# ECONOMICS OF ON-FARM MAIZE STORAGE IN TANZANIA: THE CASE OF KILOSA DISTRICT

By

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## DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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Dedicated to Amachili Pachelo and Hilda Melkior.

## List of Abbreviations

| Abbreviation | Meaning |
|---|---|
| CIF | Cost, Insurance and Freight |
| FOB | Free On Board |
| EWMU | Early Warning and Monitoring Unit |
| MDB | Marketing Developing Bureau |
| MOALD/KILIMO | Ministry of Agriculture and Livestosk Development |
| FAO | Food and Agricultural Organization of the United Nations |
| GDP | Gross Domestic Product |
| masl | metres above sea level |
| NMC | National Milling Corporation |
| RTC | Regional Trading Company |
| TFNC | Tanzania Food and Nutrition Centre |
| US$ | United States Dollar |
| TShs | Tanzania Shillings ( 1$ = TShs 70.00) |
| MRCU | Morogoro Regional Co-operative Union |
| DADO | District Agricultural Development Officer |
| RADO | Regional Agricultural Development Officer |

List of Abbreviations continued...

| Abbreviation | Meaning |
|---|---|
| BoT | Bank of Tanzania |
| IRR | Internal Rate of Return |
| BCR | Benefit-Cost Ratio |

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## ABSTRACT

This study describes the technological and economic aspects of traditional and improved farm level storage of maize in Kilosa district of rural Tanzania. A brief review of the maize industry in the country is provided. Storage patterns in two survey villages using two different kinds of traditional storage structures are examined followed by a temporal price analysis of the parallel market. An economic and financial appraisal of farm storage improvements is presented. Primary data from the survey villages and secondary data from the Ministry of Agriculture and Livestock Development are the basis for the analysis. The study reveals that farmers store grain mainly for home consumption with the surplus used for sale, seed and other socio-economic obligations. The temporal price analysis shows that parallel market price increases over time resulting from grain supply flactuations are in excess of storage costs. This provides an opportunity for storers to make profits. It is further noted that farmers are aware of rodent and insect pest losses incured in their traditional granaries. Proposed farm level storage improvements aimed at reducing these losses were found to be profitable in terms of parallel market prices. Benefit-cost ratios (BCR) ranging between 1:1 and 4:1

and internal rates of return (IRR) well above the cut-off rate of 18 percent were estimated. To ensure a stable food supply and restrained prices it is recommended that official prices should be made to vary over time to reflect storage costs. The cost-effective improvements proposed in this text may further contribute to the realization of these objectives. To be more effective it is suggested in this study that future on-farm storage improvement programs prefer the multidisciplinary systems approach over the specialists symptomatic approach.

# CHAPTER I.

## INTRODUCTION AND PROBLEM FORMULATION

### 1. Backaround Information

About 80 percent of the population in Tanzania is in the rural sector, and their real incomes depend upon both the level and structure of agricultural production; and on the prices they receive for their products and the prices they pay for consumer goods. From a micro-economic point of view other factors that determine the real incomes include the resource endowments of various individuals and the economics of agricultural production. At the national level the agricultural sector is expected to provide food for the growing population, provide resources (capital and labour) to the other sectors of the economy, to earn foreign exchange and provide market for the agricultural based industries. The major cash crops produced include,coffee, sisal, cotton, cashewnuts, tobacco, tea and pyrethrum. Some of the main subsistance crops are maize, cassava, sorghum, rice, millet, wheat and plantains.

The agricultural sector contributes 40 percent of the Gross Domestic Product (GDP) (World Bank, 1985). The crop exports account for about 80 percent of total export earnings by value. The production of export crops must therefore be increased to earn additional foreign currency. Despite the importance of the agricultural sector, its rate of growth is very low and occassionally declines. The annual rate of growth of food production which is estimated at 3.0 percent (World Bank, op. cit.) is below the annual 3.3 percent population growth rate. As a result Tanzania has experienced in the last two decades intermitent food shortages.

Recently however, a hope of increased crop production and sustained economic recovery at large has been strong as observed by increase in economic growth and per capita income. For example economic growth is currently put at over 3.0 percent in terms of GDP after a decline in real terms of several years. The figure for 1986 was 3.8 percent (Bank of Tanzania, 1987). More significant, is a recent growth in real per capita income. The latest Bank of Tanzania (BoT) figures put it at $290 (equivalent to Tshs. 20,300) ahead compared to the 1984 figure of $ 240 (Tshs. 16,800) in real terms (BoT, op. cit.).

Faulty pricing and marketing policies have been put forward as one of the reasons for the slow growth in food and cash crop production (Keeler, et al., 1982). Although Tanzanian farmers respond enterprisingly and rationally to incentives (Temu, 1977; Bryceson, 1982) the agricultural terms of trade have been unfavourable to them. Coupled with the characteristic low areas under cultivation, low levels of technological inputs, use of manual labour and hand tools and lack of adequate farming capital of the peasants, marketed food supply to feed the urban population decreased tremendously in the last decade.

Given the importance of subsistance agriculture in the economy of Tanzania, several efforts are being made in order to improve the performance of this sector in future. An encouragement to villagers to build their own improved storage facilities on self-help basis is one of these efforts. The farm storage improvements are necessary to minimize the post harvest storage losses. The rural storage projects are undertaken with technical assistance being provided by the government.

In the Tanzanian grain marketing system, rural storage have long been undertaken at peasant level. Storage facilities are not complicated nor elaborate and large. Inherently, certain costs are incured by the storer to ensure for food supply until the next harvest or in expectation of high prices during the lean season if the grain is stored for sale.

## 1.2. Nature and Scope of the Study

Maize storage in Tanzania is practiced at both producer and parastatal level. On-farm storage is actually for domestic food requirements and for speculative purposes. The parastal storage is meant to serve as a stable source of food for the high consumption centres like Dar-es-Salaam and Tanga. But if the country were to depend on Silos, it could take a long time to construct sufficient number. A reasonable equilibrium between the storage at farm level and at the parastatal level was observed in the seventies (Maro, 1976). Recently however, Msambichaka (1982) and the Marketing Development Bureau (MDB) (1986a) noted that the National Milling Corporation (NMC) - the national parastatal empowered with the legal monopoly of purchasing, storing and distributing major staple grains including maize cannot even meet its demand for storage facilities. This implies that on-farm or village storage need be encouraged.

Performance of the private on-farm storage can be evaluated through the study of the benefits and costs involved. The context of this study thus include both the technological and economic aspects. The following microquestions are relevant to the study: what are the alternative methods of maize storage? Is it technically feasible to have on-farm maize storage facilities? What determines the quantity of maize stored? What determines the quantity of maize lost in storage? What portion of maize is stored immediately after harvest? How much do prices flactuate over time? What is the average investment cost of storage facilities in common use today? What is the net income per 90 kilogram bag of maize both before storing and after storing for an average period of time? What are the major problems in maize storage? How can storage costs be minimized? Is it economically feasible to have on-farm maize storage?

These and other related questions are addressed in describing the economics of on-farm storage of maize and in solving for the best actions to achieve increased on-farm storage structures. This will ease the storage burden currently experienced by the National Milling Corporation (NMC).

## 1:3: The Problem

Peasant farmers (in Tanzania) withhold some maize as their food reserves and for speculative purposes (Mphuru and Maro, 1975; Msambichaka, 1982; Keeler, et al 1982; MDB, 1986b). The amount withheld at farm level countrywide is about 80 percent of total grain production (MDB, 1986b). Withholding of maize reduces the supply to the NMC. The reduced supplies brings losses to NMC in monetary terms. This is because the revenues obtained from sales of these low supplies can not cover the purchasing, transport, storing, processing and administrative costs incured by the NMC. To reduce these losses the NMC pushes up the wholesale (and consequently the retail) prices, and at the same time tries to prevent as far as possible the producer prices from rising. This creates a big demand for the producers grain on the private/parallel market. Parallel market traders compete to make up for the demand shortage. The buyers action raises the equilibrium price where supply and demand curves interact . This explains the high prices in the parallel markets.

Much of the grain withheld by the farmer is stored under traditional methods where great losses are experienced. However, lack of knowledge on the actual value of grain losses and the costs involved in peasant storage fail to give policy makers a good base for assessing the performance of the maize industry in Tanzania.

In a perfect market, economic theory with respect to storage suggests that the post-harvest price variation (rise) will equal the cost of storing the grain. It is of interest therefore, to find out whether the increase in price of maize in the private market is greater than the increase in storage costs per bag of grain stored per season.

Official (NMC) maize prices in Tanzania are fixed over time in a season. In the private marketing system however, the selling prices are in accordance with the laws of supply and demand. This is contrary to the state laws. Bearing in mind the inherent costs incured during transportation, processing and storage of grains it is obvious that grain costs need to differ through space, form and time respectively. This study will therefore, evaluate the benefits (losses) obtained to individual farmers and society by keeping the official prices constant within a season.

A pricing system need to ensure compensation to the farmers for storage costs. A possibility of this proposition lies on the need for building of improved grain storage facilities on-farm, and the formulation of a plausible plan of disposing of the grain as occassion demands. This would be a step toward a more rational pricing system.

## 1.4. Objectives of the Study

In the context of this study the primary objective is to evaluate the main economic aspects of on-farm maize storage in the study area. The economic aspects to be evaluated include; price variations over time, average investment costs of storage facilities, net income per bag of maize stored over time and the economic feasibility of farm storage improvements. The specific objectives include:

(i) The determination of storage patterns in the survey villages in terms of incidence of storage; size of storage structures; description of storage structures; purpose of storage; and period of storage. This objective explains first who stores grain in the village. The relationship between size of harvest and size of number of storage structures is also assessed. The description of the storage structures and how this structure is related to storage losses is evaluated. Reasons for storage are prioritized and the average duration of grain storage is also determined. Knowledge of these parameters concerning patterns of storage is used in meeting specific objectives (ii) and (iii).

(ii) An evaluation of the storage costs in terms of storage services and an examination of the rates of return to farmers practicing storage. The significance of storage costs as a factor in explaining seasonal price variations over time is studied. Farmers store maize at a cost. Prices of maize varies over time. The relationship between the two aspects is, according to economic theory, directly related. Based on private market price data over time and storage costs determined in the study this relationship is examined in the study villages.

(iii) The determination of the economic benefits which producers could derive from improved maize storage.
Farmers loose grain under traditional storage. Improvements to minimize these losses involves (monetary) costs. Farmers will only adopt a storage improvement program if the cost of the required improvements is less than or equal to the benefits accruing from the improvement program. This objective allows for the necessary recommendations regarding to the adoption or not of the suggested improvements.

Partly the above objectives will be met through the testing of the hypotheses specified under section 1.5 below.

## 1.5. Hypotheses Under Test

Three hypotheses are tested in this study. The underlying assumption(s) are given under each hypothesis. How these hypotheses are tested and the parameters/variables used in the hypotheses testing are explained in the methodology chapter (IV) below.

(i) Farmers with marketable surplus store grain to take advantage of high prices in the lean season. That is, grain is stored with the incentive of making profits in the lean season. The basic assumption is that farmers are rational producers and respond rationally and enterprisingly to price incentives.

(ii) Post-harvest price 'increase' in the private market equal cost of storage. This hypothesis stems from the assumption that price changes over time are a reflection of costs incured in storing the grain and not because of reduced grain supply over time.

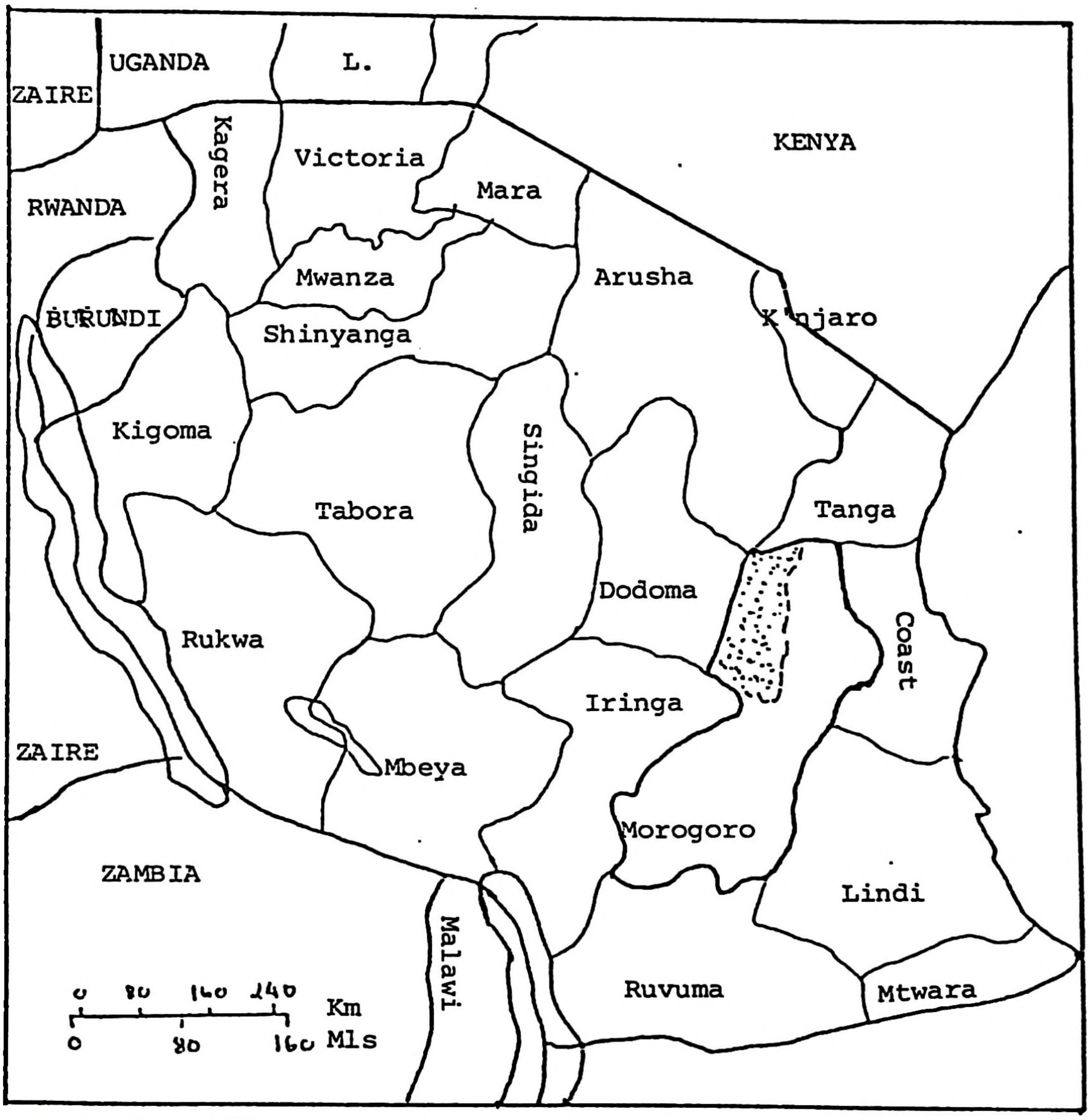
(iii) Locally produced improvements in traditional stores are economically profitable. The assumption is that if total costs of an improvement program are less than or equal to benefits accruing from the program, the (rational) farmer will accept such a program.

