the annual millet consumption requirement of an average household) to simulate increased employment opportunities for farm households in the study zones. In Ovambo, the number of FIHs decreases from 38 to 3 percent, and in Kavango, from today's 43 percent to a level of zero.

The conditions of Scenario 5 reduce the average share of grain production on total grain access of FIHs to 6 or less percent and for food secure farm households to 17 percent in Ovambo and 7 percent in Kavango. This means that grain production loses its importance with regard to household food security once more off-farm employment becomes available to the rural population of Ovambo and Kavango. The results of Scenario 5 confirm the conclusion from the preceding scenarios. Policies targeting solely improvement in the grain staple sector are not enough to deal with the problem of food insecurity in northern Namibia.

Although increased off-farm incomes affect farmers' food security more than improvements in the millet subsector, the final conclusion is not that policies trying to achieve the latter are void. On the contrary, the following five reasons explain why it is necessary that improvements in the millet subsector be pursued with regard to household food security:

(1) Although additional off-farm employment opportunities are promising, Namibia is facing the prospect of reduced off-farm employment opportunities due to the withdrawal of South African troops and the decline in its mining industries.

(2) Ovambo, and especially Kavango, are the two zones in Namibia with the highest potential for rainfed crop production. Enough labor is available in agriculture once the profitability of grain production is improved, i.e., the development of the agricultural sector to make best use of available physical and human resources seems to be of paramount importance for the economic development of Namibia.

(3) Scenario 4 demonstrated that a better performance of the millet subsector can actually reduce the number of FIHs significantly. FIHs that can not benefit from sector improvements have to be helped with other measures.

(4) The MAWRD, as well as various national and international NGOs, are already developing measures to enhance millet production and improve local and regional grain marketing.

(5) Improvements in the millet subsector can be seen as first steps toward engaging a larger portion of communal farmers in commercial food production without simultaneously increasing their food insecurity. At a time when technologies for the production of higher value crops are available, farmers might already have adopted knowledge how to integrate cash crop production into their farming system.

6.4. Grain import substitution model

The purpose of the grain substitution model is to estimate the grain import needs of the study zones under various scenarios. A base or control model is developed which estimates the aggregate grain import needs of Namibia's main millet production zones Ovambo and Kavango in 1995. Scenarios 2, 3 and 4 estimate grain import needs under the simulation of increased millet production on the household level and/or reduced millet marketing cost. The rates of yield increases and marketing cost reductions are similar to those used in the preceding Millet Procurement Model and Household Grain Balance Model (see sections 6.1.1. and 6.1.2. above).

6.4.1. Model description

The basic equation used to derive the import need from the available data is as follows:

Grain import requirement	=	**Grain consumption need**	-	**Subsistence grain production**	-	**Purchases of local grain**

The aggregate grain consumption need of 1995 is determined by aggregating sample households' annual food grain requirements and extrapolating those to the zone level. As done for the household grain balance model, the calculations of grain requirements on the household level are based on FAO recommendations regarding energy requirements for different gender and age groups.

The urban population from Ovambo (10 percent) and Kavango (5 percent) is included in the extrapolation process to reflect total grain need of the study zones. To forecast the aggregate staple grain need of rural Ovambo and Kavango for the year 2005, the following average population growth rates from the years between 1983 and 1993 are used: Ovambo 3.1 %, Kavango 2.5 % (Central Statistics Office, 1993).

The aggregate amount of subsistence grain production is calculated by adding up all households' grain consumption needs that are covered by households' own grain production. Aggregate purchases of locally produced millet are calculated by adding up all millet purchases estimated for the sample

households individually. If the aggregate amount of individual millet purchases surpasses the aggregate amount of marketable millet surplus production, the latter figure is used.

To estimate whether a household purchased millet and how much, the cheapest grain type available to individual households is determined first; i.e., household representatives have stated the current price of available millet and imported maize meal. For a sample case where millet is offered cheaper than maize meal, it is assumed the household is spending the average portion of its cash income available for grain purchases on millet (Ovambo: 45 percent, Kavango 55 percent). If maize meal is cheaper than the available millet offered, it is assumed the household balances its grain deficit with maize purchases.

With each scenario, the price of available millet changes due to the simulation of various combinations of millet sector improvements. If millet prices become cheaper, more of the farm households that are buying maize meal to balance their grain deficit switch over to commercially offered millet.

The basic assumptions and constraints applied throughout the simulations are as follows:

(1) Production, purchase, and price data collected from the randomly selected household sample are a fair representation of the overall conditions in the study zones.
(2) Although the population of the study zones increases over time, current grain production does not increase proportionally due to more land under cultivation. This is due to the fact that most of the arable land is already occupied, and since independence, the opportunity exists to move to other regions in search of off-farm employment.

(3) Farm households in the study zones consume their subsistence grain production first before they purchase food grain on the informal or commercial grain market.

(4) Households that purchase grain purchase the cheapest available; i.e., if improved production and/or marketing conditions lead to the availability of cheaper millet than maize, consumers change their purchasing behavior in favor of millet.

(5) The total amount of purchased grain from local production is not allowed to be more than the amount of local grain surplus production.

(6) Under today's grain market structure (Scenarios 1 and 2), locally produced millet surplus is not traded from one zone to the other. Surplus millet that is not sold within its own zone is counted as loss.[1]

(7) Under the conditions of improved millet marketing (Scenarios 3 and 4), inter-zone exchange of millet surplus becomes possible. Grain surplus producers that do not sell their surpluses so far are willing to do so under improved marketing conditions, i.e., when market transaction costs are reduced and commercial production is more common.

The aggregate amount of grain losses for each zone is calculated as the difference between total grain production and the sum of aggregate subsistence grain production and aggregate purchases of locally produced grain.

In the case that all maize imports are replaced by local grain production, the aggregate amount of exportable surplus is calculated by subtracting the

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[1] Results from the regression analysis determining farm households' selling behavior demonstrated that farmers closer to central markets are more likely to sell millet. Up to the present, it is very common that farmers in remote areas who produce larger amounts of surplus grain keep these in storage without making any effort to sell. Although this grain degenerates over time and thus loses its value for human consumption, its status value is still high. Similar to the number of cattle owned, the number of full granaries, whether filled with old or fresh grain, is a traditional indicator of wealth.

aggregate need of grain consumption from the total amount of local grain production.

6.4.2. Model results

This section reports model estimates of study zones' grain import requirements in 1995, demonstrates the effects that millet subsector improvements have on grain imports, and discusses the effects of population growth in the study zones long-term grain import needs. The results of this section are summarized in Table 6-4 and Figures 6-14 through 6-17.

6.4.2.1. Current import requirements (Base Scenario 1)

Under current millet production and marketing conditions, grain import requirements for the major millet production zones are substantial. According to the estimates of Scenario 1, up to 92,000 tons of grain have to be imported annually to secure adequate staple grain supply. This is 57 percent of the 162,000 tons grain consumption requirement for Ovambo and Kavango in 1995 (Table 6-4 and Figure 6-14).

Two important features of the current production system are the following: First, commercial grain production contributes only 12 percent to balance total grain consumption need. As demonstrated in previous study parts, the main explanations for this phenomenon are that most study zone farmers produce a grain deficit and can therefore not sell surplus grain. Additionally, those who

produce marketable grain surpluses are usually not used to marketing grain and discouraged by high market transaction cost.