## 1.6. Area of Study

The areas chosen for the study are in Kilosa district of Morogoro region (see figure 1.1). This selection is based on two main reasons; first, under favourable weather conditions Morogoro region is one of the main maize producing areas as table 1.1 depicts. The region is one of the nine regions (together with Tanga, Iringa, Tabora, Arusha, Mbeya, Rukwa, Ruvuma and Mwanza) which are considered as the national backbone of maize production in Tanzania. Yearly data show that more than two thirds (71 percent) of the total maize production is produced by the nine regions (Tanzania Food and Nutrition Centre, TFNC 1982; MDB 1986a). The second reason is that maize, which is a staple food in the area of study is also important in other areas with similar climatic conditions. The district also represents different agro-climatic zones with different types of storage practices.

At the time of this study the government of Ireland in conjunction with the Ministry of Agriculture and Livestock Development were implementing a construction of village communal godowns in the district. The objective of the program is to build godowns in each of the 62 villages lacking such structures. On completion, the godowns are handed over to the village. These

Figure 1.1: TANZANIA: SHOWING AREA OF STUDY (KILOSA DISTRICT) IN MOROGORO REGION




Source: Office of the DADO, Kilosa, 1987.

Morogoro regional boundary
Other regional boundaries

Kilosa District

Table 1.1: Tanzania: Regional Maize Production, 1979/80-1984/85

| Region | 1979/80 | 1980/81 | 1981/82 | 1982/83 | 1983/84 | 1984/85 |
|---|---|---|---|---|---|---|
| | | | '000 Tons | | | |
| Dodoma | 68 | 87 | 50 | 40 | 30 | 23 |
| Arusha | 227 | 166 | 129 | 179 | 209 | 127 |
| K'njaro | 50 | 35 | 40 | 58 | 41 | 60 |
| Tanga | 74 | 49 | 24 | 152 | 179 | 60 |
| Morogoro | 141 | 124 | 132 | 128 | 147 | 110 |
| Coast | 15 | 41 | 20 | 25 | 15 | 11 |
| Dsm | 2 | 1 | 1 | 0 | 1 | 0 |
| Lindi | 10 | 19 | 18 | 15 | 4 | 22 |
| Mtwara | 41 | 23 | 13 | 13 | 21 | 22 |
| Ruvuma | 153 | 280 | 208 | 296 | 301 | 142 |
| Iringa | 398 | 457 | 648 | 612 | 699 | 367 |
| Mbeya | 227 | 236 | 230 | 203 | 243 | 240 |
| Singida | 20 | 20 | 34 | 28 | 34 | 23 |
| Tabora | 80 | 80 | 72 | 105 | 105 | 101 |
| Rukwa | 79 | 126 | 102 | 153 | 157 | 160 |
| Shinyanga | 96 | 105 | 38 | 90 | 119 | 286 |
| Kigoma | 45 | 47 | 47 | 79 | 83 | 73 |
| Kagera | 23 | 33 | 25 | 58 | 57 | 63 |
| Mwanza | 102 | 51 | 60 | 86 | 90 | 76 |
| Mara | 36 | 55 | 40 | 15 | 32 | 31 |
| Total | 1787 | 2035 | 1931 | 2335 | 2567 | 1997 |

Source: Tanzania Food and Nutrition Centre, TFNC (In Press).

buildings are used as buying posts for all produce bought by the primary co-operative society on behalf of the respective crop authorities, marketing boards and parastatals. One of these parastatals is the NMC, mainly concerned with purchases of staple grains.

Maize in the survey villages serve as both a staple food crop and a cash crop. Purchases of maize (and indeed other crops) by the NMC are often delayed due to lack of funds and other institutional restraints. These two factors make temporary storage of maize before its despatch to NMC permanent storage sites inevitable. Since this communal storage takes place in the same (village) environment, their inclusion in the analysis provides a chance of comparing their performance with the private local storage structures.

### 1.6.1. <u>Location and Climate of Kilosa District</u>

Kilosa district is located in the North-Western part of Morogoro region. It lies between latitudes $6^{o}$ S and $8^{o}$ S and longitudes $36^{o}$ 30' E and $38^{o}$ E. Most of the area is 500 metres above sea level (masl). The major landforms however, lie between 2000 masl and 7000 masl. They comprise of a vast of almost flat lowland plain known as Mkata plain which cover the whole of the Eastern part of the district. The rest of the land area to the West is occupied by a backbone of uplands that run in South-East-North-Western direction.

Major landforms observed are: flat lowland plain (2000 masl); the valley bottom lands (2000 masl); the andulating lowland plain (2000 - 3000 masl); the low altitude hills (3000 - 4000 masl); the rolling upland plain (4000 - 5000 masl); and the mountain ranges (5000 - 6000 masl). The topography and the underlying parent material seem to govern the types of soils and their productivity levels. The soils range from dark -reddish-brown to red sandy loams in most parts and sandy clays in the valleys. The vegetation is complex but miombo woodlands and savannah grasses predominate. The vegetation is a favourable habitat for tsetse flies which inhibit livestock raising in most parts of the district. Table 1.2 shows the monthly rainfall distribution for the 1985/1986 cropping season. Tables 1.3 and 1.4 show the monthly rainfall distribution for the two divisions (that is Ulaya and Gairo) chosen for the study (see figure 1.2). It is observed that rain in the district is experienced for an average of 8 months (October - May) with the highest levels in between February and March. The pattern and amount of rain allow mainly for one crop of maize per cropping season.

Land tenure and farming systems is reflected in

Table 1.2: Kilosa District: Monthly Rainfall Distribution, 1985/86

| Amount | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm | | | | |
| Average | 36 | 78 | 142 | 142 | 125 | 201 | 217 | 74 | 1028 |
| 1985/86 | 0 | 80 | 148 | 216 | 90 | 191 | 136 | 60 | 922 |

Source: Office of the DADO, Kilosa district monthly reports.

Table 1.3: Ulaya Division: Monthly Rainfall Distribution, 1985/86

| Amount | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm | | | | |
| Average | 89 | 124 | 179 | 103 | 72 | 99 | 203 | 88 | 957 |
| 1985/86 | na [1 | 192 | na [1 | 110 | 48 | 199 | 281 | 38 | 868 |

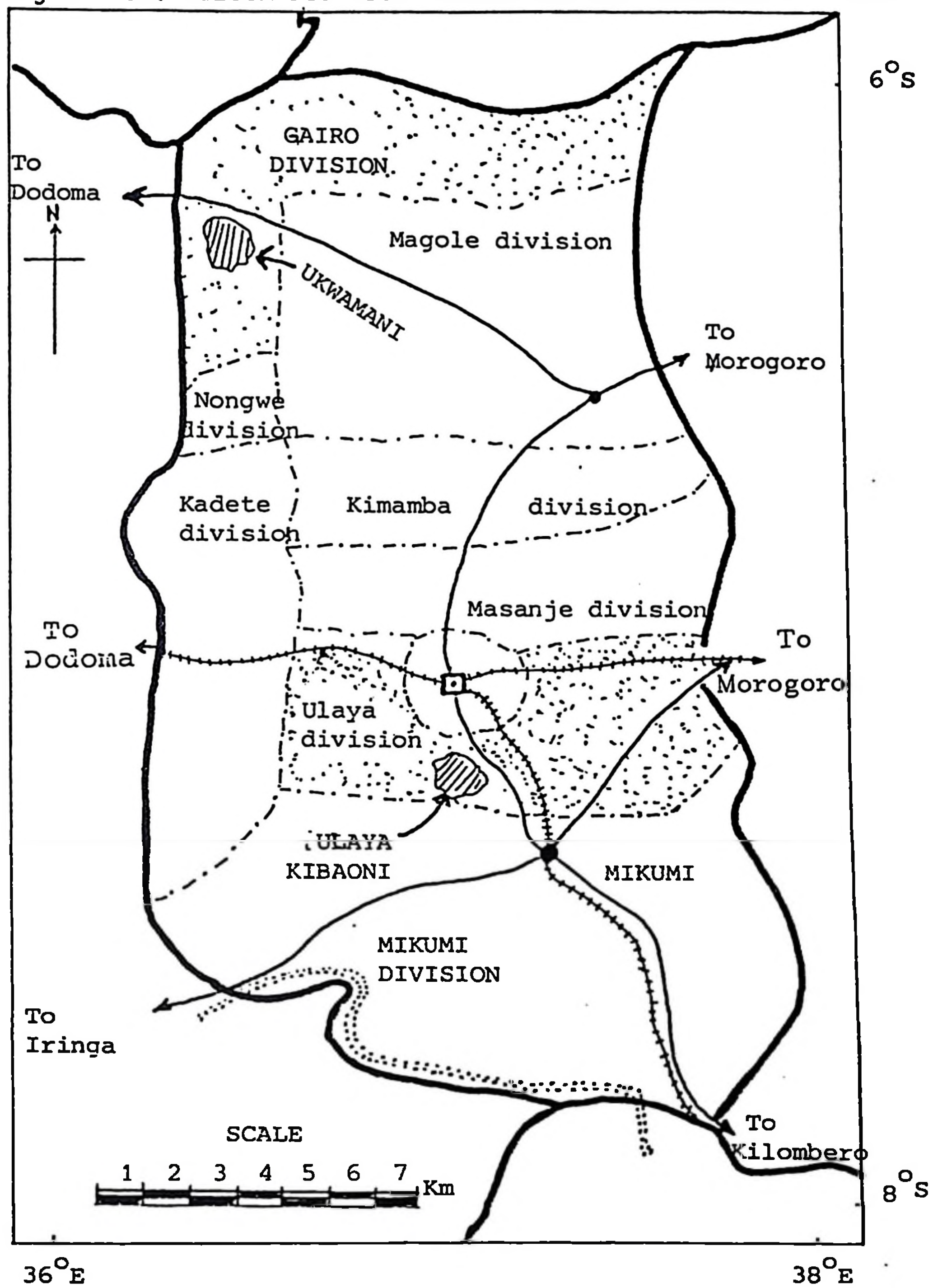
Source: Office of the DADO, Kilosa district monthly reports.
[1 na means figures not available

Table 1.4: Gairo Division: Monthly Rainfall Distribution, 1985/86

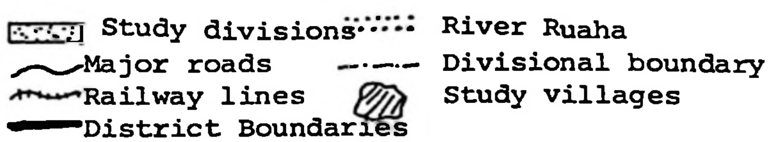
| Amount | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | mm | | | | |
| Average | 21 | 43 | 92 | 65 | 96 | 42 | 77 | 49 | 485 |
| 1985/86 | 12 | 22 | 43 | 77 | 71 | 42 | 72 | 45 | 385 |

Source: Office of the DADO, Kilosa district monthly reports.

Figure 1.2. KILOSA DISTRICT: DIVISIONS AND VIILAGES OF STUDY




Source: Office of the DADO, Kilosa, 1987.



the fact that land is a public commodity. The village government regulates the distribution and ownership of land as provided for under the Village and Ujamma Village Act of 1975. Most cultivation is done by the hand hoe. Crops grown as sale crops include sisal, cotton, rice, maize, coconut and sunflower. Those grown either in mixed cropping or monocropping are maize/legume, sorghum/legume, cassava/legume, bulrush millet/sorghum and maize/legume/cassava. The legume crops include cowpeas, pigeon peas and green grams.

The district population was 2.8 million people in 1978 with an annual growth rate of 2.9 percent (TFNC, 1982). There are three original tribal groups. The Northern part is inhabited by people of Wakaguru origin. The central zone is occupied by Wasagara, while the southern zone is inhabited by Waridunda. Most of the villagers however, are currently multi-tribal in composition.

### 1.6.2. Villages Selected for the Study

Most of the information put hereunder was obtained from the Kilosa DADO office. There were two villages which were selected for this study, that is Ulaya Kibaoni of Ulaya division in southern Kilosa and Ukwamani of Cairo division in Northern Kilosa, figure 1.2 refers. This selection was based on the types of storage structures used in the two villages.

While farmers in Ulaya division use the "chanja", those in Gairo division use the "chidong'a" structure. Farmers in Central Kilosa use either of these two dominant structures. These structures are explained under section 5.3.4 in chapter V.

Ulaya Kibaoni is situated 20 kilometres south of Kilosa town. It has a population of 2,000 people. It is a typical Sagara peasant village. The absence of a big external market for food crops, make the cultivation of the main food crops to be mainly for subsistance. Both cultivation and storage are therefore based on local practices; and, modern methods of cultivation are gradually being adopted. The main crops excluding the traditional cash crops (like cotton), are maize and rice. Other crops grown are cassava, cowpeas, pigeon peas, sorghum, bananas, sugarcane and coconuts. Storage is mainly carried out with maize. All other farm products are normally consumed, with only the quantity needed for seed reaching the next growing season.

Ukwamani village is 150 kilometres West of Dar-es-Salaam along the Dar-es-Salaam - Dodoma highway. It is a Kaguru village with a popultion of 1,700 people. The village has adopted to a large extent commercial production and storage practices. Storage practices are carried out as a result of high production levels. The crops mainly stored are maize and sorghum. Other crops grown are bulrush millet, sunflower, beans, cassava and groundnuts. Livestock are also raised. These include; cattle, sheep and goats.

## 1.7. Plan of Study

The main objective of this study is to evaluate the main economic aspects of farm storage, based on technological bearing in terms of patterns of maize storage. This evaluation is partly realized by testing three hypotheses set forth on the basis of storage costs and grain prices over an average period of storage. Two villages from the district are chosen. This choice is based on the different types of storage structures used in the villages. The differences in the structures used provides an opportunity for comparing their performance. Morogoro region is also potentially a big maize producer. Both primary and secondary data are utilized to effect the study.

Chapter II of the study outlines the importance of maize in Tanzania and it explains how this grain features in the economy of the country. Literature review regarding storage and farm storage in particular is narrated in chapter III. Chapter IV reviews the methodology used. Parameters used in the analyses, data sources and the means utilized in attaining the data are explained in this chapter.

Chapter V presents and discusses the empirical evidence from the research. Finally summary of results and policy recommendations based on the study are outlined in chapter VI.

# CHAPTER II

## THE IMPORTANCE OF MAIZE IN TANZANIA

### 2.1 Introduction

Maize, rice and wheat are the most important cereal crops grown in Tanzania and form the major sources of food in the country. Maize and rice are produced mainly by smallholders while production of wheat is confined to state owned farms. Maize and rice are marketed through the official marketing organization, that is , the Co-operative unions and the NMC. A large portion of maize and rice production is consumed directly by the farmers.

Maize is produced almost entirely from rainfed areas, mostly by small and middle scale farmers. Some large scale producers grow maize in Iringa, Mbeya and Arusha regions. In order to understand how maize fits in the general economy of Tanzania, it is necessary to understand its importance relative to other food crops, and to look at how much of the crop is consumed on-farm, how much is sold through co-operative unions, NMC, and other channels. This chapter attempts to explain the production, supply, demand and institutional arrangement of the maize grain in the country. For purposes of comparison other staple foods (mainly rice and wheat) are where necessary, included in the explanation.