Table 6-4. Model Results: study zones grain import needs, grain production, and production losses (in '000 MT, % of aggregate consumption need in parentheses)*

		Scenario 1 base year 1995	Scenario 2 increased production	Scenario 3 improved marketing	Scenario 4 incr. production impr. marketing
Grain imports	**MT**	**92**	**47**	**68**	**0**
	%	(57)	(29)	(42)	(0)
Subsistence production	**MT**	**51**	**76**	**51**	**76**
	%	(31)	(47)	(31)	(47)
Commercial production	**MT**	**19**	**39**	**43**	**86**
	%	(12)	(24)	(27)	(53)
Exportable surplus	**MT**	**0**	**0**	**0**	**10**
	%	(0)	(0)	(0)	(6)
Production losses	**MT**	**24**	**57**	**0**	**0**
	%	(15)	(35)	(0)	(0)

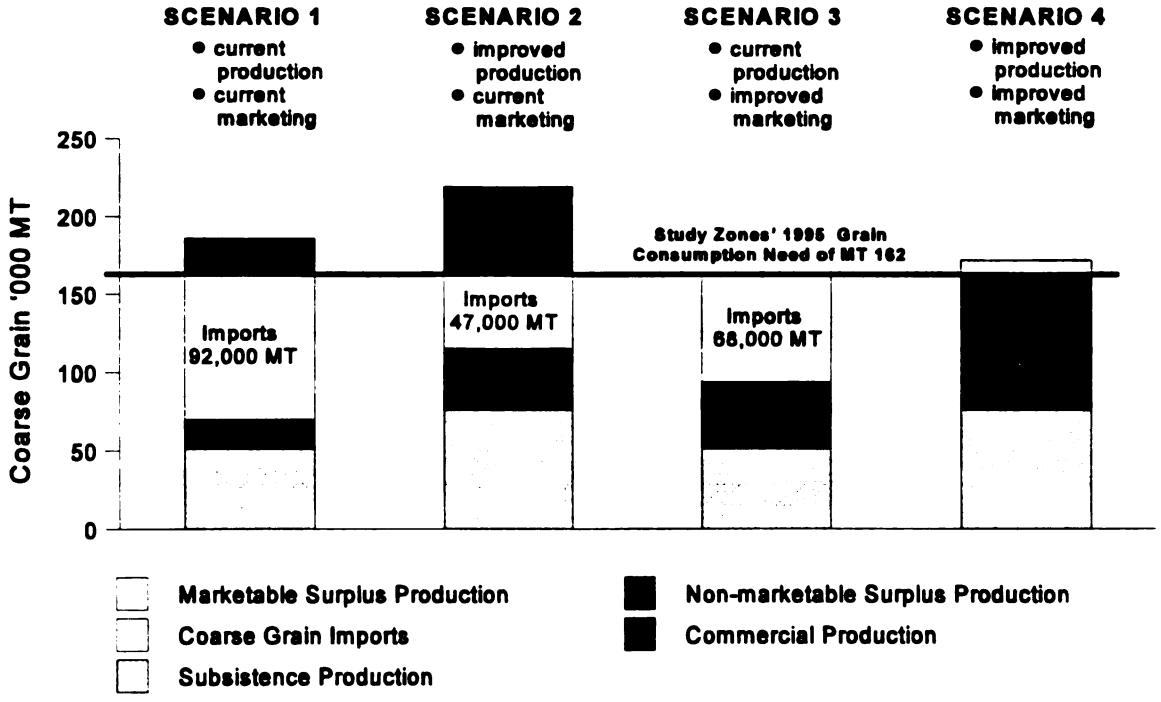
Data Source: Namibian Millet Subsector Project Surveys, 1992/93 and my own calculations

* based on the estimate of 162,000 tons of grain consumption requirements in the study zones in 1995

Second, aggregate grain losses are comparatively high. They amount to 15 percent of current grain consumption requirements. Even worse is the fact that these grain losses amount to 34 percent of Ovambo and Kavango's aggregate grain production (subsistence and commercial). The production losses are not so much explained by poor grain storage practices. But, traditional perceptions permit wealthier farmers to display large grain reserves in

the storage baskets as a status symbol without making an effort to engage in any marketing activities that could transfer millet surpluses to areas with production deficits. Also farmers in remote who want to sell their marketable millet surplus often face often such high marketing cost that prefer to keep it in storage where only small amounts are sold or given away to poor neighbors, while the rest loses its consumption value over time.

Figure 6-14. Potential grain import substitution based on population estimates for the year 1995 of Ovambo and Kavango



Data Sources: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

Individual food safety concerns are the third factor contributing to high losses of marketable grain surplus. To reduce the risk of food shortages due to consecutive drought years, farmers' storage/marketing thresholds tend to be high. In the case that several good harvest years follow each other, grain reserves are not used for a long time. Eventually, they have to be replaced with grain from more recent harvests. By then, the old grain reserves have lost their consumption and market value due to rot and insect infestation.

6.4.2.2. Effects of sector improvements (Scenarios 2 - 4)

The simulation of production and/or marketing improvements significantly affects aggregate import needs in the study zones. The sole increase of hectare yields on the household level simulated in Scenario 2 reduces the 1995 grain import requirements by almost 50 percent, to 47,000 tons. The two effects causing these large import reductions are increased subsistence production and increased millet purchases on the household level. The latter is caused by the reduced production costs that are passed on to the consumers via reduced millet prices on the informal and commercial grain market.

Although in Scenario 2 aggregate grain production is increased by 78,000 tons, the reduction of grain imports amounts only to 45,000 tons. The reason for this disproportional effect on grain import is the insufficient development of the current millet marketing system reflected in the scenario conditions. The poor market development prohibits inter-zone grain exchange of local surplus production and thus increases current grain losses to the level of 57,000 tons.

The sole improvement of millet marketing conditions simulated in Scenario 3 leads to a reduction of grain import needs by 24,000 tons, or 26 percent of current import needs. This import reduction is achieved by converting the surplus production that is currently not marketable into marketable surplus. Although the import reductions achieved in Scenario 3 are much less than those achieved in Scenario 2, the results are still impressive. The pure marketing solution is appealing because it makes better use of already existing resources rather than emphasizing the production of more grain, of which a significant amount will be lost.

The results of the best world Scenario 4, which combines production increases with marketing cost reductions, are encouraging. If such improvements could be applied to cover today's grain consumption requirements of 162,000 tons, even exportable surplus of 10,000 tons could be produced.

However, it seems very unlikely that the simulated sector improvements will be achieved in the near future. It is also doubtful that all maize imports can be crowded out by a more efficient communal grain sector. The two reasons supporting the latter argument are the foreseeable change in consumers' food preferences toward maize meal consumption, and increased grain consumption need due to continuing population growth. The preference change towards "modern food staples" among younger population sections was already documented during the preceding consumption Chapter 5. To get a better understanding of how population growth might counterbalance potential import

reductions, the following section presents simulation estimates that take population growth into account.

6.4.2.3. Projections for the year 2005 (Scenarios 1 - 4)

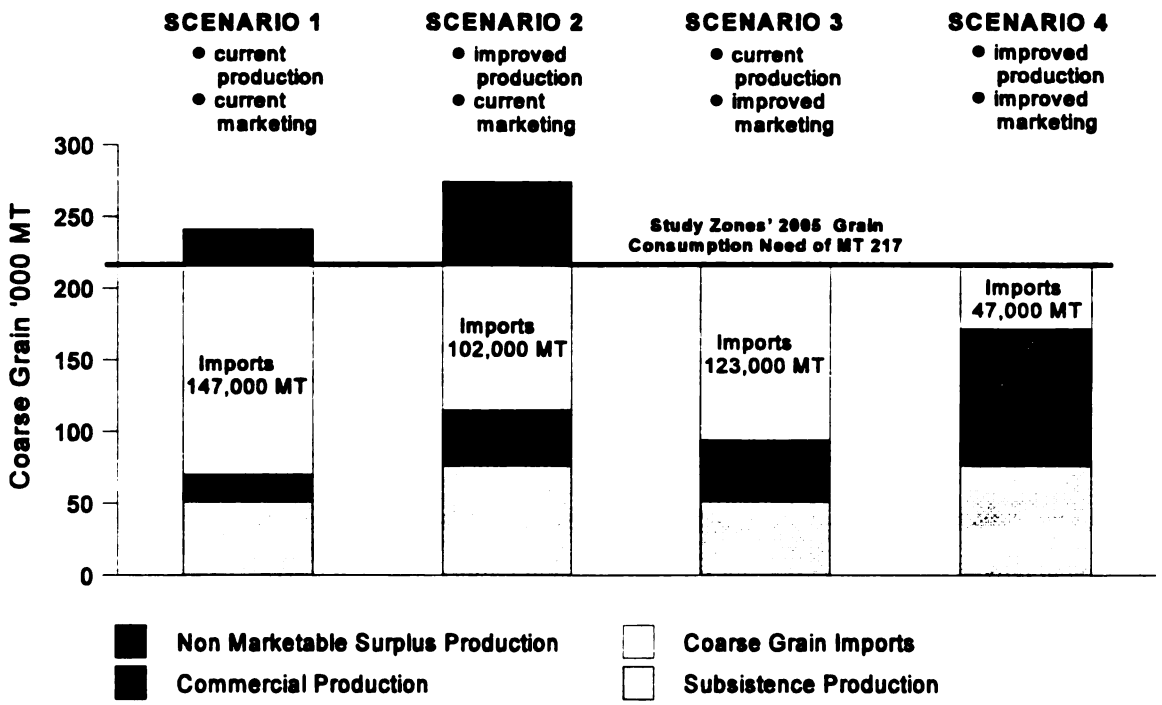
Introducing population growth into the modeling of study zones' grain import requirements alters the perspective from which millet subsector improvements can be judged. So far, the simulation results of Scenario 4 implied that grain imports could be totally substituted with local grain production if subsector improvements could be achieved instantly. However, experiences in other countries have demonstrated that it takes between 10 to 15 years to identify and disseminate improved and sustainable millet production technologies while developing simultaneously an effective grain marketing system. Therefore, it is necessary to estimate grain import requirements based on population figures forecasted for the middle and long run.