## 2.2 Production Trends and Share of Smallholder in Maize Production

The outlook of the development of maize production over past years is a reflection of increase in hectarage and the productivity per land unit. However, total maize production trends during the past two and a half decades indicate fluctuations.

According to MDB, (1986 a) of the Ministry of Agriculture and Livestock Development (MOALD) 1985/86 recorded the highest national maize harvest of 2127 thousand tons for the period between 1973/74 and 1985/86 (table 2.1).

The figure for rice (496 thousand tons) is also the highest for the same period. Increased levels of production for these cereals can be attributed to the increased participation of smallholders as a result of the price incentives and increased inputs availability provided by the government from 1980/81 when the Structural Adjustment Program (SAP) aimed at revamping the economy was launched. The MOALD (1984) estimated that the annual growth rates in output for the period between 1973/74 and 1982/83 were 3.7 percent for maize, 7.4 percent for rice and 7.7 percent for wheat. The relative contributions of area expansion and the productivity per land unit to overall growth in output are shown in table 2.2 below.

Table 2.1: Tanzania: Estimated Production Figures for Maize, Rice and Wheat, 1973/74 - 1985/86

| Production year | Crop | | |
| --- | --- | --- | --- |
| | Maize | Rice | Wheat |
| | '000 Tons | | |
| 1973/74 | 1761 | 223 | 85 |
| 74/75 | 1367 | 265 | 82 |
| 75/76 | 1449 | 346 | 69 |
| 76/77 | 1664 | 314 | 64 |
| 77/78 | 1465 | 387 | 55 |
| 78/79 | 1720 | 262 | na |
| 79/80 | 1726 | 291 | 87 |
| 80/81 | 1500 | 200 | na |
| 81/82 | 1654 | 320 | na |
| 82/83 | 1651 | 350 | 58 |
| 83/84 | 1939 | 356 | 74 |
| 84/85 | 2067 | 425 | 83 |
| 85/86 | 2127 | 496 | 71 |

source: MDB (1986 a), table 4, page 9.

Table 2.2: Sources of Growth of Output for Maize, Rice and Wheat, 1973/74 - 1982/83

| Crop | Output | Area | Yield |
|---|---|---|---|
| | ................ | %[1] ........................ | |
| Maize | 3.7 (100) | 1.3 (35) | 2.4 (65) |
| Rice | 7.4 (100) | 2.8 (38) | 4.6 (62) |
| Wheat | 7.7 (100) | 5.6 (73) | 2.1 (27) |

Source: Ministry of Agriculture and Livestock Development, MOALD (1984), table 2.11, p 43.

[1] Figures outside paranthesis are the annual rates of growth; those within show the contribution of areas and yield to the total output growth.

The ministry has projected that there will be a substantial production increase of about 39 percent in the long run up to year 2000 (MOALD, 1984). This will be achieved through an area expansion of over 14 percent and a yield increase of 22 percent. The advance will be based on research and development work. Ruvuma, Rukwa, Iringa, Mbeya and Morogoro regions will get special attention as far as maize production is concerned.

Smallholders in Tanzania play a central role in food crop production and agriculture in general. For example, TNFC, (1982) estimated that the total smallholder areas under cultivation for maize, rice and wheat in 1980/81 were respectively 1090 thousand hectares, 160 thousand hectares and 32 thousand hectares. The corresponding total areas under cultivation were 1101 thousand hectares, 170 thousand hectares and 42 thousand hectares. Table 2.3 indicates that in the 1980/81 cropping season smallholders contributed about 99 percent of total maize production and about 96 percent of marketed production.

Table 2.3: Share of Smallholder in the Production of Maize, Rice and Wheat, 1980/81

| Crop | Indicator | | | | |
|---|---|---|---|---|---|
| | Small-holders | Cultiv-ated area | Mean farm size | Total Prod-uction | Marketed Product-tion |
| | '000 No. | '000 Ha. | Ha. | % | % |
| Maize | 1150 | 1090 | 1.0 | 99 | 96 |
| Rice | 320-400 | 160 | 0.5 | 92 | 55 |
| Wheat | 5-10 | 32 | 0.5-100 | 70 | 36 |

Source: Extracted from TFNC (1982), table 1.10 , p. 33.

## 2.3 Economics of Maize Production in Morogoro Region - A Gross Margin Analysis

Cost of production is a major factor in determining appropriate producer prices for food crops under government price setting. The aim of the government is to ensure that farmers receive a fair return for their labour. In the parallel market however, prices are determined by market supply and demand forces. In this section gross costs of production and gross returns to labour in smallholder production in Morogoro region are estimated for maize. The estimated costs of production and returns to labour presented hereunder are based on two recent MDB publications and the 1982 Work calender for Morogoro region. Because of the slight diversity in production methods, cropping patterns, soil characteristics and rainfall throughout the region, these estimates might not be representative for the region, (and indeed the district and study villages) as a whole. However, it is hoped that the cost of production estimates provided here might be a good basis for understanding of returns to labour for maize.

As noted above returns to labour vary widely due to differences in production practices and differences in market prices. For example, in some parts of the region (including the research sites) there are two cropping seasons for maize. However, the area under cultivation (and hence the yield) for the first crop is so small to bear any significant alteration in these estimates. Tables 2.4 and 2.5 show the estimated returns to labour for maize in pure stand for typical smallholder and for improved smallholder in Morogoro region. Estimated costs and returns in these tables also show that the returns to labour differs greately between the NMC and the open markets. This is caused by the differences in producer prices offered by the two markets. While the average regional open market price for maize was TShs. 12.30 per Kilogram for the 1985/86 cropping season, the official price was TShs. 6.40 per kilogram. It is noted for example that for a typical smallholder the return per labour day was Tshs. 43.28 in terms of the NMC and Tshs. 88.67 for the open market at the same inputs level. The repective returns for an improved smallholder were Tshs. 61.59 and Tshs. 149.00. The differences in the returns per labour day between typical and improved smallholder is also explained by the total number of labour inputs which are 78 man-days for the typical smallholder and 135 man-days for the improved smallholder.

Table 2.4: Morogoro Region[1] : Gross Margin Analysis; One Hectare Maize pure Stand, Typical Smallholder 1985/86

| Item[2] | Type of market | |
|---|---|---|
| NMC | NMC | Open |
| Labour | Man days | |
| Land preparation | 7 | 7 |
| Planting | 6 | 6 |
| Weeding | 44 | 44 |
| Fertilizer | - | - |
| Harvesting/ Shelling | 16 | 16 |
| Marketing | 5 | 5 |
| Total | 78 | 78 |
| Costs | TShs | |
| Seeds | 190 | 190 |
| Fertilizer | - | - |
| Bags | 152 | 152 |
| Tools | 122 | 122 |
| Transport | - | - |
| Total | 464 | 464 |
| | Kg | |
| Yield per Ha. | 600 | 600 |
| | TShs. | |
| Price per Kg | 6.40 | 12.30[3] |
| Realization per Ha. | 3840.00 | 7380.00 |
| Gross margin | 3376.00 | 6916.00 |
| Return per labour day | 43.28 | 88.67 |

Source: Modified from MDB (1986a), Table 28, p.51.

1 Morogoro region is considered as a medium potential region.

2 Only variable costs are considered.

3 Based on an annual open market average price of TShs. 1107.00 per 90 Kg bag.

Table 2.5: Morogoro Region: Gross Margin Analysis; One Hectare Maize Pure Stand, Improved Smallholders, 1985/86.

| Item | Type of market: NMC | Type of market: Open |
|---|---|---|
| | Man days | |
| Labour | | |
| Land preparation | 5 | 5 |
| Planting | 10 | 10 |
| Weeding | 50 | 50 |
| Fertilizer | 1 | 1 |
| Harvesting | 45 | 45 |
| Threshing/shelling | 10 | 10 |
| Bagging/stocking | 4 | 4 |
| Walking | 10 | 10 |
| Total | 135 | 135 |
| Costs | TShs. | |
| Hired labour | 1125 | 1125 |
| Tractor | - | - |
| Seeds | 165 | 165 |
| Fertilizer | 2922 | 2922 |
| Bags | 152 | 152 |
| Tools | 121 | 121 |
| Total | 4485 | 4485 |
| | Kg. | |
| Yield per Ha | 2000 | 2000 |
| | TShs. | |
| Price per Kg. | 6.40 | 12.30 |
| Realization per Ha. | 12800.00 | 24600.00 |
| Gross margin | 8315.00 | 20115.00 |
| Return per labour day | 61.59 | 149.00 |

Source: Modified from MDB (1986 a), table 29, p.52.

2.4 Màize Supply Trends (NMC Purchases)

The supply or sales patterns to a large extent reflect the production systems. Due to the large share of smallholders in maize production, the marketing system is faced with extremely dispersed supply structure, except in some parts of the southern highlands. The high number of smallholders and the fact that maize is a food crop mainly grown for subsistance, implies that only a small portion of the quantity produced is legally sold as a surplus to quantities consumed at household level. For example, MDB (1986a) estimated that for Tanzania mainland as a whole, only 8.4 percent (178.5 thousand tons) of the estimated 1985/86 (1,067 thousand tons) production was marketed through official channels, see Table 2.6. Official purchases are much more important in relatively isolated surplus regions such as Rukwa and Ruvuma. Other surplus regions which are near high consumption centres experiencing intermittent shortages like Dar-es-Salaam, market even lesser portions of their surplus through official channels and sell most of their surplus on the open market. Furthermore, the low levels of NMC purchases can be explained by the low prices they offer to the farmers relative to the parallel market prices.

Purchases of maize, rice and wheat by NMC and it's predecessor, the National Agricultural Products

Board (NAPB), since 1970/71 are shown in Table 2.6. Maize puchases doubled from 90 thousand tons in 1985/86 to 175 thousand tons in 1985/86. Maize purchases in 1985/86 shot up to 178.5 thousand tons, the highest level since 1978/79. A bumper harvest and low prices on the open market brought many farmers back to the offical channels as predicated by the gorverment (MOALD, 1984).

The seasonal pattern of supply follows the pattern of harvest times. Variations between years may be considerable depending on the timing of the rains. Major determinants of the seasonal and regional supply patterns are the diversified production conditions in Tanzania. Another important factor is as noted above, the high proportion of smallholder production which leads to extremely dispersed supply structure. This dispersed structure is unstable because the domestic (household) demand for maize intensifies the effects of weather conditions on harvests. Bad harvests, result in decline in market output because domestic requirements must first be satisfied. Market supply in these cases is a residual of domestic demand.

Table 2.6: <u>NMC Purchases of Maize, Rice and Wheat, 1970/71-1985/86</u>

| Marketing Year | Crop | | | | | |
|---|---|---|---|---|---|---|
| | Maize | | Rice | | Wheat | |
| | '000 Tons | %[1] | '000 Tons | %[1] | '000 Tons | %[1] |
| 1970/71 | 186 | na | 61 | na | 43 | na |
| 71/72 | 43 | na | 45 | na | 57 | na |
| 72/73 | 106 | na | 48 | na | 47 | na |
| 73/74 | 74 | 4.2 | 39 | 17.5 | 28 | 35.3 |
| 74/75 | 24 | 1.8 | 15 | 5.7 | 14 | 17.1 |
| 75/76 | 91 | 6.3 | 12 | 3.5 | 25 | 36.2 |
| 76/77 | 128 | 7.7 | 15 | 4.8 | 27 | 42.2 |
| 77/78 | 213 | 14.5 | 35 | 9.0 | 35 | 63.6 |
| 78/79 | 220 | 12.8 | 34 | 13.0 | 29 | na |
| 79/80 | 162 | 9.4 | 30 | 10.3 | 27 | 31.0 |
| 80/81 | 105 | 7.0 | 14 | 7.0 | 28 | na |
| 81/82 | 89 | 5.4 | 15 | 4.7 | 23 | na |
| 82/83 | 86 | 5.2 | 21 | 6.0 | 31 | 53.4 |
| 83/84 | 71 | 3.7 | 22 | 6.2 | 28 | 37.8 |
| 84/85 | 90 | 4.4 | 12 | 2.8 | 33 | 39.8 |
| 85/86 | 179 | 8.4 | 16 | 3.2 | 50 | 70.4 |

Source : MDB (1986 a), table, p.10.

[1] compiled on basis of figures from Table 2.1.

## 2.5 Maize Demand Patterns and Inter-Regional Trade

Maize is a major staple food crop particularly for the low income sections of the population (Mrema, 1984). The Ministry of Agriculture and Livestock Development, MOALD (1984) estimated the average per capita demand for maize to be 411 grams per day in 1980. The projected demand for year 2000 is 444 grams per day. This is in line with the projected growth rate of 8.0 percent. Maize is the dominant source of calories and MDB (1986a) data indicates that it accounts for about 61 percent of total calorie intake (Table 2.7 refers). In urban areas the percentage is somewhat lower.

Maize demand has been growing throughout the country through population pressure and changing preferences, but as noted earlier official maize production has become increasingly concentrated in a few agriculturally high potential regions. The demand for maize at national level is expected to rise from 1,557 thousand tons in 1980 to 3,059 thousand tons in year' 2000, an increase of about 3.4 percent. Table 2.8 indicates that this projected rate of growth in demand is lower than the projected growth rate of demand for wheat (6.2 percent) and rice (4.8 percent). This is obviously expected since maize is likely to produce more calories per hectare than other crops as the table depicts.

Table 2.7: Tanzania: Overview of Total Available Staple Food Consumption and Maize, Rice and Wheat Markets, 1986/37

| Type of food | Indicator | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rural calories from staples [1 | Urban calories from staples [1 | Total calories from staples | Total production | Marketed production [2 | | Marketed through co-operatives | | Marketed through open market | |
| | | | | | Proportion of total | Total amount | Proportion of total | Total amount | Proportion of total | Total amount |
| | % | | | '000 Tons | % | '000 Tons | % | '000 Tons | % | '000 Tons |
| Maize | 62 | 53 | 61 | 2128 | 25 | 532 | 9 | 191 | 16 | 341 |
| Paddy [3 | 8 | 24 | 10 | 497 | 50 | 248 | 3.5 | 17 | 46.5 | 231 |
| Wheat | 0 | 2 | 1 | 70 | 75 | 53 | 63 | 45 | 12 | 8 |
| Sorghum/Millet | 8 | 6 | 8 | | | | | | | |
| Cassava | 13 | 11 | 12 | | | | | | | |
| Potatoes [4 | 5 | 3 | 5 | | | | | | | |
| Bananas | 4 | 2 | 4 | | | | | | | |
| Total [5 | 100 | 100 | 100 | | | | | | | |

Source: MDB, (1986 a), Table 1, p.4.

[1 Foods were converted to calories using a FAO food composition table.
[2 The remaining amount was consumed domestically (by households)
[3 All in paddy equivalent(67% paddy to rice conversion).
[4 Includs sweet potatoes, round potatoes and yams.
[5 100% by definition; sum of percentages may differ slightly due to rounding.

For maize, throughout 1961-1980, there has been a constant supply shortage, with the exception of 1966 and the period between 1976 and 1980, when the crop requirement was met. Since majority of Tanzanians live and work in rural areas, the demand there far exceeds the urban demand. However, a pressing need for food grains is more noticeable in urban areas where almost the entire population depends greatly on the NMC for it's purchases. The increase in population in the urban areas (caused by the rural-urban drifts) seem to have led to an increase in demand for food marketed through offical channels.