Figure 6-15 presents import requirements based on the assumption that the simulated millet subsector improvements could be achieved by the year 2005. In this example, the aggregate demand for grain staples is adjusted to 217,000 tons, assuming that recent trends in population growth continue in the study zones.

Under these propositions, aggregate grain demand can not be covered by local millet production in the future. Even if the "best world" Scenario 4 applies, roughly 20 percent of the estimated grain requirements, or 47,000 tons of grain, have to be imported in 10 years' time. Valuing these import requirements on the

basis of the 1993 import parity price of white maize, foreign currency in the value of US $12.3 million are necessary to balance study zones' grain requirements.[1]

Figure 6-15. Potential grain import substitution based on population estimates for the year 2005 of Ovambo and Kavango



Data Sources: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

* To forecast the aggregate staple grain requirements, the following average population growth rates from 1983 to 1993 are used: Ovambo 3.1 percent, Kavango 2.5 percent.

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[1] On the basis of weighted grain import figures from the USA and South Africa the MAWRD calculated a parity price for white maize of N$ 787.24 per ton. At the exchange rate of 1993, this ton price converts to US-$ 262.

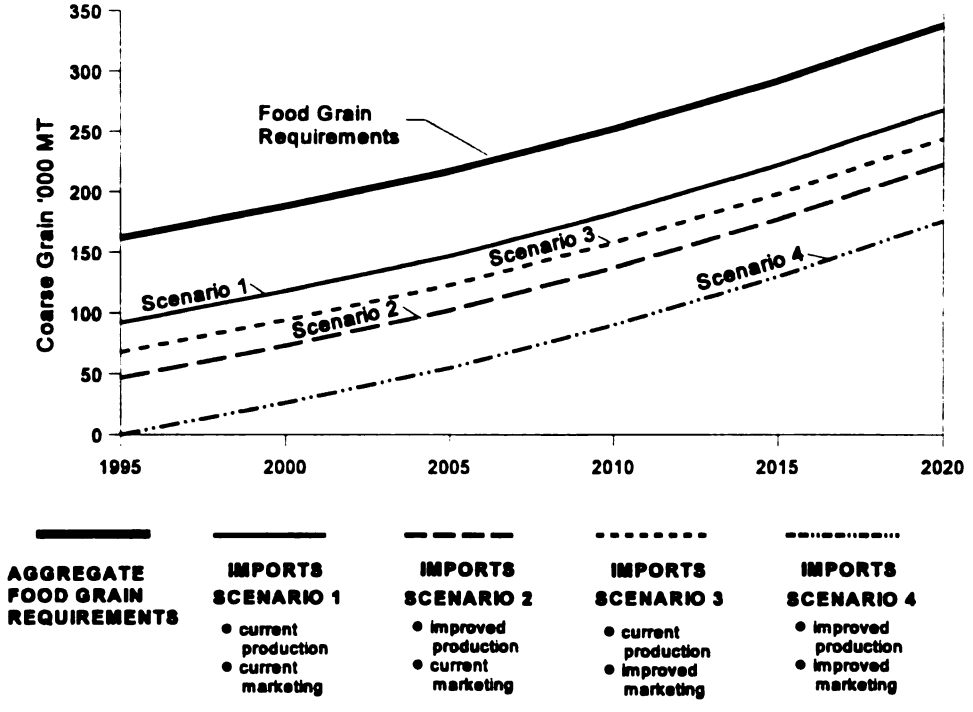
The fact that agricultural policies targeting the improvement of the millet subsector will not be able to fully eliminate Ovambo and Kavango's grain imports in the future might be used as an argument against such policies. To counter such arguments, it is necessary to point out that future grain imports will be significantly higher if no subsector improvements are achieved. Simulation results of Scenario 1 (no sector improvements) for the year 2005 yield a grain import need of 147,000 tons. This is three times the amount estimated under improved subsector conditions in Scenario 4.

Figure 6-16 demonstrates that, in the long run, substantial reductions of grain imports are possible due to millet sector improvements. The thick solid line reflects the increase of food grain requirements over time due to continuous population growth in the study zones. The line of Scenario 1 indicates the amount of food imports necessary if no grain sector improvements take place. The three lines of Scenario 2 through 4 reflect the import needs under the simulated scenarios of millet sector improvements. The line of Scenario 4 shows the trend of grain import requirements for the study zones once all potential millet subsector improvements are achieved.

Finally, to estimate the potential middle term effect that millet subsector improvements in the study zones could have on national grain imports, it is assumed that millet production increases and improvements in the grain marketing structure are achievable within the next 10 years. Figure 6-17 demonstrates the possible development path from the 1995 position of

Scenario 1 to the improved subsector conditions of Scenario 4 reached by the year 2005.

Figure 6-16. Projections of aggregate grain consumption and import requirements for the study zones until the year 2020 based on four millet subsector scenarios* (in '000 MT)

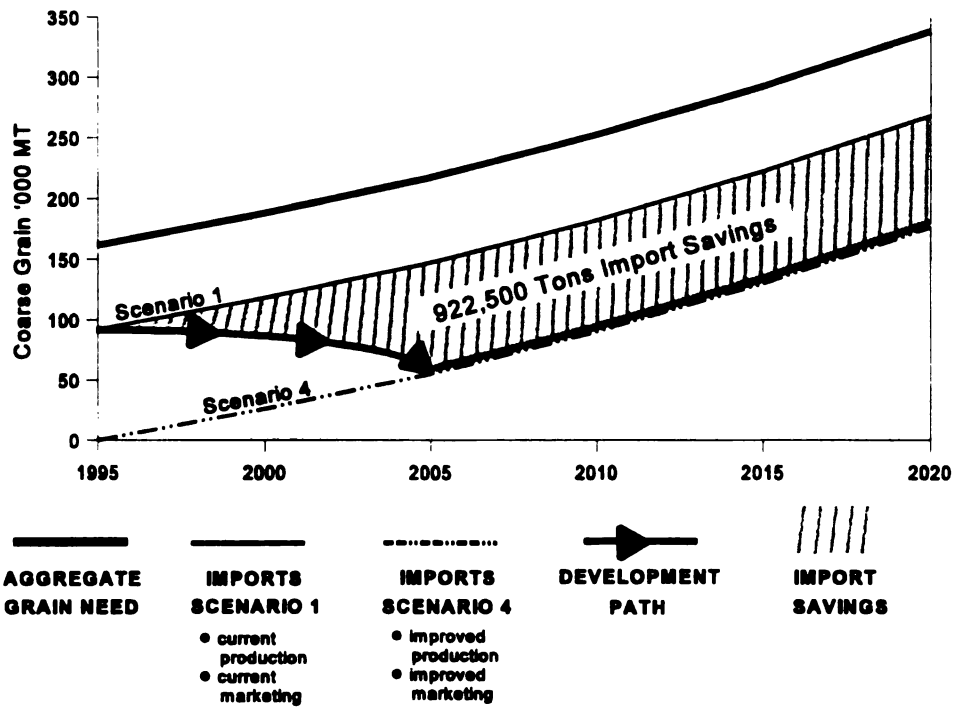


Data Sources: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

The grain import savings achieved through these subsector developments are presented in the shaded area between the two lines. Over the next 10 year until 2005 cumulative import savings are 247,500 tons or US$ 64.8 million (using the 1993 import parity price for white maize). Assuming that no further productivity increases will be achieved in the millet subsector after the year 2005

but population growth rates persist, the cumulative import savings are estimated to be 922.500 tons or US$ 241.7 million by the year 2020.

Figure 6-17. Projections of the potential millet subsector development path and resulting grain import savings for the study zones



Data Sources: Namibian Millet Subsector Research Project, 1992/93 and my own calculations

6.5. Chapter Summary

The chapter summary describes briefly the purpose and structure of the three simulation models established and presents the results of each individual model.

6.5.1. Purpose of the simulation models

The purpose of the simulation models was to determine whether millet subsector improvements such as increases of farmers' millet yields and reductions of farmers' millet marketing costs lead to an significant improvement of the millet subsector performance.

The performance of the millet subsector is measured according to the following parameters: First, the procurement costs of millet meal expressed in percent of unit prices of maize meal observed at rural and urban grain markets in Ovambo and Kavango or predicted for the future at the respective markets (Millet Procurement Model). Second, the number of food insecure households expressed in percent of all rural farm households in Ovambo and Kavango (Household Grain Balance Model). Third, the amount of grain import requirements necessary to balance the aggregate grain deficit in Ovambo and Kavango, expressed in thousands of tons of staple grain imports (Grain Import Substitution Model).

The simulation models are based on primary and secondary data from the Millet Subsector Research Project, 1992/93. The most important millet subsector parameters used in the simulations are as follows: The average millet yield of farmers operating below the average in each zone Ovambo and Kavango can be raised to these averages, while the yields of farmers operating above current zone averages can be raised by 66 percent. It is assumed that the production cost of millet surplus farmers can be reduced from N$ 670 to N$ 420 per ton in Ovambo and from N$ 620 to N$ 370 per ton in Kavango. It is

estimated that improvements in the communal grain marketing system could reduce farmers' transportation/marketing costs of millet by 55 percent in Ovambo and 45 percent in Kavango.

After modeling the mathematical relations between millet subsector parameters and subsector performance measures for each of the three simulation models each model is executed under four different scenarios indicated in Table 6-5.

Table 6-5. Potential improvements of millet subsector parameters and their application across the model scenarios

Improvements	Scenario 1 'base run'	Scenario 2	Scenario 3	Scenario 4 'best world'
Yield increases& production cost reductions	no	**yes**	no	**yes**
Marketing cost reductions	no	no	**yes**	**yes**

Data Source: Namibian Millet Subsector Project Surveys, 1992/93 and my own calculations

Each model is supplemented by simulating a parameter change external to the millet subsector. For the Millet Procurement Model, the possibility of a significant reduction in maize import prices is considered, demonstrating that increased price competition from other production zones in the region could reduce commercialization prospects for the Namibian millet subsector significantly.

For the Household Grain Balance Model increased household cash income indicates that policies promoting off-farm employment opportunities could affect household food security at least as much as policies in the agricultural sector.

For the Grain Import Substitution Model, the increase of staple food demand due to population growth in the study zones is simulated to demonstrate that expected grain import reductions on the national level based on millet sector improvements might only be temporary.

6.5.2. Results of the millet procurement model

The millet meal procurement model attempts to determine which procurement/processing channel is most cost effective and whether improvements of millet production and marketing conditions make millet competitive with maize.

Current millet production and marketing costs (Scenario 1)

The estimation millet meal procurement costs under current, non-improved cost conditions and their comparison with maize meal prices observed in rural and urban food markets in 1993 demonstrates that if small scale hammermills (semi-mechanical small scale processing) are introduced today millet meal could be offered to rural consumers at prices lower than those of maize meal (Ovambo: 19 percent, Kavango: 30 percent).

Separate cost reductions for millet production and processing (Scenario 2/3)

The simulation of reduced cost for millet production and to lesser extent the simulation of reduced millet marketing cost make millet meal competitive for most processing options. However, the outcome is more diverse once the prerequisite for long-term competitiveness is used, i.e., if it is demanded that millet meal prices have to remain competitive even if current maize meal prices are reduced by 20 percent. Now, the only alternative that stays competitive in both study zones is semi-mechanical small-scale processing with hammermills in rural communities.

Results under improved millet production and marketing conditions (Scenario 4)

Scenario 4, simulating reductions in millet production and marketing costs simultaneously, leads to millet meal procurement costs that are significantly lower than those under 1993's subsector conditions. The lowest cost achievable for rural consumers stems from local processing with small-scale hammermills where millet has to be dehulled manually. This option leads to millet meal prices that undercut current maize meal prices in rural Ovambo by 43 percent, and in rural Kavango, by 47 percent.

Except for full-mechanical small-scale milling with a dehuller, all other processing options provide millet meal to rural and urban markets at costs that are 20 percent less than 1993 maize meal prices.

Conclusions

Policy initiatives and agricultural programs to reduce millet production, and marketing costs in Ovambo and Kavango increase millet's competitive position. By far the most cost effective policy initiative is to introduce semi-mechanical millet processing with small-scale hammermills at community level. This solution could be competitive under current subsector cost conditions. Additional advantages from the introduction of small-scale processing technology in rural areas are increased off-farm employment and income opportunities, as well as incentives to organize local grain markets, if not yet existent, close to the processing location.[1]

6.5.3. Results of the household grain balance model

The Household Grain Balance Model investigates how improvements of millet production and marketing conditions in Ovambo and Kavango affect percentage of food insecure households (FIHs) in these zones. The model relates millet production and marketing costs mathematically with household food security. The model identifies households as food insecure if they neither produce enough grain to cover their annual grain requirements nor earn enough cash income to purchase the amount of grain necessary to balance their grain production deficit.

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[1] Zimbabwe's recent policy reforms have stimulated private investments in a large number of small scale mills in rural and urban areas. Namibian policy makers may want to examine Zimbabwe's experience.

Estimations of the base or control Scenario 1 reveal that 38 percent of the farm households in Ovambo and 43 percent of those in Kavango are currently food insecure.

Effects of subsector improvements on the number of food insecure households

The results from Scenario 2 (improved production conditions), Scenario 3 (improved marketing conditions), and Scenario 4 (simultaneous improvements of Scenarios 2 and 3) demonstrate that policies designed to improve the food grain sector in northern Namibia could have a considerable impact on the number of FIHs.

Under the conditions of the 'best world' Scenario 4, the percentage of FIHs is reduced to 23 percent in Ovambo and 27 percent in Kavango. However, translating these figures into absolute numbers, still 139,000 people from Ovambo and 35,000 from Kavango are food insecure. Scenarios 2 to 4 show that improvements in the agricultural sector alone can not overcome severe rural poverty.

Effects of increased off-farm employment on the number of FIHs

To simulate increased off-farm employment in rural areas, farm households' cash earnings are increased by N$ 6000 per year in Scenario 5. This income increase reduces the percentage of FIHs from 38 to 3 percent in Ovambo and from 43 percent to zero in Kavango. This finding reveals that political empowerment and economic development of Namibia's rural majority

has to be pursued in agriculture and non agriculture because grain production accounts for less than 40 percent of food security requirements.

6.5.4. Results of the grain import substitution model

The grain import substitution model estimates potential short and middle term reductions in grain import requirements for Ovambo and Kavango under improved millet production and marketing conditions. Study zones' staple grain requirements are estimated on the basis of FAO data about daily food requirements of individuals and population estimates from the Central Statistics Office in Windhoek.

Results regarding current grain import requirements

It is estimated that under the millet subsector conditions of the year 1993, Ovambo and Kavango have an annual grain import requirement of 92,000 tons. This amount represents 57 percent of the zones' annual food grain requirements.

Potential short-term effects of millet subsector improvements

Holding aggregate food grain demand at the level of 1993 while simulating improvements in millet production and marketing conditions reduces grain import needs dramatically. The simulation of increased production in Scenario 2 reduces aggregate import requirements from 92,000 to 47,000 tons of grain. Reduced marketing costs simulated in Scenario 3 reduce grain import requirements to 68,000 tons. Simulating cost reductions in millet production and

marketing simultaneously leads to 100 percent grain self-sufficiency for the study zones and a marketable millet surplus of 10,000 tons for export.