There is a lively inter-regional trade of food commodities in the mainland Tanzania. Part of this trade, notably for all uncontrolled products, is perfectly legal. Most of the inter-regional trade of controlled products like maize is however, illegal since it is against the law.

For maize the main surplus regions comprising Iringa, Mbeya, Rukwa and Ruvuma supply most of the country. Rukwa supplies the North-Eastern regions. These regions also receive maize from Kilimanjaro and Arusha and occassionally from Urambo in Tabora region. Urambo also supplies Kigoma. Mbeya and Iringa send most of their surplus to Dar-es-Salaam and Morogoro while Dodoma is being supplied by

Table 2.8 : Estimated Growth of Consumption of Major Food Items, 1980 - 2000

| Crop | Consumption year 1980 | 1985 | 1990 | 2000 | Annual growth rate 1980 - 2000 |
|---|---|---|---|---|---|
| | ------------ | '000 Tons | ------- | | %[1] |
| Rice | 333 | 403 | 525 | 830 | 4.8 |
| Maize | 1557 | 1844 | 2191 | 3059 | 3.4 |
| Millet | 334 | 394 | 462 | 638 | 3.3 |
| Sorghum | 478 | 560 | 651 | 873 | 3.3 |
| Wheat | 107 | 139 | 199 | 357 | 6.2 |
| Cassava | 950 | 1116 | 1316 | 1855 | 3.4 |
| Bananas | 1763 | 2032 | 2325 | 3059 | 2.8 |

Source: Ministry of Agriculture and Livestock Development, MOALD (1984), table 6, p.15.

[1] Calculated from the formula

$$r = \left[ \left(\frac{C_n}{C_o}\right)^{1/n} - 1 \right] \times 100$$

where, $r$ = Annual growth rate.

$C_n$ = Consumption in year 2000

$C_o$ = Consumption in year 1980

$n$ = Number of years = 20

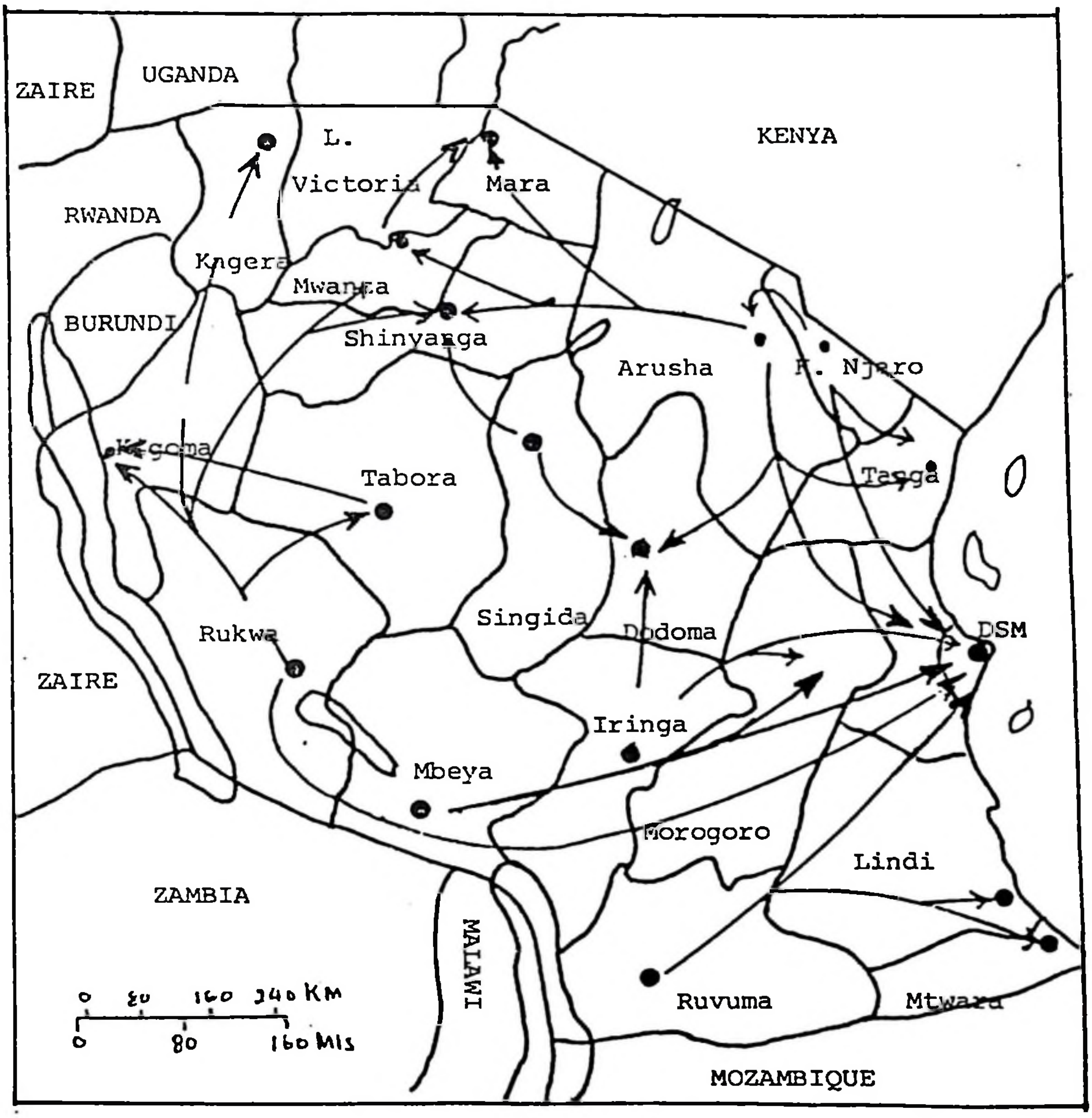
Mpwapwa in the same region, Iringa, Singida and Arusha. Lindi and Mtwara recieve maize from Ruvuma, which also sends supplies to Dar-es-Salaam. Other sources of supply to Dar-es-Salaam are Korogwe in Tanga region and the Northern regions. Maize flows are thus rather complex and often long in distance mainly because of the remote location of the most important production areas. Figure 2.1 shows the inte-rregional transfers of dried maize in Tanzania mainland as narrated above.

## 2.6 Maize Imports and Exports

Most of the grains consumed in Tanzania is from domestic production. However, past years indicate that this has not been the case. Agricultural production is liable to considerable fluctuations in Tanzania. Rainfall is the main cause of fluctuations, and poor production years are the main cause of imports of maize and other preferred staples, that is paddy and wheat. Continued need for food imports is in part due to the structure of food markets in Tanzania. Importation of maize and other staple cereals features prominently; especially in years of severe cereals shortfall. For instance between 1974 and 1976, the country had an average shortfall of about 73 thousand tons or 40 percent of the demand (Msambichaka, 1982).

The worst years of food grain shortfalls in Tanzania were in the second decade after independence. Of the grain imports, maize accounts for the biggest share both in terms of volume and

Figure 2.1: TANZANIA: INTER-REGIONAL TRANSFER OF DRIED MAIZE.




Source: Designed from section 2.5, p. 34.

⟶ Direction of grain flow.

value. For example in 1974, 1975 and 1980 out of 384.7; 520.7 and 315.1 thousand tons, maize alone accounted for 65.9 percent, 57.5 percent and 68.2 percent respectively and the cost of these imports has been substantial (Msambichaka, op. cit.).

The total foreign exchange earnings from all sectors of the economy were TShs. 2861 million in 1974; TShs. 2765 million in 1975 and TShs. 3800 million in 1980. Out of these earnings, 25.0 percent; 24.8 percent and 18.7 percent were used by the NMC - the only maize importers in 1974, 1975 and 1980 respectively for importing grains. Maize alone had a percentage share of 12.5; 10.3 and 8.6 in the respective years. (Msambichaka, op. cit).

Recently, a relatively optimistic growth rate has been projected for maize exports to neighbouring countries. For example maize imports in 1985/86 were at their lowest level (6.1 thousand tons) since 1978/79 when NMC had exporable surplus of 49 thousand tons. Table 2.9 indicates a slight decline in maize imports between 1976/77 and 1979/80. 1980/81 recorded the highest level of imports of 274.6 thousand tons.

## 2.7 National Milling Corporation (NMC) Sales

NMC sales of maize, rice and wheat since 1974/75 are shown in Table 2.10. Demand for these NMC products far exceeds supply because price is set below equilibrium price and so NMC actually rations its

Table 2.9: Maize Imports and Exports by NMC, 1975/76-1985/86

| Marketing year | Imports [1] Commercial | Aid | Total | Exports [1] | Trade balance | Value [2] |
|---|---|---|---|---|---|---|
| | '000 Tons | | | | | $10^6$ Tshs |
| 1975/76 | 79.5 | 27.0 | 106.5 | - | -106.5 | 105 |
| 76/77 | 34.6 | 7.0 | 41.6 | - | -41.6 | 57 |
| 77/78 | - | 34.3 | 34.3 | - | -34.3 | 44 |
| 78/79 | - | - | - | 49.0 | 49.0 | - |
| 79/80 | 32.5 | - | 32.5 | 28.0 | -4.5 | 50 |
| 80/81 | 188.1 | 86.5 | 274.6 | - | -274.6 | 452 |
| 81/82 | 14.5 | 217.1 | 231.6 | - | -231.6 | 369 |
| 82/83 | 17.0 | 106.4 | 123.4 | - | -123.4 | 190 |
| 83/84 | 125.1 | 69.2 | 194.3 | - | -194.3 | 461 |
| 84/85 | 110.9 | 17.6 | 128.5 | - | -128.5 | 439 |
| 85/86 | 3.1 | 3.0 | 6.1 | - | -6.1 | 18 |

Source: MDB (1986a), table 7, p.14.

[1 Imports and exports are recorded here on NMC purchasing year basis, that is, 1 June - 31 May.

[2 This is an estimate based on CIF price of US $ 150/t and an exchange rate of TShs. 20.00 per US $. The imports and exports are valued at the same exchange rate.

Table 2.10: NMC Sales of Maize, Rice and Wheat, 1974/75-1985/86

| Marketing year | Maize grain | Maize flour | Total [1 | Rice | Wheat [2 | Total [3 |
|---|---|---|---|---|---|---|
| | Produce | | | | | |
| | '000 Tons | | | | | |
| 1974/75 | na | na | 210 | 38 | 60 | 272 |
| 75/76 | na | na | 137 | 38 | 59 [4 | 205 |
| 76/77 | na | na | 134 | 56 | 74 | 232 |
| 77/78 | na | na | 109 | 77 | 86 | 240 |
| 78/79 | na | na | 156 | 70 | 93 | 280 |
| 79/80 | na | na | 223 | 61 | 55 | 303 |
| 80/81 | na | na | 293 | 77 | 42 | 373 |
| 81/82 | na | na | 286 | 78 | 58 | 378 |
| 82/83 | 19 | 171 | 209 | 72 | 57 | 303 |
| 83/84 | 58 | 176 | 254 | 79 | 34 | 333 |
| 84/85 | 95 | 114 | 220 | 58 | 67 | 307 |
| 85/86 | 87 | 63 | 157 | 28 | 51 | 207 |

Source: NMC sales reports (several).

[1 Expressed as maize equivalent, (90% maize to maize flour conversion).
[2 Expressed as wheat equivalent, (75% wheat to wheat flour conversion).
[3 Expressed in edible form (that is, flour).
[4 Estimate figure.

supplies. NMC sales of maize flour and maize grain in 1985/86 were considerably below the sales level in 1984/85. In the year 1985/86, sales of maize grain exceeded sales of maize flour. Consumers seem to consider maize grain as a better choice because of the fact that the flour often sold is of poor quality. NMC sales of maize grain and maize flour go primarilly to Dar-es-Salaam where respectively 59 percent and 53 percent of the 1985/86 total sales were conducted. (MDB, 1986a).

## 2.8 Grain Management Institutional Arrangement in Tanzania

The food system consists of a set of functions including food production, consumption and marketing. The marketing function is made up of food processing, storage and distribution functions. The function co-ordinates the production and consumption activities.

Food consumer demand is signalled to the producers through a pricing mechanism. Likewise, producers demand for production inputs and consumer goods is co-ordinated in the marketing system through the pricing mechanism. Hence, the pricing mechanism plays a dual purpose of signalling food consumer demand to producers and producers demand for agricultural inputs.

Crucial food marketing elements to be considered in a national food strategy are: How much food to produce to meet the present and projected demand; the optimal size of a national strategic grain reserve as well as the on-farm storage; accessibility in the rural areas; how much grain to be imported to close the gap between domestic supply and demand; and good pricing policies to ensure adequate food supply and demand.

### 2.8.1. Domestic Grain Markets

The Tanzanian grain market consists essentially of three channels, namely: government quasi-government companies; private traders; and local/village markets (Lele and Candler, 1984). The NMC is by far the largest parastatal institution which undertakes the marketing of food grains. Others include the Regional Trading Companies (RTCs), Co-operative unions and primary societies, and until recently, the General Agricultural Exports Company (GAPEX)[1].

The NMC, RTC (and GAPEX) constitute the official or legal marketing channels while private traders and the local markets form the parallel or

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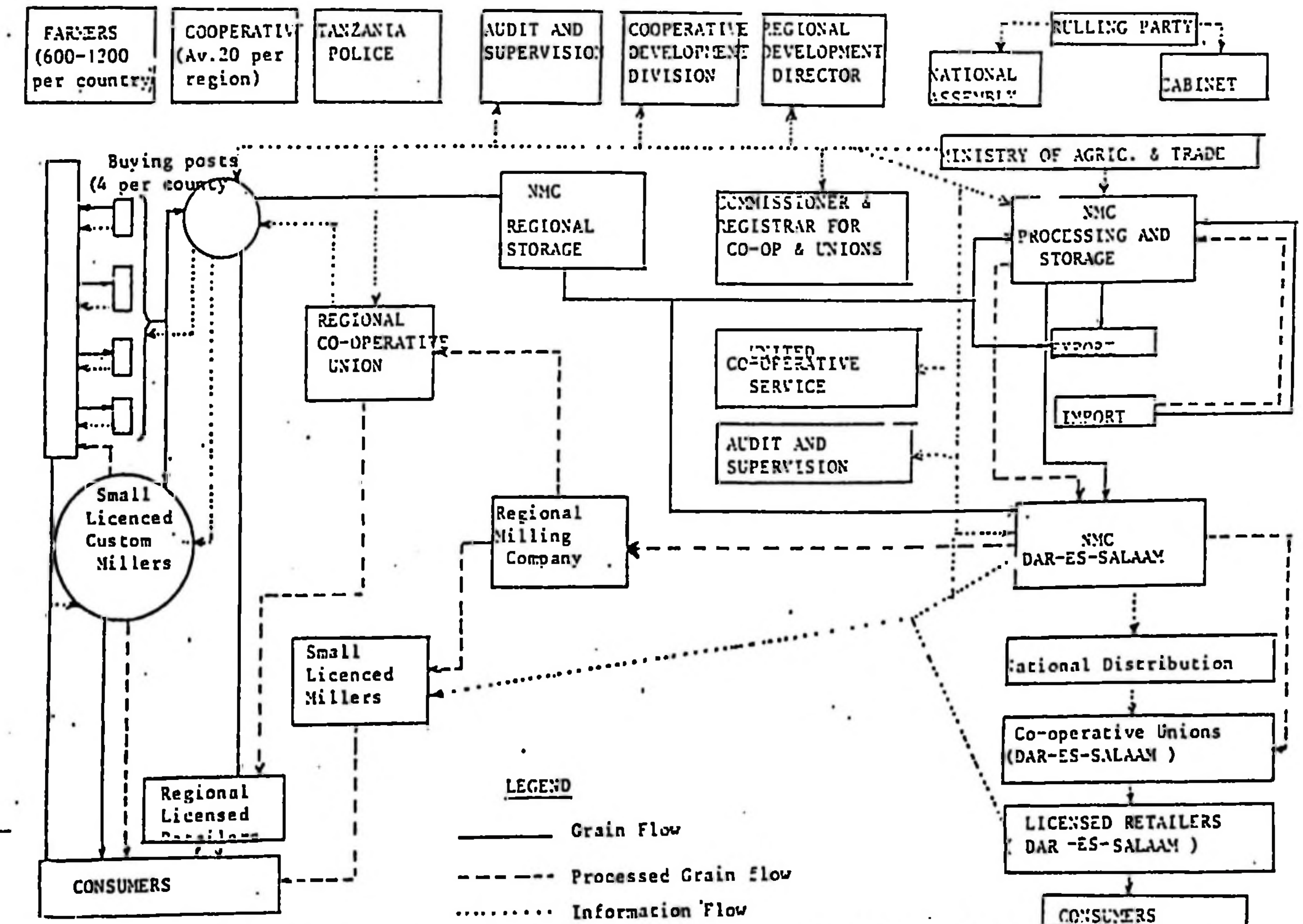
1 GAPEX was dissolved by the government towards the end of 1986.

unofficial channel. The NMC and RTC branches operate in the regional and district centres with a central administration at the national level. The official marketing institutions are under the jurisdiction of the Ministry of Trade.

The NMC has a legal monopoly of buying and selling food grains domestically as well as to import and export food. The RTCs and Co-operative Unions operate exclusively in the domestic markets. The private and village/local markets operate independently. The interaction of the official and parallel marketing outlets forms a complex grain management institutional system as shown in figure 2.2.

Essentially, the figure shows that the grain produced by farmers can reach consumers through the two major channels which operate within the same market structure. Grain can either reach consumers through the parallel markets or through the official channels. The flow of grain in the official markets is relatively restricted due to its heirarchical nature which allows for delays in grain delivery to storage or deficit areas. The NMC and RTCs cater mainly to a portion of the urban food consumers, while the remaining portion of the urban and most of the rural areas are served by the parallel market. Due to limited supplies, the official markets are

Figure 2.2. TANZANIA : GRAIN MANAGEMENT INSTITUTIONAL ARRANGEMENT




Source: Marketing Development Bureau, MDB (1982). In Ngowi, D. (1984), figure 4.1, p.75.

unable to satisfy all the food demand of the urban population. The parallel markets therefore play an important role in serving both the urban and rural consumers (Keeler, et al., 1982).

2.8.2 Food Pricing Mechanism

The official consumer prices in Tanzania are based on the import parity (Keeler, et al., 1982; Mitchell, et al., 1983). The technical aspects of the price setting process is undertaken by the MDB. The MDB recommendations are then forwarded to the Economic Committee of the Cabinet for consideration and approval. Prices are usually announced in July prior to the growing season.

Both the official food and pruducer prices once announced by the government remain constant for the whole growing season. These prices used to be the same all over the country, but recently prices of a few crops (including those of maize) have been allowed to vary in different regions based on the costs of production. The parallel market prices on the other hand, vary from place to place and over time depending on the supply and demand conditions. Price variation aspects over space, time and form are detailed in Chapter III below.

2.9 Chapter Summary

Maize is the prime staple cereal grown in

Tanzania. The crop is mainly grown by smallholders and it is almost entirely from rainfed areas. In the past years production outlook has been a reflection of both increased area under cultivation and increased productivity per land unit. Although maize is mainly grown for domestic food requirements, a small portion is sold either to the official (NMC) or the parallel market. Maize demand in the country (especially in the urban areas) has been increasing as a result of population pressure and changing preferences. The national maize supply structure on the other hand is dispersed reflecting differences in production systems and differences in the timing of rains which (consequenly) leads to different patterns of crop harvests. Whenever severe shortages of grain are experienced, NMC has been forced to ration its supplies. However, the inter-regional trade system also assists to even out the supply and demand imbalances by transfering the grains from surplus regions to deficit areas. Poor production has occasionally caused a substantial importation of grains from abroad to cover the supply shortfalls. Maize has accounted for the largest share in terms of volume and value of all the imported grains in the last 10 years.

Table 2.11 summarizes the maize production, demand, supply and foreign trade balance features in

Table 2.11: Production, NMC Purchases, Sales and Trade Balance for Maize
[1
1970/71 - 1985/86

| Production/Marketing year | (1) Production | (2) NMC purchases | | (3) NMC sales | (4) Trade balance (Exports-Imports) |
|---|---|---|---|---|---|
| | '000 Tons | '000 Tons | % | ------'000 Tons | ------ |
| 1970/71 | na | 186 | na | na | na |
| 71/72 | na | 43 | na | na | na |
| 72/73 | na | 106 | na | na | na |
| 73/74 | 1761 | 74 | 4.2 | na | na |
| 74/75 | 1367 | 24 | 1.8 | 210 | na |
| 75/76 | 1449 | 91 | 6.3 | 137 | -107 |
| 76/77 | 1664 | 128 | 7.7 | 134 | -42 |
| 77/78 | 1465 | 213 | 14.5 | 109 | -34 |
| 78/79 | 1720 | 220 | 12.8 | 156 | 49 |
| 79/80 | 1726 | 162 | 9.4 | 223 | -5 |
| 80/81 | 1500 | 105 | 7.0 | 293 | -275 |
| 81/82 | 1654 | 89 | 5.4 | 286 | -232 |
| 82/83 | 1651 | 86 | 5.2 | 209 | -123 |
| 83/84 | 1939 | 71 | 3.7 | 254 | -194 |
| 84/85 | 2067 | 90 | 4.4 | 220 | -129 |
| 85/86 | 2127 | 179 | 8.4 | 157 | -6 |

Sources: (1) Table 2.1, p. 24.
(2) Table 2.6, p. 33.
(3) Table 2.10, p.42.
(4) Table 2.9, p. 41.

[1 Figures may slightly be inconsistent due to different sources of data.

Tanzania for the past one and a half decades. Two aspects are observed from the table. First, the proportion of grain production bought by the NMC is very small. This implies that most of the grain is retained for domestic utilization or for sale through the parallel market where relatively higher prices are realized. Secondly, there has been an intermittent maize shortage underlined by the negative trade balances. These features underscore the need to review the present grain management institutional arrangement and to take initiatives to increase domestic maize production in order to cut off the large import bills. As previously noted improved storage (especially in the rural areas) to reduce grain losses is one of the possibilities which can be undertaken to improve the performance of the agricultural sector. Price incentives and increased input availability to farmers and the relaxation of the inter-regional grain flow restrictions may also assist the government to realize these objectives.

# CHAPTER III

# LITERATURE REVIEW

## 3.1 Introduction

In order to understand the position of this study, a review of the relevant literature is fundamental. Many studies have been carried out on the storage of grain in Tanzania and elsewhere. Here an attempt is made to revise the aspects of mainly on-farm storage in the country.

In Tanzania's private (uncontrolled) market for agricultural products, price instability is a common phenomenon. Price changes over time, space and form directly affect the income levels of peasants. A review of price variations is initially presented under section 3.2. Reasons behind these price variations and the role played by storage, transport and processing costs is introduced. The theory of competitive storage is then reviewed in section 3.3. The assessement of the relationship between temperal price variations and cost of storage over time is also explained in this section.

Review of studies concerning on-farm storage is given under sections 3.4 through 3.7. While noting that great grain losses are experienced in traditional storage practices, a re-examination of the improvements proposed in previous studies regarding the use of improved rural storage technologies is provided under section 3.7. Section 3.8 gives the chapter summary and explains how the literature is relevant to this study.

### 3.2 Price Variations in Agriculture

As noted above price instability in the private marketing of agricultural products in Tanzania is inherent. This is so because of the seasonal nature of output, difficulties in adjusting production to demand under uncertain weather, and low price elasticities of demand for basic food grains. Due to these low elasticites of demand, the consumption of basic food is almost constant throughout the year and as a result even small fluctuations in their yields tends to be associated with large variations in their prices. Where commodity markets are narrow, price fluctuations are magnified by speculative activities. Sharp price increases after the bulk of a seasonal crop has moved into wholesale channels discourage purchasing by consumers without benefiting the producers.

In Tanzania, as noted earlier, official prices for grains stay constant throughout the marketing season. This is not true for the parallel market prices. Keeler, et al., (1982) noted that within - year price movements on parallel markets demonstrates that the prices faced by consumers on these markets climb consistently throughout the year. Price variations are also observed spatially as a function of transport costs. Furthermore, prices differ for different forms of the same product to reflect processing costs.

### 3.2.1 Price Variations Over Space

The geographic locations of some agriculturally productive regions (in Tanzania) such as Kilimanjaro and Arusha make them readily accessible to the major consuming town centres. Other regions such as Rukwa and Ruvuma, despite being very productive are remote and inaccessible to the major consuming town centres. There is thus need for controlling official agricultural prices so that optimal resource allocation in food production can be determined by taking into account the comperative advantage in production and accessibility to the market. Specifically, if costs of production are high, produce price should also be set higher.

Prior to 1974, the agricultural prices in Tanzania were pan-territorial. This was aimed at stimulating production in the remote areas and to equalize income among regions (Ndulu, 1980; Keeler, et al., 1982; Ngowi, 1984). The analysts of MDB (1986 a) support the regional pricing that takes into account the production comparative advantage as well the proximity to the market.

Most rural areas are inaccessible for most of the year. To ensure a sufficient food supply in these areas, a regional pricing system might be preferred to a pan-territorial system, the latter's objective being to ensure adequate food supply in the urban areas by subsidizing the transport costs. The government has realised the importance of stimulating food production by setting "right" prices, taking into account the regional differences and accessibility to the market. The 1984/85 prices for maize, paddy and sorghum reflected this government desire (Table 3.1). However, the prices of cassava and beans continued to be pan-territorial to stimulate the production of these commodities for the urban areas.

It was noted previously that one of the reasons behind pan-territorial pricing was to stimulate production in the remote areas such as Rukwa and Ruvuma. There is no doubt that this objective has been achieved albeit at a high fiscal cost. For example in the 1980/81 crop marketing year, the government incurred TShs. 40 million to transport grains from Rukwa and Ruvuma to the major consuming towns. It is interesting to note that the same grains were sold for only TShs. 36 million, indicating a government transport subsidy of TShs. 4 million (Ringia, 1986).

Table 3.1: Regional (per kilogram) Producer Prices Announced for Products Purchased by NMC, 1984/85

| Region/District | Maize | Paddy | Wheat | Sorghum/ Bulrush Millet | Cassava I (Makopa) | Cassava II (Udaga) | Beans I | Beans II |
|---|---|---|---|---|---|---|---|---|
| | TShs. | | | | | | | |
| DSM/Coast | 2.50 | 6.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Morogoro | 4.00 | 6.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Tanga | 4.00 | 6.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Mtwara | 2.50 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Lindi | 2.50 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Arusha | 4.00 | 4.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Kilimanjaro | | | | | | | | |
| Mwanga | 4.00 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Same | 4.00 | 6.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Other Districts | 4.00 | 4.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Dodoma | | | | | | | | |
| Urban/Rural | 2.50 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Other Districts | 4.00 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Singida | 2.50 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Tahora | 4.00 | 6.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | |
| Kigoma | 4.00 | 6.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Rukwa | 4.00 | 4.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Mwanza | 2.50 | 6.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Mara | | | | | | | | |
| Tarime | 4.00 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Other Districts | 2.50 | 4.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Shinyanga | | | | | | | | |
| Kahama | 4.00 | 6.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Other Districts | 2.50 | 6.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Kagera | 4.00 | 4.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Iringa | 4.00 | 4.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Mbeya | | | | | | | | |
| Chunya | 4.00 | 6.00 | 4.50 | 3.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Other Districts | 4.00 | 6.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |
| Ruvuma | 4.00 | 4.00 | 4.50 | 2.00 | 2.00 | 0.90 | 8.00 | 3.50 |

Source: Marketing Development Bureau, MDB (1983), Appendix Table V.

### 3.2.2 Price Variations Over Time and Form

Price variability in the parallel market of food grain in Tanzania and elsewhere for example see Schmidt (1979) and Maritim (1985) stimulate the storage and processing demand in the rural and urban areas. This is so due to the fact that the storer or the processor expects a higher price after storing or processing the produce. The official prices do not stimulate such functions. Farmers occassionally depend on the parallel market for their food requirements. Experience has taught them that the prices in the parallel market vary during the season-prices are lowest at harvest and are very high soon before harvest. Farmers therefore sell the residual after all the family food requirements are satisfied. Mphuru and Maro (1975) showed that this is the case even in Morogoro region where this study was carried.

Rational farmers (process and store) their grain to sell later in the season to take advantage of high prices. Thus farmers who sell at harvest time have lower incomes than those who sell later in the season. However the decision to store grain meant for sale is made only after considering the costs involved in the storage practice. If the total revenue exceeds storage costs then there is an incentive to store the grain.

Table 3.2 shows that the price of maize flour in

Table 3.2: Alternative (per kilogram) Market Prices for Maize Flour, 1982/83 [1

| | Nov-Dec 1982 | Jan-Feb 1983 | Mar-Apr 1983 | May-June 1983 | July-Aug 1983 | Sept-Oct 1983 | Average |
|---|---|---|---|---|---|---|---|
| | | | | TShs. | | | |
| Morogoro | 7.04 | 7.65 | 7.04 | 18.15 | 5.19 | 4.95 | 8.34 |
| Lushoto | 5.96 | 6.19 | 6.42 | 7.46 | 8.99 | 6.20 | 6.87 |
| Arusha | 4.57 | 4.77 | 4.57 | 4.73 | 6.19 | 5.95 | 5.13 |
| Mbulu | 6.11 | 5.60 | 6.11 | 6.11 | 5.39 | 3.83 | 5.52 |
| Moshi | 4.88 | 5.26 | 4.03 | 5.05 | 7.55 | 5.20 | 5.33 |
| Mpwapwa | 6.57 | 6.65 | 7.45 | 5.42 | 4.26 | 4.20 | 5.76 |
| Singida | 6.11 | 6.01 | 5.80 | 5.12 | 4.57 | 4.70 | 5.39 |
| Tabora | 3.95 | 5.03 | 4.65 | 4.88 | 4.88 | 5.95 | 4.89 |
| Urambo | 3.95 | 3.95 | 4.05 | 3.80 | 4.18 | 4.70 | 4.11 |
| Sh'yanga | 8.27 | 8.58 | 6.83 | 7.11 | 8.20 | 8.45 | 7.91 |
| Mwanza | -- | 7.14 | 7.42 | 7.96 | 7.96 | 7.45 | 7.59 |
| Kigoma | 7.96 | -- | 7.35 | 5.92 | 5.39 | 6.20 | 6.56 |
| S'bawanga | 4.10 | 4.07 | 3.29 | 3.33 | 3.72 | 3.20 | 3.62 |
| Mbeya | 5.03 | 5.34 | 5.49 | 4.57 | 4.41 | -- | 4.97 |
| Njombe | 3.33 | 3.33 | 3.49 | -- | 3.33 | -- | 3.37 |
| Iringa | 5.19 | 5.29 | 5.19 | 5.11 | 5.19 | 4.08 | 5.00 |
| Songea | 3.10 | 3.54 | 4.26 | 4.26 | 3.26 | 2.38 | 3.47 |
| Mtwara | 5.49 | 5.65 | 6.11 | -- | 7.96 | -- | 6.30 |
| Lindi | 5.74 | 5.49 | 5.49 | -- | 6.14 | -- | 5.72 |
| Average of reporting markets | 5.69 | 5.79 | 5.73 | 6.05 | 5.99 | 5.45 | 5.90 |

Source: Marketing Development Bureau, MDB (1983) Table 8.3, p. 29.