Potential long-term effects of millet subsector improvements

Unfortunately, the encouraging results from above hold only if the annual population growth rates of 3.1 percent in Ovambo and 2.5 percent in Kavango would drop instantly to zero. Since this seems unrealistic, the simulations of Scenario 2 to 4 are repeated, assuming that current population growth rates persist in the middle and long-term and that it would last until the year 2005 to implement all the millet subsector improvements discussed above.

Now the simulation results reveal a long-term dependency on food grain imports for the study zones. If by the year 2005, the millet subsector could reach the 'best world' Scenario 4, grain import needs would decline from the 1993 level of 92,000 to 47,000 tons. Although dependent on grain imports, it is estimated that if millet subsector improvements are implemented by 2005 a total of 2.5 million tons of grain imports could be saved during the next period of 25 years until 2020.

Conclusions

The population growth, even if it slows down over the next decades, will probably over-compensate for improvements in the millet subsector. Nevertheless, grain import savings due to millet subsector improvements will still be very high in the long run and therefore worth being considered and undertaken as soon as possible.

7. SUMMARY AND CONCLUSIONS

7.1. Background

The continuation of Namibia's grain deficit after independence in 1991 pressured agricultural policy makers for action. Since more than half of Namibia's 1.5 million people were living in the main millet producing zones of Ovambo and Kavango in northern Namibia, the government decided to give priority to the development of the millet subsector. At the same time, ICRISAT announced that its pearl millet variety 'ICTP 8203', which was distributed in Namibia for the 1988/89 cropping season under the name Okashana 1, would enable farmers to double their yield from about 300 to more than 600 kg/ha with local agronomic practices. The head of the Namibian crop research also suggested, that with improved cultivation practices, smallholder could produce 2.4 tons per hectare in the future (ICRISAT, 1991).

Under the impression that an increase in millet yields could soon eliminate the grain deficit, the Ministry of Agriculture, Water, and Rural Development (MAWRD) shifted its attention from production issues to policies to commercialize the millet subsector. It was also assumed that by enabling communal farmers to produce a surplus of millet that could be sold to commercial traders, household food security would improve in the study zones, farmers' cash incomes would increase, and the amount of foreign currency needed for grain imports would decline significantly.

Policymakers in Windhoek also assumed that a commercial grain market was not functioning in the millet production zones. Therefore, the Namibian

Agronomic Board (NAB) proposed to introduce guaranteed producer prices for millet and create a one-channel millet marketing scheme in collaboration with the Namibian Development Corporation (NDC). After careful review of all available information the MAWRD eventually decided that more information about the millet production and marketing system was necessary to formulate an effective grain policy for the communal areas in northern Namibia including an assessment of the long term competitiveness of millet in the national food economy.

In August 1992, the MAWRD initiated the 'Millet Subsector Research Project, 1992/93' in collaboration with International Crop Research Institute for Semi-Arid Tropics (ICRISAT) and with financial support from the German Ministry of Economic collaboration BMZ. The BMZ financed 18 months of fieldwork and 8 months of data analysis by a member of the Agricultural Economics Department of the Michigan State University, USA. The project goals were (a) to collect basic information about the current structure and conduct of the millet subsector, (b) to evaluate the prospects for the commercialization of the millet production, and (c) to recommend alternative ways to assist millet producers in Ovambo and Kavango. (hereafter called study zone)

Between August 1992 and January 1994 four surveys were conducted in the study zones on the household and market level. The data were processed and preliminary research findings were presented at the first national millet subsector workshop in Windhoek. Survey data were subsequently analyzed and a baseline research report was made available at a second national workshop in

November 1994. A final report on millet processing alternatives was completed in February 1995.

7.2. Objectives and data sources

The objective of this dissertation research was to analyze household and market level data collected by the 'Millet Subsector Research Project' in order to address five research questions:

(1) What are the current patterns of millet production, marketing, and consumption in Namibia's most populated regions Ovambo and Kavango?

(2) Which factors determine household production, marketing, and consumption behavior?

(3) What yield increases and reductions in millet marketing cost can be expected for the future based on certain hypothetical scenarios?

(4) How would these hypothetical improvements in the millet subsector affect (a) the number of food insecure households, (b) the price competitiveness of locally produced and processed millet against imported maize, and (c) the need to import maize into the study zones ?

(5) What are recommendations for future grain marketing and food policy research?

Most of the data for this study came from four surveys that were carried out in Ovambo and Kavango between August 1992 and January 1993. One household survey and one field measurement survey were conducted covering the same sample of 320 farm households living in one of 16 survey communities of the study zones. The household survey included three visits to each sample household during different phases of the 1992/93 millet production season: field

preparation, field management, and grain harvest and threshing. Data were gathered on household characteristics, cash income, agricultural production patterns, millet production marketing practices, as well as food consumption and purchase behavior. After harvest, the field measurement survey measured the size of fields on which sample farmers produced millet during the 1992/93 season.

A millet market survey was conducted after the millet harvest in November 1993. This survey targeted commercial grain traders in rural and urban areas of the study zones. The survey investigated whether a commercial millet market exists, and if so, to determine its strengths and weaknesses.

From February 1993 to the end of January 1994, a food price monitoring survey was conducted at 15 communities and at four urban grain markets in the study zones. Prices of millet, maize and other food staples were collected every two weeks at 59 retail outlets. At the beginning of the millet harvest in July 1993, millet producer prices were included in the price monitoring survey.

Secondary data were acquired on rainfall patterns in the study zones, grain production estimates since independence, crop yields on research stations and in on-farm trials, and the costs of processing millet with various processing technologies.

The data from the Millet Subsector Research Project cover the 1992/93 production year. The research findings of this dissertation are based on cross-section analysis because prior to Namibia's independence, time series data were not collected on grain production in communal areas.

7.3. Conduct and performance of the millet subsector

This section presents the five most important areas of research findings concerning the conduct and performance of northern Namibian millet subsector participants with respect to millet production, marketing and consumption. The findings are obtained from the descriptive and regression analyses of the survey data from the 1992/93 production season.

7.3.1. Current and new technologies

Survey farmers' average millet yields from the 1992/93 season are with 200 kilogram per hectare in Ovambo and 250 kilogram per hectare in Kavango close to the average of the only available yield estimates conducted by the MAWRD between 1991 and 1995. The average number of hectares cultivated with grain was 2.9 hectare in Ovambo and 2.5 in Kavango. Aggregate estimates of the MAWRD of the annual millet area indicate that in 1992/93 Kavango farmers cultivated the usual amount of land while farmers from Ovambo cultivated significantly less. The latter can be explained with the late arrival of rains in 1992/93 compared to farmers' experience from the 80s and weakened draft animals in Ovambo, due to the severe drought in the production year 1991/92.

Twenty percent of all farm households in Ovambo use manual labor for all field preparation activities. Less than 1 percent of farmers owned tractors and less than 5 percent used chemical fertilizer. Cattle manure was used in Ovambo where livestock can be kept close to fenced millet fields. In Kavango shifting

cultivation is still a common practice. Fields are unfenced and livestock herds are kept in distant areas.

Contrary to the claim of crop scientists, the survey farmers using Okashana 1 neither increased yields significantly in the direction of 600 kilogram per hectare nor the marketable surplus of millet in comparison to farmers not using Okashana 1. On-farm trials by ICRISAT and Namibian crop scientists during the 1992/93 production season revealed that improved management practices, including the application of chemical fertilizer on traditional varieties, produced significantly higher yields than the cultivar change to Okashana 1. From these on-farm trails it was concluded that farmers using manure or chemical fertilizer and improved agronomic practices could increase their yields by at least 66 percent. The main advantage of Okashana 1 is its early maturity, which is a valuable trait when the rainy season starts late and yields are generally depressed. Survey data revealed that in very short rainy seasons Okashana 1 yielded with an average of 125 kilogram per hectare about 40 percent more than local millet varieties that average only 90 kilogram per hectare.