[1 Grain converted to flour at 90% extraction rate; one tin of maize is assumed to be 18 kg.

the parallel market at Morogoro town market was 55 percent higher in February 1983 than in October 1983, an absolute difference of Tshs. 2.7 per Kilogram (MDB, 1983). Throughout the country, maize prices are the highest soon before harvesting (for maize April to June) and are lowest at harvesting (July to October), table 3.2 refers.

Prices of grains in the parallel market therefore differ spatially, over time and with product form to reflect transportation, storage and processing costs and the risks involved in the (illegal) marketing. It is interesting to note that recently even the government has come to understand the logic of differentiated prices. This is underlined by the goverments decision to vary the prices of some commodities at least spatially.

## 3.3 Theory of Competitive Storage and Need For Storage

Storage of food grains have long been undertaken at some level in the marketing systems of many countries. Due to inadequacies of parastatal organizations storage functions have often been undertaken also by the farmers and the middlemen. At any level considered grain storage is either meant for food requirement and provision of seed and feed on one hand and for speculative purposes on the other hand. An examination of the guiding policies in both cases is thus necessary.

Hall (1970) points out that the nature of the part played by storage in marketing varies from area to area, depending on the length and direction of the marketing channels through which grains flows from producer to consumer. In pure subsistance farming societies, the grain produced may not go out of the village. Under such circumstances each family has its own storage structure and a marketing system in such areas is the sale of small lots of grain by producers to nearby consumers.

### 3.3.1 Theory of Competitive Storage

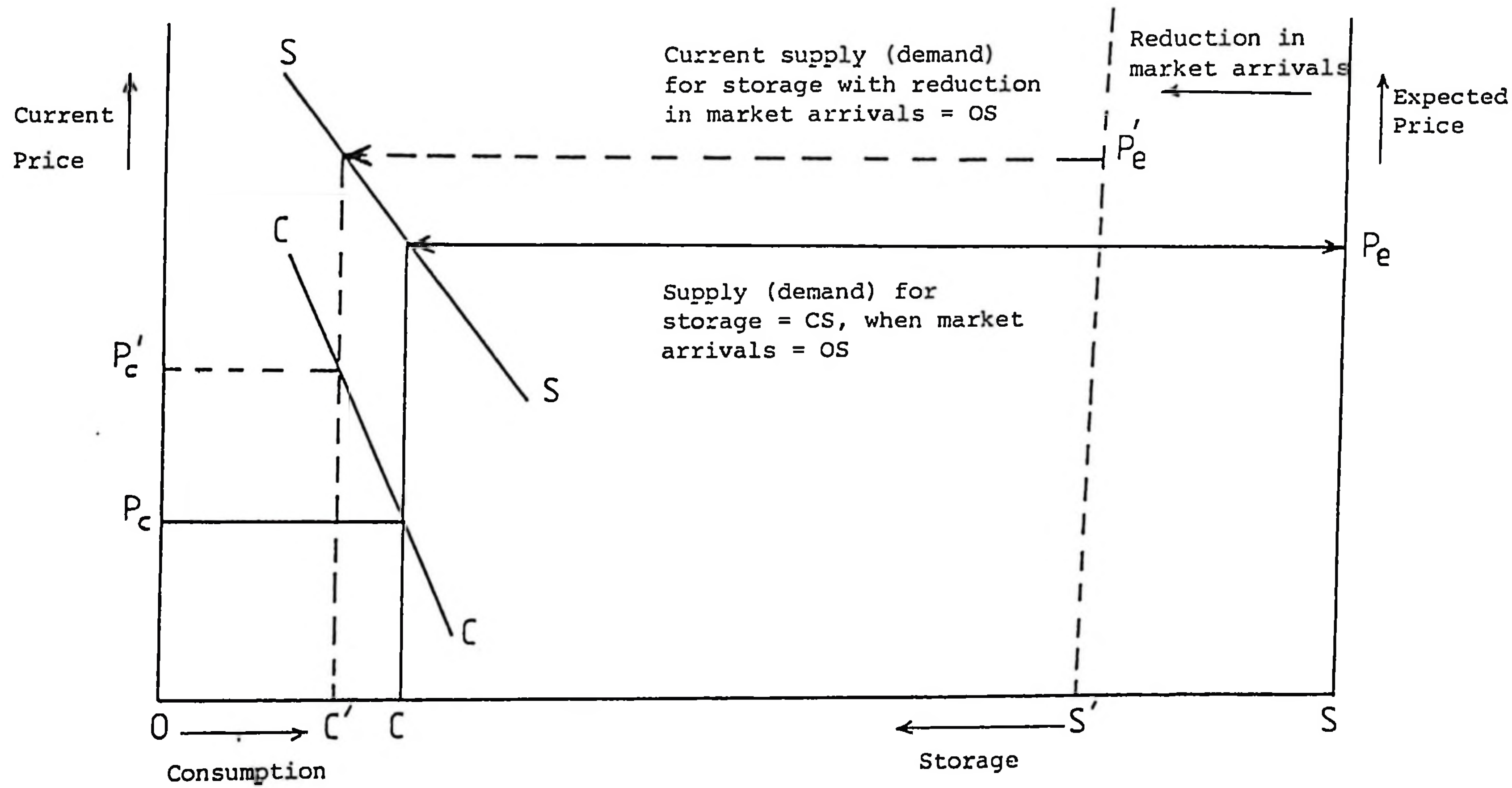
We earlier noted that in a perfectly competitive market economic theory on regard of storage suggests that post-harvest price rise will equal the cost of storing grain. A price rise greater than costs of storage provides the opportunity for traders or farmers practicing speculative storage practices to make profits. A major result of recent work, for example that of Hays and McCoy, (1978) and Helmberger and Akinyosoye, (1984), on the theory of competitive storage is that in periods of sufficient scarcity, the price of a commodity is determined by supply and demand for current comsumption and processing. In the periods of sufficient abundance, on the other hand, price is determined by supply and total demand, the latter representing the demand for speculative storage as well as for consumption.

In line with the above argument, Sexauer (1977) points out that the theory regarding inter-temporal price relationships establishes that the difference between the current price of a storable commodity must be equal to the marginal cost of storage. The relationship between the amount of commodity held in storage with the temporal price spread gives rise to a supply of storage curve. This supply of storage curve, according to Brennan (1958) and Working (1949) slopes upward to the right. More storage will be supplied at a high return per unit and less storage at a low return per unit stored.

On allocation between consumption and storage, Vankataramanan and Muralidharan (1972) explain that the supply of grain arrivals at any time in a market is matched by the demand of the grain arrivals in the same market. The demand for grain market arrivals at any time represents the sum total of the joint demand for current consumption and storage. The allocation between present consumption and storage in commodity markets is based on the relation between expected prices relevant to the period of storage, current prices and storage costs.

Figure 3.1 explains the above relationship. If the total amount of commodity available for allocation is OS, current price is Pc and expected

Figure 3.1: ALLOCATION OF GRAIN BETWEEN CONSUMPTION AND STORAGE




Source: Vankataraman and Muralidharan,(1972), diagram 1, p. 2.

price is Pe, the amount demanded for current consumption is OC and the demand for storage is CS.

Under the "normal" seasonal pattern, the seasonal product is allocated through the year by the relationship of current price and expected prices to storage costs. As the next crop year approaches, price declines rather abruptly to the next seasonal low. Figure 3.2, adapted from Tomek and Robinson (1972) explains this relationship of price variations over time as related to storage costs.

The farmer therefore stores a commodity if he expects the benefits of storage to equal or exceed the costs of storage. If:

Pe is the expected price in future

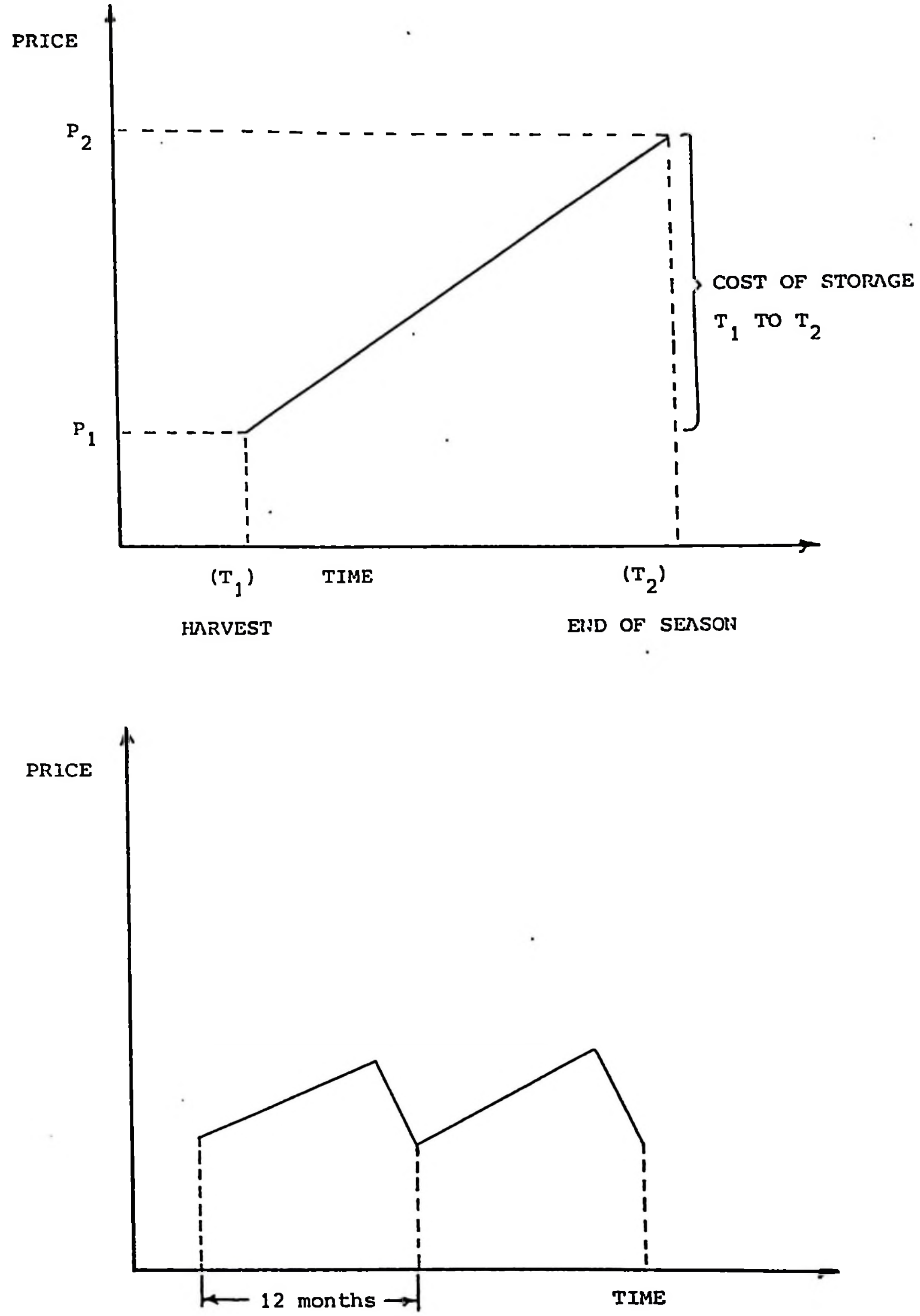
Pc is the current cash price, and

Ct is the cost of storage between the two time periods, the storage takes place if

$$Pe - Pc \geq Ct.$$

In a multiperiod demand case, Bressler and King (1970) point out that through speculative actions, prices through time are interrelated by storage costs. If the supply and demand outlook for the future are for significantly higher prices, products will be put into storage. Speculation and storage operations will continue as long as the difference between expected and current prices exceeds storage costs since this excess will represent potential

Figure 3.2: PRICE VARIATIONS OVER TIME AS RELATED TO STORAGE COSTS.




Source: Tomek and Robinson (1972), Fig. 9-2, p. 172.

profits. In equilibrium, then, future and present prices will differ by exactly the costs of storage and potential profits.

In summary it is noted that the prices of grains differ with the supply and demand patterns over time and the temporal price spread gives storage supply curve. This implies that farmers will only store when storage costs are less than the expected future profits. According to work by Maro (1975) prices in the study region vary over time due to the inherent seasonality in production. On the basis of the theory of storage this study evaluates the farmers average propensities to consume and store out of produce. The relationship of the parallel market prices and the costs of storage in the traditional storage structures is studied to see on whether those farmers who store for speculative purposes earn profits from the future sales of their produce.

3.3.2 Need for Storage

It was earlier noted that the seasonality of agricultural production is natural. Producers also have low holding capacity for their products immediately after harvest. These two aspects, coupled with farmers' immediate cash needs may result in the immediate selling of grains. This in turn may lead to a sharp decline in parallel market prices during the harvesting period. Couch (1967) noticed that the "unwise" decision to sell at harvest when the price may be low results in repurchasing of the same grain during the period of scarcity when the price is correspondingly high.

The simple answers for need for storage are thus to get domestic food supplies for the family and to obtain the advantages of a sellers market. The latter is true for farmers with marketable surplus and the merchants. Without these merits a high percentage of the grain grown for re-sale would as noted above be sold at harvest. Even this system could lead to storage difficulties for the merchant.

To tackle the storage problem effectively, the alternatives are either to depend upon large warehouses operated by the public agencies or to improve and /or create additional storage facilities with the farmers. Sufficient storage facilities will thus operate by absorbing supplies in times of relative abundance and by releasing them in times of relative scarcity. They will thus attempt to even out the fluctuations in annual supplies and also to keep within limits the fluctuations in price in the unofficial market.

Therefore one obvious but important implication of these price movements is that the parallel market provides incentives to store grain past the harvest season. Producers of surpluses can realize a higher price, and farm households around the subsistance level need to store grain to avoid paying the high parallel market price. More grain is therefore available to households with grain shortfalls than would be available in the absence of price fluctuations (Dandekar, 1957; Keeler, et al., 1982).

In summary, we noted that the temporal price relationships consider markets in time and interrelationships of market prices through storage costs. Production and consumption are usually seperated in time although in some occassions they must be simultaneous. The time lag between production and consumption need to be bridged by the creation of time utility. Storage is a productive activity which bridges this gap at a given resource cost.