7.3.2. Household income and grain self-sufficiency

The household surveys revealed that the average annual per capita income (cash plus imputed value of own production) was N$ 480 in Ovambo (US$ 160) and N$ 380 in Kavango (US$ 130). The annual per capita income of Ovambo households that earn off-farm income is N$ 910 compared with N$ 110

for Ovambo households without off-farm earnings. The average annual income per capita in Kavango households with off-farm employment is N$ 710 versus N$ 100 for households without of farm income. Correlation analysis revealed that households' cash income is positively correlated with the use of mechanical plowing service and negatively correlated with manual field preparation. However, regression results indicated that cash income has little affect on households' millet area or yields. The explanation for this is that most of the households earning cash income do not invest money into their millet production in order to turn it to a commercial enterprise but make investments to lesson the burden of manual labor of their own household members.

Although millet is the staple food in the study zones, the surveys reveal it contributes much less to rural households consumption and cash income than originally assumed. For the 55 percent of rural households that have no off-farm income millet contributes an average of 42 percent of farm income. For the 45 percent of farm households that earn income from off-farm employment, millet contributes on average only 10 percent to their total income. This demonstrates that activities outside of agriculture such as school education and off-farm employment have become important.

The surveys reveal that 33 percent of the farm households in Ovambo and 51 percent in Kavango cultivate less than 2 hectares and derive less than a third of total household income from agriculture. This indicates that development programs in the study zones must look beyond the farm toward income and employment creation in rural non-farm activities.

During the 1992/93 production year, 75 percent of Ovambo households and 68 percent of Kavango households in rural areas met less than 30 percent of their household grain needs from farming. As a result most rural households are net grain buyers. Many are too poor to purchase sufficient food to meet their household food needs. An estimated 38 percent of rural Ovambo households and 43 percent of rural Kavango households are food insecure.

7.3.3. Marketable surplus of millet

Seventy percent of the survey farmers in Ovambo sell neither millet to traders nor to neighbors, 30 percent sell millet in years having a good season, and less than one percent sell millet every year. By contrast, 18 percent of Kavango farmers sell millet every year and 54 percent sell millet after good harvest years. Although Kavango's population is only a forth of the population in Ovambo, the aggregate marketable surplus is larger in Kavango than in Ovambo. The 1992/93 household survey does not provide enough data to estimate the amount of millet that farmers barter or sell informally between each other. But survey data about the frequency and the usual amounts per millet sale indicate that the farmers who sell grain sell more often to their neighbors in small quantities rather than selling to commercial traders. The analysis of the millet trader survey indicate that from the estimated 70,000 tons of millet produced in Ovambo during the year 1992/93 only 2,800 tons were sold to commercial grain traders. In the same year about 4,400 tons were sold on the commercial market in Kavango out of a total 15,000 tons millet production.

Based on FAO recommendations for the minimum energy requirements per capita, Kavango and Ovambo needed 153,000 tons of grain for human consumption in 1993. Only 85.000 tons or 55 percent of this requirement could be covered through local millet production during 1992/93. The rest had to be met with grain imports, mainly maize from South Africa. This reveals millet production has to expand significantly if northern Namibia wants to become more food self-reliant in the future.

The long-term potential to increase the marketable surplus of millet is higher in Kavango than in Ovambo. Due to higher annual rainfall and the availability of more fertile land, millet yields are already under current, unimproved production practices higher in Kavango than in Ovambo. An important constraint on the expansion of the millet cropping area in Kavango is that the fertile land along the Kavango river is already under cultivation and most arable land in other areas is difficult to access because rural roads are non existent and drinking water is scarce.

7.3.4. Consumer grain preferences and consumer prices

Most rural and urban consumers from the study zones prefer millet over maize. Seventy seven percent of the surveyed households in Ovambo and 94 percent in Kavango stated they prefer millet over maize. The farmers that do not produce enough grain to cover their household needs try to purchase unprocessed millet informally from neighbors, which is the cheapest source of calories. However, millet is only available in informal markets during part of the

year and the millet offered by commercial grain traders is very expensive. Therefore, many consumers are forced to purchase maize from domestic and imported sources, mainly South Africa.

Although majority of the surveyed farmers perceived millet superior to maize and regression analysis revealed that millet purchases increase with higher cash income the long-term exposure to maize due to lack of millet in the market is shifting rural consumers preference toward maize. In Ovambo were the grain production deficit is larger than in Kavango already twenty percent of the surveyed households claim they got so used to maize that they are indifferent to the consumption of millet or maize. Also, the number of those who claimed they like the taste of a millet/maize mix better than that of pure millet was larger in Ovambo than in Kavango.

None of the survey respondents that stated a preference for maize explained this with the fact that maize is available in meal form while millet can only be acquired in unprocessed form. They rather explained their preference with the continued consumption of maize that made them less used to the taste of millet. But an increasing number of urban consumers is willing to endure long waiting periods to have a local miller process their millet. This is an indication that millet processing will become a more important issue as incomes increase in rural areas.

7.3.5. Constraints on commercial millet marketing

Between 40 and 60 percent of rural farmers in the study zones hire transportation to sell their millet. Survey date for the 1992/93 production year indicate that Ovambo farmers that sell millet pay up to 40 percent and Kavango farmers up to 60 percent of the value of traded millet for transportation. Such high marketing cost are probably the reason why many farmers sell millet only within the boundaries of their community.

Also, between 40 and 60 percent of the study zone farmers do not have access to a local market. During the 1992/93 surveys most of those farmers expressed the need for a place were millet is regularly traded. For the households that are in need of grain but cannot acquire millet from neighbors because of a local millet shortage such markets would allow to make their demand known to farmers with marketable millet surplus and traders. For farmers with marketable millet surplus local markets could provide a simple alternative to the organization of long distance transport of grain to a far distant market. Results from the cross-section logit model regarding farmers' millet marketing behavior also indicate that farmers' proximity to grain markets increases the likelihood of millet marketing significantly.

7.3.6. Angolan millet imports

Since the severe drought in 1991/92, grain traders from urban Ovambo started to import millet from Angola. During the 1992/93 production year, Angola supplied more than a third of Ovambo's total commercial millet trade but only

three percent of the commercial millet trade in Kavango. The Angolan millet supply between 20 and 140 percent cheaper than the millet offered by Namibian surplus producers to commercial grain traders. It originates from the province Huila, Lubango about 500 kilometers north of Ovambo were large-scale commercial farms produce under more favorable climatic conditions than exist in northern Namibia. The following three factors might have contributed to the millet imports from Angola: (1) The war in Angola blocked access to grain markets in towns so that northern Namibia with its millet deficit production became a welcome market alternative. (2) Due to the poor economic state of Angola's economy, its currency was undervalued to such an extent that Angolan agricultural products became competitive in Namibia. (3) The warfare limited south Angola's access to imported goods via Angolan harbors. Thus, the access to consumer goods via trade with northern Namibia became attractive.

Although it is undetermined whether the supply of relatively cheap Angolan millet will continue in the future the fact that countries other than South Africa are supplying grain to northern Namibia indicates that the prospects for Namibia's millet subsector will increasingly depend on its competitiveness with grain imports from South Africa and neighboring countries such as Angola, Zambia, and Zimbabwe.

7.4. Simulation results of policy and technological changes

Three simulation models were used in Chapter 6 to quantify the effects of the development and dissemination of improved millet production technologies

and the improved functioning of the local millet market system on three food policy issues: (1) household food security in the communal north, (2) competitiveness of locally produced and processed millet versus maize meal, and (3) substitution of national maize imports and saving of foreign exchange.

To be able to simulate policy and technological change, the potential increase in farmers' millet yields and the potential reduction in farmers' millet marketing cost had to be estimated. Primary data collected during the 1992/93 household surveys reveal that average millet yields were 240 kg/ha in Ovambo and 260 kg/ha in Kavango. The regression analysis of millet yields indicated that the use of manure or chemical fertilizer increases millet yields by 157 kilogram per hectare on average. This result is in agreement with secondary data from ICRISAT's 1992/93 on-farm cropping trials which indicate that farmers using manure, could increase their yields by up to two thirds if they also adopted improved agronomic practices. From these results it was estimated that yield increases in the future could reduce the average production costs of farmers producing a marketable millet surplus by 40 percent or from N$ 670 to N$ 420 per ton in Ovambo and from N$ 620 to N$ 370 per ton in Kavango. Since the majority of farmers do not have access to manure it was estimated that the introduction of improved production technology would increase average yields by 20 percent in Ovambo and 30 percent in Kavango in the long-term.