### 3.3.3 Welfare Implications of Commodity Storage

The main objective of literature on welfare implication of commodity storage is to deduce the welfare implications of price stabilization for producers, consumers and society as a whole. A common approach is to compare market performance with no storage with performance when storage is used to stabilize price or some other variables. Hall (1970) suggests that the first objective of any storage scheme should be to increase the income of the farmers without necessarilly inflating the price paid by consumers.

According to work by Helmberger and Weaver (1977) intertemporal equilibrium is determined for a competitive market when private inventories are held. Production and storage decisions respond to rational expectations of uncertain prices. Numerical expressions for gains (losses) to buyers and producers are derived in this context. Competitive equilibrium maximizes gains to society. Programs that stabilize price either completely or partially generate benefits to producers and losses to buyers relative to competitive equilibrium.

Deviations between actual and expected prices would likely cause considerable financial stress among farmers. Further, differences between expected and actual prices are found to be much greater in the absence of competitive storage. Thus, whether prior to storage producers and buyers can expect to gain (lose) from competitive storage industry depends on the level of certainty (uncertainty) of current and expected future prices. Though arbitrageus cannot expect gains from competitive storage they could expect gains from non-competitive storage levels. The net gains to society or consumers are maximized when storage is at the competitive level. These gains are in the form of the reduced unearned increments by speculators, that is, the reduction in differences between producer and retail prices in excess of storage costs.

### 3.4 Grain Storage in Tanzania

Grain storage in Tanzania is practised at both parastatal and producer level. The present available NMC storage facilities are below the required capacity in terms of national food security requirements. There are family storage capacities which can store almost 80 percent of the family harvest. However, the percentage of grain that is stored on-farm varies from place to place. Family grain stores are easily prone to vermin attack and pest infestation.

Because storage of grain on any larger level must be either a village activity or an NMC operation, parallel markets are legally unable to use more efficient methods to store and re-sell other people's grain in the period before harvest. This has raised the price of grain to consumers unable to depend on the NMC. The parallel market is there due to food shortages, poor marketing system and poor distribution. The denial of legal access to transportation and storage by private/parallel traders only increases the inefficiency and instability of parallel markets in particular and the national grain marketing system in general.

The cost of grain imports can be considerably higher than the costs of preventing grain losses on-farm. On-farm storage for one thing, can be achieved using locally available resources, appropriate technology and motivation.

Storage at national level is scarce and costly. The total government owned and hired storage capacity is about 408 thousand metric tons (about 11 percent of crop). The effective long-term storage capacity is about 210 thousand metric tons (Ngowi, 1984). This capacity is almost fully utilized except for a few godowns/silos in Tanga and Lindi regions (table 3.3).

Seven months is considered long enough to process imports in case of domestic production shortfall, and hence a strategic grain reserve should at least be able to sustain consumption for seven months or to hold 5 percent of the projected food demand (McIntire, 1981). To be food self-sufficient, Tanzania requires about 4.4 million metric tons of cereals. Seven months cereal supply is about 2.7 million metric tons. Ngowi (1984) has proposed the optimal size of a strategic grain reserve for maize and course grains and rules for the release of grains. For emergency purposes, the available national storage capacity is not enough. In good years, Tanzania produces enough cereals for immediate consumption and for strategic grain reserve.

Two observations are in order. Tanzania lacks

Table 3.3: Government Owned and Hired Storage Capacity, 1981

| Region | Government Storage Capacity | | Utilization | Hired capacity | | Additional planned capacity |
|---|---|---|---|---|---|---|
| | Godowns | Silos | | Godowns | Utilization | |
| | --------'000 Tons---- | | % | '000 Tons | % | '000 Tons |
| Dar-es-Salaam | 41.6 | 18 | 98 | 14.2 | 99 | 15.0 |
| Coast | 1.7 | -- | 92 | 8.6 | 97 | 1.0 |
| Morogoro | 8.0 | -- | 98 | 3.9 | 100 | 14.0 |
| Tanga | 8.8 | -- | 57 | 3.0 | 98 | 5.6 |
| Mtwara | 2.0 | -- | 100 | 24.0 | 92 | 12.6 |
| Lindi | 2.5 | -- | 76 | 6.5 | 100 | 1.0 |
| Arusha | 26.2 | 26 | 100 | 19.0 | 100 | 22.0 |
| Kilimanjaro | 15.2 | -- | 100 | 10.1 | 99 | 2.1 |
| Dodoma | 22.2 | -- | 100 | -- | -- | 41.6 |
| Singida | 7.2 | -- | 87 | -- | -- | -- |
| Tabora | 13.8 | -- | 90 | 3.0 | 92 | 7.6 |
| Kigoma | 6.5 | -- | 97 | -- | -- | 2.0 |
| Rukwa | 8.0 | -- | 100 | 0.8 | 95 | 18.5 |
| Mwanza | 12.0 | -- | 100 | 11.0 | 100 | 6.0 |
| Mara | 8.5 | -- | 98 | -- | -- | 5.0 |
| Shinyanga | 6.4 | -- | 94 | -- | -- | 22.0 |
| Kagera | 3.0 | -- | 92 | 0.8 | 97 | 3.5 |
| Iringa | 24.1 | 14 | 100 | -- | -- | 13.0 |
| Mbeya | 16.6 | -- | 100 | 1.3 | 100 | 5.0 |
| Ruvuma | 9.0 | -- | 99 | -- | -- | 2.0 |
| Total | 243.3 | 58 | | 106.4 | | 198.9 |

Source: National Milling Corporation NMC, (1982). In NGOWI, (1984), table 2.9, p.25.

the technical and managerial resources needed to manage the national strategic grain reserves. Secondly, and more important, most of the godowns/silos are not adequate and are located in the urban centres. Most of the rural areas are not accessible due to poor feeder roads. Hence, national grain reserves held in the urban centres do not, at all, guarantee food security in the rural areas. Therefore, the national strategic grain reserves should not be a substitute for the alleviation of the rural transport and the on-farm storage problems. More so because the government views the future of storage requirements for NMC operations to be very high on basis of the expected future growth in output.

### 3.5 <u>On-Farm Grain Storage</u>

Farm grain storage have long been undertaken in Tanzania and elsewhere. Many scholars have taken trouble to study the technological and/or economic aspects of farm storage and grain storage in general. Here an outline of the different approaches used in economic studies of farm storage are outlined. A review of on-farm grain storage in Tanzania and the relationship between the length of grain storage and extent of damage is also provided.

### 3.5.1 Approaches Towards On-Farm Grain Storage Studies

There are a lot of technological discussions on farm storage and factors accelerating and impeding crop spoilage of various sorts, and of particular storage systems. Trend analysis of the variation of prices within and between seasons have also been highlighted. These trends have been compared to storage costs so as to estimate benefits accruing from storage over time. Both financial and economic appraisal on farm level storage improvements have been carried out elsewhere.

Boxall, et al., (1977) carried out a research on the prevention of farm level food grain storage losses in India. In this study, the pattern of storage and a technological appraisal of the observed traditional structures were carried out. Structure and pattern of storage losses were studied and were used as the basis for the determination of social benefit-cost ratios of improving the storage structures. A similar approach was adopted by Greeley (1982), Lipton (1982) and Tyagi (1982).

Bungundu (1970); and Mphuru and Maro (1975) carried out studies of on-farm storage in Northern Nigeria and Morogoro and Iringa regions of Tanzania respectively. In these studies the harvesting and preperatory stages of the crop harvests before storage; and methods of storage including steps taken by farmers in reducing storage losses caused by rodents and insect pests are described.

Inter-temperal price movements and returns to storage studies have also been undertaken by a number of authors notably: Davis and Brooks (1967); Vankataramanan and Muralidharan (1972); Hays and McCoy (1978); Helmberger and Akinyosoye (1984); Monterosso, et al., (1985) and MDB (1986a). Basing on time series data trend analyses were carried out to assess the variation of prices through time intra-seasonally and inter-seasonally. Some of these studies were carried out using simple linear regressions. Others used non-linear seasonal regression models to get the best estimates of price trends. For example, Vankataramanan and Muralidharan (op. cit.) used such model to explain the difference between the grain price at harvest time and the price during the lean period within a season and between seasons for a period of 5 years in primary and secondary markets of India.

One clear observation from the above discussion is the similarity of the methods adopted in the different studies. The specifications on regard of the methodology adopted for this study are outlined in Chapter IV below.

### 3.5.2 On-Farm Grain Storage in Tanzania

Farm level storage has been neglected in the past. The major objective of the previous studies concerning storage has been a general technical evaluation of different structures as related to storage losses. Little has been done about the economic evaluation of this storage in terms of temporal price variations, average storage investment costs, net income per unit of stored grain and the economic feasibility of farm storage improvements.

The 80 percent food approximated to be stored at farm level is mainly for food requirement. There is, however, a high degree of variation reflecting size of household, interaction between cropping patterns and proximity to central markets. For example, farmers in remote high potential areas like Rukwa and Ruvuma retain most of their produce because they are far from high consumption centres like Dar-es-Salaam. Farmers from accessible regions like Morogoro have incentive to sell most of their crop to traders who ferry the produce to main consumption centres.

Any grain surplus to domestic/household consumption needs may be sold. After harvest grain meant for sale to the NMC is temporarilly stored in bulk or bags in co-operative buying posts before being tranfered to a more permanent type of store owned by the NMC.

There is a wide range of grain storage structures reported earlier, for example, see Mphuru and Maro (1975), but little attention however, is paid to the quality of farm level stores. The contradiction between the economic concern of farmers in the conditions of their grain and frequently poor storage hygiene is probably explained by a lack of knowledge of loss prevention methods and by the acceptance of storage losses as inevitable. The important agents of loss - insects and rodents are known as such and while a variety of traditional control methods are practised they are inadequate especially with the high yielding varieties (HYV) which are more prone to pest attacks.

### 3.5.3 Length of Storage and Extent of Grain Damage

The extent of damage of maize stored in traditional stores by farmers in Iringa and Morogoro regions of Tanzania was as high as 20 percent in the first three months of storage and as high as 70 percent for maize stored over a year (Mphuru and Maro, 1975). Ngowi (1984) puts the annual loss figure at national level to be 14 percent.

Similar losses have been reported in other tropical countries in Africa, for example Mphuru and Maro (op. cit.) reports that in Zambia a loss of 13 percent of the grain crop stored for a year is attributed to insect attack. Davies (1967) estimates losses due to insect pests in Uganda at 10 percent of the grain crop for one season storage.

It should be noted that the extent of damage is not only dependent on the length of time in which the grain remains in storage but appears to depend also on the type of storage. For example, Harris (1941) observed that the quality of maize is relatively prolonged when the product is stored with the sheaths/husks.

## 3.6 Costs of Grain Storage

We noted previously that certain costs are associated with grain storage and these costs are undertaken by the storer to make sure of domestic food supplies over a season and in expectation of high prices in the lean season. Costs of farm storage include; first, the fixed costs which are comprised of ; interest on investment, depreciation, insurance on building and equipment and property taxes. Secondly, there are the variable costs which are comprised of; insurance on grain, treating and conditioning, maintenance and operating expenses, labour and shrinkage and quality loss. Costs of farm storage construction are expected to vary with type and capacity of facilities. The costs of handling and storing grain in farm storage therefore, gives the breakdown of total annual storage costs on a per unit basis per year basing on fixed costs and variable costs. The same is indeed true for government and/or parastatal storage.

Basing on empirical studies, Davis and Brooks (1967), Maro (1976) and Sexauer (1977) concluded that fixed costs decline with size whether the stores are kept full or not. The variable costs per unit of produce stored are highest for storage structures which have the highest insurance costs. Otherwise, the variable costs are constant for most of the types and sizes of stores.

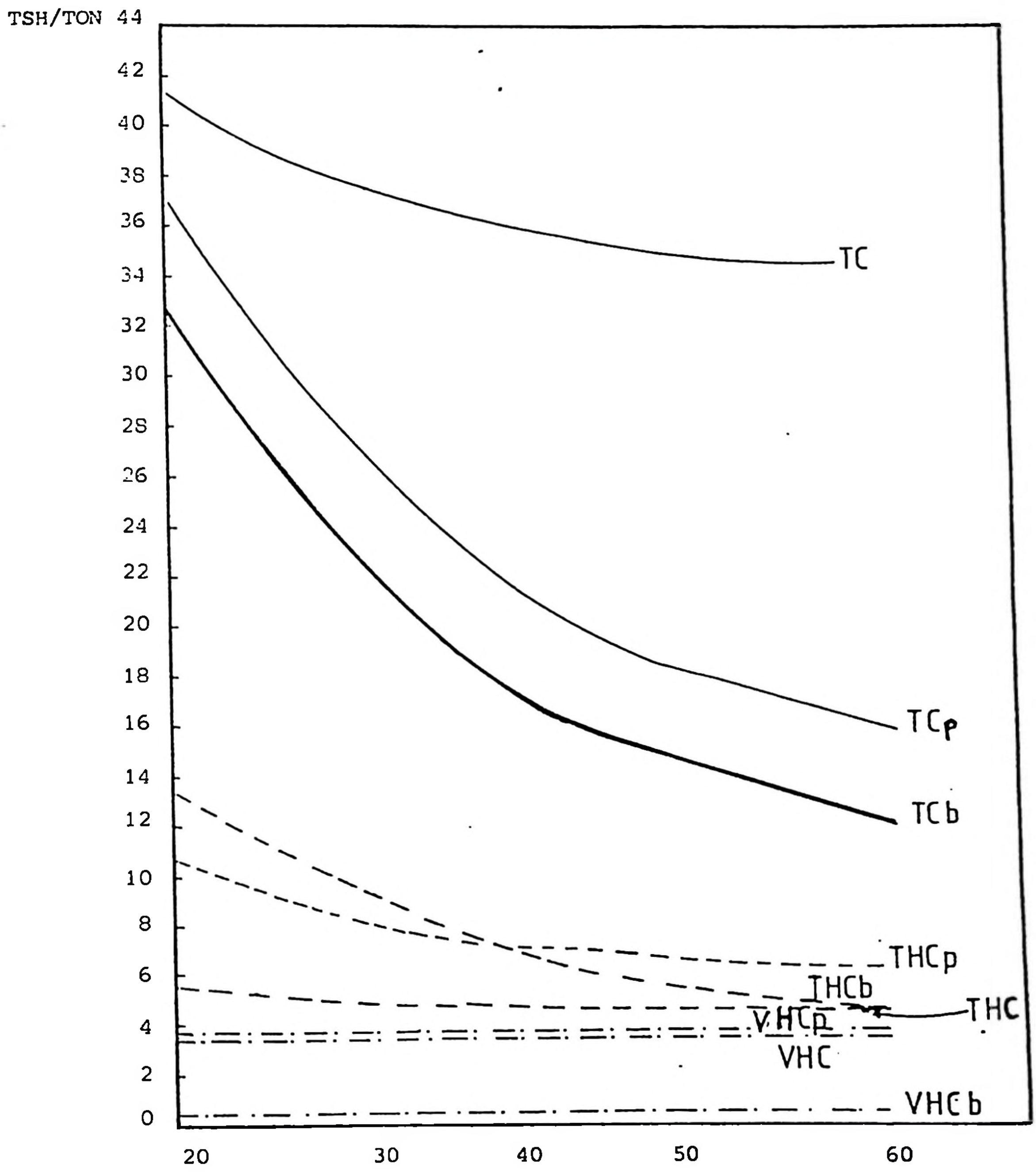
The largest part of the total per unit cost of storing grain on the farm is fixed cost. These costs remain whether the facility is used or not. The variable costs vary with the use of the facility. The size of structure that can be constructed with a given amount of money will affect cost according to the number of tons it will hold. The largest capacity that can be built for a given sum results in the lowest cost per unit of storage capacity, provided that the capacity is used. Farm storage is seldom used over the initial capacity; that is, once harvest is completed and the farmer has put the grain into farm storage, additional grain is seldom delivered to farm storage until next season. The information on cost of construction and equipping different kinds of storage can assist in deciding the volume and kind of storage a farmer can build with a given quantity of money.