The household and market level surveys from the 1992/93 production year demonstrated that farmers' average millet marketing costs add 40 percent to the initial millet production costs in Ovambo and 60 percent in Kavango.

However, the surveys also indicated that farmers who have access to local markets pay about half the amount for marketing of what farmers pay without access to a local market. We further assume that farmers average cost of millet marketing could be reduced by roughly 50 percent if market improvements were made such as organizing local market days, improving roads, and providing market information to farmers and traders.

7.4.1. Millet processing and competitiveness with maize

One of the most important issues with regard to the commercialization prospects of the millet subsector is whether locally produced and processed millet can become competitive with maize that is imported from South Africa and processed by large Namibian milling companies outside the study zones. Until the end of 1993 only few organizations gained some expertise with millet processing with hammermills and the marketing of millet meal. The Namibian Development Corporation had developed a large scale processing operation in Kavango, two farmer cooperatives had used middle scale millet processing, and two NGOs had tested and introduced small scale processing on the community level.

Based on data from the above mentioned enterprises the "Millet Procurement Model" compared alternative millet procurement channel/processing options to identify the most cost effective way to provide processed millet to rural and urban areas in the north. For the model it was assumed that large and middle scale hammermills are located in urban or rural

centers respectively and that the hammermills are combined with mechanical dehullers that remove the grain's shell before the actual milling process. It was also assumed that small scale hammermills are operated in rural communities and that the dehulling of the millet could either be done manually or mechanically.

The base or control scenario of the Millet Procurement Model compared various procurement channels and millet processing options based on 1992/93 production and marketing cost. The results of the model indicated that under current subsector conditions locally produced and processed millet could become price competitive with imported maize meal, if small scale hammermill technology were used at the community level. The model estimates demonstrated that with the introduction of small scale hammermills at the local level millet meal prices would be 19 percent lower than the 1993 maize meal prices in rural Ovambo and 30 percent lower than the 1993 maize meal prices in rural Kavango. The simulation of reduced production and marketing costs for millet producers led to a significant increase in competitiveness of millet that is locally processed with small scale hammermill technology (Ovambo: -43 percent, Kavango: -47 percent). The simulated reductions in production and marketing cost also makes the procurement of millet via middle and large scale millet processing operations competitive with processed maize but to a lesser extent than community based small scale hammermills.

7.4.2. Household food security

On the basis of demographic and production data from the 1992/93 household surveys and FAO recommendations for the minimum energy requirements per capita, the "Household Food Balance Model" estimated that 38 percent of rural households in Ovambo and 43 percent in Kavango were food insecure between 1992/93 and the 1993/94 harvest. The simulation of an increase in millet yields and reduction of marketing costs revealed that policies that improve millet sector performance in the future could reduce food insecure households from 38 to 23 percent in Ovambo and from 43 to 27 percent in Kavango.

An hypothetical increase of household income by an average salary of an unskilled laborer (N$ 6000 per year that allows at 1992/93 prices the purchase of the annual millet consumption requirement of an average household) would reduce the percentage of food insecure households from 38 to 3 percent in Ovambo, and from 43 to 0 percent in Kavango. This finding underlines the importance of non-agricultural employment opportunities for reducing household food insecurity.

7.4.3. Grain imports

The "Grain Import Substitution Model" estimated that the 1995 grain import requirement in Ovambo and Kavango was 92,000 tons or 57 percent of annual food grain requirements. Under the assumption that it will take approximately 10 years to carry out millet production and marketing

improvements and current population growth rates will persist until 2005 (Ovambo: 3.1 percent, Kavango: 2.5 percent) the simulation results reveal a potential decline of grain import requirements from 92,000 tons in 1995 to 47,000 tons in Ovambo and Kavango by the year 2005. This potential reduction in grain imports could generate gross savings of US$ 12.3 million in the year 2005 (on the basis of the 1993 parity price of imported white maize) and cumulative gross savings of US$ 64.8 million from 1995 to 2005.

7.4.4. Constraints on the improvement of the millet subsector

Although the simulation results indicate that increased yields, reduced marketing costs, and cost effective processing technologies could help to achieve some of policy makers' goals for northern Namibia, the general prospects for the millet subsector are not optimistic for the following reasons:

(1) Uncertain rainfall will generate yield instabilities.

(2) Farmers will increase their investments into staple grain production only, if it is perceived to be profitable on a recurring basis. The heavy migration to Windhoek since independence indicates that many would prefer temporary employment in the capital to farming in communal areas.

(3) Okashana 1 has not lived up to the claims of crop scientists. Moreover, improved millet technologies suitable to the varying production conditions in the study zones are not yet identified at this time.

(4) In Kavango, large areas of rain fed land for crop production are unaccessible for small holders because of the lack of rural roads and a reliable source of drinking water.

(5) Grain imports from neighboring countries, such as millet from Angola have added a new dimension to the national food security policy debate. Keeping the boarders open is of obvious benefit to Namibian traders and to net food buyers in Ovambo and Kavango.

(6) Consumers' preference will likely shift from millet to maize as younger consumers become used to maize meal because of the lack of a reliable supply of locally processed millet.

7.5. Implications for millet policy

The research findings reveal that changes in production, marketing, and processing can improve the overall performance of the millet sector and thus improve the living conditions of the rural population in Ovambo and Kavango. However, the constraints described in the preceding section demonstrate the difficult task of decision makers to design a grain policy that on the one side fosters the millet sector development while on the other does not aggravate problems of rural poverty and food security that even an improved millet sector is unable to solve. The four areas to be addressed by policy makers are the following:

7.5.1. Crop production

Although Okashana 1 has not lived up to the initial expectations of crop scientists, it can be of value as a niche variety during short rainy seasons. But more research is needed on existing millet landraces and other early flowering varieties and agronomic practices that are suitable to the varying conditions in the study zones.

Because Kavango's potential for commercial millet production is significantly higher than in Ovambo, the government should give priority to develop local grain markets, improve roads and the supply of drinking water in Kavango.

The survey findings that millet contributes much less to households' consumption and cash income in the study zones, than initially assumed leads to the conclusion that alternative crops should be tested in the study zones and made available to farmers as soon as possible. Crops that might have potential in the study zones are sorghum, groundnut, cowpea, phaselus beans, pigeonpeas, and bambara nut.

The simulation results of the Grain Import Substitution Model reveal that at the current rate of population growth, the study zones do not have the potential to become grain self-sufficient in the medium. From this it is concluded that government policy should focus programs (a) on increasing grain production in alternative production zones, with more favorable rainfall conditions, such as Caprivi in the east and the commercial farming area south of the study zones, and (b) on rural economic development to generate income and employment in the study zones.

7.5.2. Marketing in rural areas

The Namibian government should encourage and facilitate the development of a more market-oriented millet subsector. The government

should not pursue the proposed one channel millet marketing scheme and large-scale processing scheme.

In Kavango were many farmers are producing a marketable surplus, the most severe millet marketing constraints are: a lack of local markets and vehicles, high cost of hired transportation, and long distances to markets. Additionally, traders from urban trading centers complained about difficulties in locating and reaching farmers with marketable millet surplus in remote areas. Rural communities without local agricultural markets should be informed about and encouraged to organize local market days according to their needs to exchange agricultural products among community members and attract long-distance traders. The initiation of local market days will not require any government investment. When local markets become very popular and the trade volume of perishable products increases significantly, investments in physical market structures may become necessary.

The construction of feeder roads will make remote grain production areas (especially in Kavango) more accessible. The encouragement of private taxis and buses help exploit price differences between various areas.

To encourage commercial millet trade between rural communities over long distances (including trade between Ovambo and Kavango), traders need to be better informed about the prices and crop situation in different markets. A feasibility study of a market information service should be carried out. The 1992/93 food price monitoring survey reveals that the gathering of price data could be accomplished in a relatively cheap and reliable manner. Since most

communal farmers listen to the radio on a regular basis, grain market information could be included in radio broadcasts.

7.5.3. Millet processing

In most rural households women have to process millet manually. This is a laborious and time consuming work. In the towns Oshakati and Rundu, an increasing number of consumers are requesting maize processors to process their millet. This is an indication that the demand for millet processing will grow as household incomes increase in rural areas and women's opportunity cost for labor begin to rise.

The government should encourage private traders to invest in small scale millet processing technology. Government could provide training for rural entrepreneurs and farm cooperatives in how to set up and maintain an efficient processing business. The Millet Procurement Model has shown, small scale hammermills can be competitive with imported and processed maize in villages. Some rural development projects have demonstrated that the hammermill technology is adaptable to rural needs and provides an affordable alternative to manual processing. In addition, small-scale mills generate more rural employment than middle and large-scale processing units.

7.6. Attacking rural poverty

Although the expansion of millet production could contribute significantly to the development of northern Namibia, additional policies are needed to address rural poverty and unemployment. Study findings clearly demonstrate that improvements in the millet subsector cannot offer a solution to rural poverty for a significant fraction of the rural population in the study zones. A third of rural households in Ovambo and 51 percent in Kavango cultivate less than 2 hectare and derive less than 33 percent of their total income from agriculture. Therefore, benefits of improved millet production technology will accrue primarily to households with adequate productive resources to produce a marketable surplus.

Rural households with limited resources have to find non-agricultural income sources. While the men of resource poor households tend to look for off-farm employment opportunities in non communal regions, women are largely engaged in activities complementary to agriculture such as raising small animals, dairy processing, handicraft, and trade. Simulation results from the Household Food Balance Model revealed that roughly a quarter of the study zone population would still be food insecure, even if millet production were expanded and the real price of millet were reduced. The implication of these findings is that policies are urgently needed to generate alternative jobs and incomes in the study zones.

7.7. Implications for future research

Three areas warrant further research attention: First, to better determine the prospects for millet, more research is needed on millet technology development and farm management research which could be conducted jointly by the national extension service and the newly established agricultural research department of the MAWRD.

Second, national and international researchers should focus on strategies to enhance the productivity in agriculture and rural economic development programs to (a) create off-farm jobs for men close to their rural homesteads and (b) link women's income generating activities with market institutions that can respond efficiently to consumer demand. Such programs require careful monitoring, evaluation, and re-design in a learning by doing mode of operations.

The third area of research is regional grain trade in the light of recent millet imports from neighboring countries such as Angola, Zambia, and Zimbabwe. Research is needed to investigate the size of this trade potential to determine how improved trade links could affect Namibia's regional and national food security.

APPENDIX A

Table 1. Correlation coefficients of the PLOWHOE variable (use of hoe as sole plowing equipment; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh male headed	-.2444	.000	eastern Kavango	.2107	.021
hh grain self-sufficiency	.2259	.001			
hh earns migration income	-.2010	.004			
migation employment largest income source	-.1982	.006			
percent of hh members literate	-.1418	.047			
hectare yields	-.1742	.030			
larger ha category	-.3239	.000			
1992/93 grain production	-.1820	.010			
eastern Ovambo	.1906	.007			

Table 2. Correlation coefficients of the PLOWANIM variable (use mainly animal spann for plowing; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh grain self-sufficiency	.2259	.001			
own tractor	-.1463	.039			
plan selling of grain at planting time	.2050	.004			
1991/92 grain production	-.1514	.048			
hh judge soil as good	.1655	.019			
western Ovambo	.2377	.001			
central Ovambo	-.2811	.000			
sells millet in some years	.1566	.027			
sells millet never	.1566	.027			
close to market	-.1382	.0.51			

Table 3. Correlation coefficients of the PLOWTRAC variable (use mainly tractor for plowing; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh male headed	.1847	.009	hh grain self-sufficiency	-.1770	.054
hh earns migration income	.2163	.002	hh earns migration income	.2018	.028
hh cash earnings	.2244	.001	hh cash earnings	.2231	.015
migation employment largest income source	.1612	.027	migation employment largest income source	.2159	.025
percent of hh members literate	.2177	.002	percent of hh members literate	.2832	.002
own a motor vehicle	.2504	.000	hectare cultivated in 1992/93	.2214	.035
own a tractor	.2308	.000	more than 5 ha cultivated	.1915	.037
plan selling of grain at planting time	-.1592	.024			
larger ha category	.2271	.004			
central Ovambo	.3469	.000			
eastern Ovambo	-.1961	.005			

Table 4. Correlation coefficients of the DRFTANIMPLOW variable (ownership of draft animals and plow; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh grain self-sufficiency	.1727	.014	hectare cultivated in 1992/93	.2820	.007
larger ha category	.2271	.004	hectare per adult-equivalent	.2438	.020
central Ovambo	.3469	.000	1992/93 grain production	.2871	.002
eastern Ovambo	-.1961	.005			

Table 5. Correlation coefficients of the LANDCONSRT variable (household has problem to cultivate new land; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh male headed	-.1553	.030	hectare cultivated in 1992/93	.2820	.007
hh cash earnings	-.2432	.001	hectare per adult-equivalent	.2438	.020
percent of hh members literate	-.1456	.045	1992/93 grain production	.2871	.002
hh adult-equivalent	-.2390	.001			
hectare cultivated in 1992/93	-.2313	.004			
hectare per adult-equivalent	-.1970	.014			
larger ha category	-.3032	.000			
more than 5 ha cultivated	-.3180	.000			
1992/93 grain production	-.2351	.001			
sells millet in some years	.1712	.017			
sells millet never	-.1712	.017			
close to market	-.2184	.002			

Table 6. Correlation coefficients of the HHLABSHRT variable (household experienced labor shortage; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
western Ovambo	.1880	.009	western Kavango	-.2237	.019

Table 7. Correlation coefficients of the MILLETPRICE variable (local price for millet at the begin of planting; N$/KG)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
uses chemical fertilzer	.3420	.000	difficulties with land clearing	-.2888	.040
central Ovambo	-.2720	.000	owns moter vehicle	-.3150	.022
sell millet some years	- .1916	.008	western Kavango	-.2842	.039
sell millet never	.1916	.008	sell millet never	-.3992	.027

Table 8. Correlation coefficients of the MNRALLFLDS variable (use fertilizer (manure & chemical) on all fields; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh grain self-sufficiency	.1905	.007	hectare cultivated in 1992/93	.2628	.012
own a motor vehicle	.1408	.047	hectare per adult-equivalent	.3307	.001
plan selling of grain at planting time	.1858	.008	more than 5 ha cultivated	.2654	.004
larger ha category	.1890	.018			
1991/92 grain production	.1610	.035			
1992/93 grain production	.1408	.047			
hh judge soil as good	.1887	.007			
western Ovambo	.2123	.003			
central Ovambo	-.2700	.000			
sells millet in some years	.1986	.005			
sells millet never	-.1986	.005			

Table 9. Correlation coefficients of the CHEMUSE variable (use chemical fertilizer; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh grain self-sufficiency	.1404	.052	close to roads	.2011	.030
eastern Ovambo	-.2429	.001	western Kavango	-.2610	.004
			sells millet in some years	.1833	.050
			sells millet never	-.2580	.005

Table 10. Correlation coefficients of theEXPOKASH variable (experience with Okashana 1 before 1992/93; DUMMY, 1 = yes)

OVAMBO			KAVANGO		
Correlated Variable	**Coef.**	**Sig.**	**Correlated Variable**	**Coef.**	**Sig.**
hh male headed	.1804	.011	hectare cultivated in 1992/93	.2608	.013
hh grain self-sufficiency	.3175	.000	hectare per adult-equivalent	.2651	.012
hh cash earnings	.1655	.020	1992/93 grain production	.1941	.035
percent of hh members literate	.2689	.000	central Kavango	.2160	.019
hh adult-equivalent	.1512	.033	close to market	-.3050	.001
own a motor vehicle	.2177	.002			
plan selling of grain at planting time	.1499	.035			
larger ha category	.2590	.001			
hectare yields	.2278	.004			
1992/93 grain production	.1531	.031			
hh judge soil as good	.1430	.044			
western Ovambo	.3537	.000			
eastern Ovambo	-.3038	.000			
sells millet in some years	.2030	.004			
sells millet never	.-.2030	.004			

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