### 3.6.1 Costs of Grain Storage in Tanzania

In Tanzania, Maro (1976) has indicated that the costs of farm level storage are high relative to large-scale storage facilities, may be due to scale diseconomies. This view is in support of Agricultural Consultants (AGRICONSULT) report to the Tanzanian government who, according to Maro (1976), basing on the data available to them, found unit cost of grain storage and handling to be lower the larger the volume of grain stored. Further they found that at any particular volume (starting with 20 thousand metric tons) bin silos offer a much lower per unit cost than either pit silos or warehouses (godowns). This is shown in figure 3.3. Accordingly, they recommended the system of bulk handling and storage in Tanzania.

Monterosso, et al.,(1985) in contrary, point out that storage planners in developing countries including Tanzania often exploit scale economies in grain facilities by building large units far from producers without accounting for the effect on transport costs. Regarding Africa, Green (1982) writes: "storage debacles-centering on failure to expand capacity and inappropriate selection of type and location -have worsened transport bottlenecks...

Figure 3.3: TANZANIA: STORAGE AND HANDLING COSTS; DIFFERENT TYPES OF STORAGE FACILITIES, TSH. PER TON.




Source: Maro (1976), Fig. 4, p. 112.

——— Total costs (TC) incl. Capital investment

- - - - - Total handling costs (THC)

—·—·— Variable handling costs (VHC) incl. bags.

——— Pit silos (elsewhere ind. by lower case "p")

——— Bin silos (elsewhere indi. by lower case "b") horror stories (abound) of gross transport, back and forth movement of the same grain. ...In Tanzania argueably 150 to 200 percent of the necessary ton mileage has been used with a high monetary and opportunity cost in fuel and vehicles".

This implies that the "think big" strategies are likely to be quite ineffecient. Monterosso, et al., (op. cit.) therefore, recommends decentralization of storage-more smaller units closer to the farmer. In addition to lowering transport costs decentralization makes per unit costs of storage with private farmers be lower than the parastatal costs. Ringia (1986) for example showed that it costs the NMC an average of Tshs. 270 per metric ton to store grain. The private processors can undertake storage at a lower cost of Tshs. 168 per metric ton.

### 3.6.2 Storage Losses as a Variable Cost of Storage

The greatest concern, of cost of storage studies pertains to the difficult determination of losses. Farmers in poor countries are not, of course, ignorant of storage losses, since ingenious systems to prevent these losses have been devised long ago, reports (Lipton, 1967). Numerous estimates have been made of losses from traditional grain storage systems; in Tanzania losses have been estimated at 10 percent (FAO,1968); 20 to 70 percent (Mphuru and Maro, 1975) and 14 percent (Ngowi, 1984). These differences perhaps stem from the different methods applied in the loss determination.

Lipton (1982) and Maxwell (1982) concluded that losses in traditional Post-Harvest Technology Systems (PHTS) are lower than generally proposed. For example, work done by Tropical Products Research Institute (TPRI) on maize in Zambia and Kenya and on millet in Mali show that total loss in all post-harvest operations including storage was less than 8 percent. Further to this, Lipton (1971) gives prior reason why food losses from traditional stores should be negligible: "Being (the cultivators') years' supply of food and seed, (the store) is well taken care of. We must draw from it daily for food so it is watched closely and any insect infestation is taken care of at once".

It is thus clear that there are contradicting conclusions as regards to loss assessments. Information on the quantity of grain lost in storage is difficult to obtain. Greeley (1982) and De Lima (1979) point out that it is difficult to incorporate the different types of loss into a single index of food loss. Recording the price effect of nutritive deterioration for example, is not really possible because the loss is not necessarily reflected in the selling price of grain. Farmers may not even consider grain loss as the major problem (Bahemuka, 1985). Specifically, Greeley (1982) pinpoints that the loss assessment methods for storage are the most complex of all the operations. This is because the estimation of insect losses for example, requires laboratory analysis of samples.

In general, losses in any type of store increase - not in a simple linear fashion - with the period of storage, exposure to pests per unit of time, the quantity of crop stored and the poorness of quality of crop at time of storage. Evidence by Lipton (1971) shows that the destruction of crop is much more than proportional to these parameters. The linear fashion assumption in purely adopted for analytical convenience. The alternatives to improved storage techiniques will be geared towards reduced period of storage, pesticide campaigns, alteration of size of storage unit and better pre-store drying or disinfection.

## 3.7 Need for Farm Storage Improvements: The Basis for Financial and Economic Appraisal of Storage Improvements

The alternatives to improved storage techniques described above, will achieve the same object as improved storage techniques, namely to cut losses in store. Thus the benefit-cost ratio (BCR) values and internal rate of return (IRR) values of such alternatives must be examined so as to compare them with the benefit-cost ratios and internal rates of return of the more promising of the new storage methods. The main point of improving a storage system is to reduce the crop's exposure to the pest. But for any given storage techniques exposure is not constant. Thus an intergrated approach is likely to be more effective. Therefore, the decision to use any particular protection alternative depends on the cost involved and the potential benefits. Faced with the possibility of pest damage, the farmer is interested in actions that reduce the damage as long as the amount of expenditure is commensurate with the amount of probable reduction.

Metcalf and Luckman (1975), point out that benefit-cost ratios differ with the initial condition of a cost in terms of pest infestation and moisture content; scale of production; and type and length of storage-all factors having an influence on the benefits and costs involved in improved storage. For example, for large scale storage a BCR of 5:1 is that which is the minimum acceptable while for a subsistance farmer the respective BCR may be 3:1 (Metcalf and Luckman, op. cit.). Naturally, the farmer will adopt a method (of improved storage) when he could get the highest BCR.

Empirical evidence on benefits from improved storage are numerous. For example, Lipton (1971) reports that the IRR (excluding the benefits of speculation), on improved storage systems tested is around 15 percent for maize, cow-peas and sorghum in West Africa; and (much less reliably) about the same for a range of crops in India. He also suggests that losses (particularly to African maize) are smaller, and hence returns to improved storage lower, than is normally believed. Low (1976) on the other hand concluded that use of ethylene dibromide prior to storage prevented losses by 20.6 percent-equivalent to a 5:1 BCR. There was thus a substantial marginal increase in total maize available for consumption and sale as a result of the reduced maize losses. Low (op. cit.) concluded further that the profitability of using improved maize practices is almost doubled when maize storage losses are reduced.

## 3.8 Chapter Summary

It is apparent from the above review that there are plenty of good technical discussions on rural storage. There are, however, very little discussions of economic relationships in crop storage in Tanzania and elsewhere. In many of the studies engineering optima are mixed up with economic optima.

The serious empirical studies in developing countries are mostly at research station level and tend to advocate the substitution (rather than improvement) of traditional storage structures for new storage techniques. The research station calculations of storage costs (especially labour costs) are evaluated at going market prices. The true cost to the peasant farm unit is far below the reasearch station estimate. This is because farmers use locally available materials and family labour that would otherwise stand idle, that is the opportunity costs for these resources are too low especially during the slack seasons.

In order to estimate the real benefits and costs to improved storage and alternative storage systems at farm level, this study conducts economic fieldwork basing on technical aspects primeditated during the pre-test survey. Bearing in mind the many categories of storage systems, two were selected for this study basing on their prominency in use and their adequacy on expected rates of return. A comparison of the economic and financial feasibility of improved traditional storage methods and the village communal (godown) structure is carried out. This determined which of the two systems is more paying in monetary terms. This study therefore provides the basis for the technical and economic aspects necessary for the introduction of effective farm storage in Tanzania. Details of the specifications of the study parameters are outlined under chapter IV below.

# CHAPTER IV

## METHODOLOGY AND MODELS FRAMEWORK

### 4.1 Introduction and Conceptual Framework

The economic evaluation of on-farm maize storage in Kilosa district of rural Tanzania encompasses three major aspects. Namely, to determine the patterns of farm-level storage; to evaluate the storage costs in terms of storage services and an examination of the rates of return to farmers practicing storage; and to determine the economic and financial returns which farmers could derive from farm storage improvements. The first aspect of the study has been done largely by explaining the harvesting and pre-storage practices, the extent of storage and the storage structures found in the survey villages and by estimating the size of storage, period of storage and storage losses. The second aspect is done by performing a temperal price analysis in relation to costs (both fixed and variable) of farm storage. For the final aspect BCR and IRR values of farm storage improvement are computed using the method described by Gittinger (1982). Each of these procedures and methods is now discussed in somewhat greater detail.

## 4.2 Pre-Test Survey

A pre-test survey was carried out in the district. The purposes of this pre-test were to: establish storage methods practiced in the district; to identify data sources; and to uncover field problems in the acquisation of the relevant data needed for the study. One leader was interviewed in each of the 4 villages initially proposed for the study and a maximum of 5 household heads were interviewed using the questionnaire. During this visit government and village leaders were visited to discuss the purpose of the study.

The researcher lived for one week in each of these villages to obtain a greater understanding of farming and maize storage aspects before the final questionnaire was developed (see Appendix I). The pre-test results showed that farmers were not able to remember what exactly they did with their food over time. Farmers do not keep records of what and how much food they dispose of per month. The problem of record keeping is mainly caused by the fact that food sales or disposals made by each family per month, are very small. Some individuals could sell food stuffs in bulks. Those had some kind of records. But those were mostly large scale farmers.

It was also noted from the pre-test survey that traders, school teachers and other civil servants indulged themselves in (maize) storage activities although they were not fully involved in agricultural activities. For purposes of completeness in conclusions derived from the study, these groups of households were also included in the final sample for interviewing.

In the final analysis only two villages (that in Ukwamani and Ulaya Kiboani - see section 1.6.2 above) were selected basing on three main reasons which were evident from the pre-test survey. Firstly, these two villages used two different types of structures which were prominent in the district (see full description of the structures under section 5.3.4). Secondly, the village godowns project sponsored by the Irish government (see section 1.6) was at the time of this study constructing godowns in these villages. It was thus convenient to get the necessary cost data needed to compare the performance of the communal storage and private (peasant) storage. Thirdly, it was from these very same villages where monthly parallel market price data needed for the temporal price analysis for the 1985/86 and 1986/87 marketing seasons were readily available (see appendix II).

## 4.3 Data Collection Procedures

### 4.3.1 Sources of Data

Both primary and secondary data sources were used to gather information needed for the analyses in this study.

Primary data were obtained from farmers by means of a questionnaire ( see Appendix I). These data were mainly used to analyse the farmer's storage practices. Other primary sources of data included (personal) observations and participation in some of the storage activities by the researcher.

Secondary data were mainly obtained from the Early Warming and Monitoring Unit (EWMU) and the MDB. Other sources included the NMC and the TFNC. These data included climatic factors, official and parallel market prices of maize and other staples, storage improvement programs and food grain marketing trends.

There were no formal questionnaires for the major part of the secondary data. Instead, questionnaires were prepared before-hand and discussed with the relevant authorities of the data sources. The authorities were found to be conversant and well apt to interviews and discussions. In many cases they voluntereed much detailed and useful information which had not been thought possible to obtain before-hand; for example maize trade balances and costs of materials used in the construction of the village godowns were readily available for the periods 1985/86 and 1986/87.

### 4.3.2 The Sampling Procedure

The sampling procedure applied to the farmers of the two survey villages, that is Ukwamani in Northern Kilosa and Ulaya Kiboani in Southern Kilosa. Ukwamani has a total number of 283 households while Ulaya Kiboani has 800 households.

#### 4.3.2.1 The Sample Size

The populations (N) from which the samples were chosen was the total number of households registered by the village authorities for the 1986/87 cropping season. These numbers were 283 and 800 for Ukwamani and Ulaya Kiboani respectively. A sample (n) was chosen from each of these villages such that n/N was at least equal to or greater than 5 percent of the total number of households (Boyd et al., 1981). For purposes of this study a sample size of 50 farmers from each of the two villages was adopted.

#### 4.3.2.2 The Sample Selection

The sample of 50 respondents was drawn randomly from the register of farmers provided by the village secretary for each of the two villages. No regard was given to the spatial distribution of farmers in a village so long as they fell within the village.

#### 4.3.2.3 The Formal Survey and Questionnaire Administration

The main method which was used to collect primary data was a formal survey. A questionnaire of the format in Appendix I was administered with the assistance of two enumerators over a discontinous period of four months (December 1986 - March 1987).

Each enumerator was able to interview at least 2 farmers per day and a maximum of 5 farmers a day depending on the willingness of the respondents to answer questions quickly. Where a farmer was not present during a visit, his wife was interviewed. Where both were absent during a visit, arrangements were made to call back again some other time.

## 4.4 Hypothesis Testing and Models Specification

To meet the objectives of the study (outlined under section 1.4) functional relationships between variables gathered during data collection were carried out. To test the hypotheses put forward under the study some specific methods and models of analysis were applied. This section specifies these methods and models and the variables involved in the testing of each hypothesis. Under this section the source of each variable and the postulated or theoretical behaviour of the models used are outlined.

The main analytical methods utilized in this study are descriptive analysis, cross-tabulations, spatial price analyses and financial analysis. Descriptive analyses and cross-tabulation are used to identify farmer conditions and constraints, and storage patterns. Temporal price analysis is used to test the relationship between price variations over time and storage costs. Financial analysis, like BCR and IRR calculations are used to evaluate returns to improved rural storage. Using these principles, the analytical methods used in this study are discussed according to the three main issues that are examined in this thesis.

### 4.4.1 Maize Storage Patterns and Marketing Decisions

The first issue seeks to establish maize utilization and storage systems. The survey results are tabulated using frequency tables and charts to show the actual situation in the study area. This is important in understanding the systems and in evaluating the existing maize storage practices and marketing decisions.

The verification of study hypothesis number (i), that farmers with marketable surplus store grain to take advantage of high prices in the lean season is achieved by collecting data on the time/month when farmers with marketable surplus sell their produce and at what prices -that is, if they decide to sell their grain in the parallel market.

### 4.4.2 Temporal Price Analysis

The second proposition of the study seeks to determine the temporal price behaviour. The nature of temporal price relationships for the 2 selected villages during 1985/86 and 1986/87 were examined by analysing seasonal price variations in relation to costs of storing grain. This analysis meets objective number (ii) of the study, that is, evaluation of storage costs and the significance of these costs in explaining seasonal price variations. The second hypothesis, that post-harvest price increases in the private market equal cost of storage is thus verified.

The expected seasonal increase in price per (90 Kilogram) bag which would be consistent with a perfect market may be calculated as follows: (Hays and McCoy, 1978).

$$E(P_{ti}) = P_{to} + t(I + L + D) \qquad (4.1)$$

where

$E(P_{ti})$ = expected price per bag of grain stored in $i^{th}$ month (that is, including storage costs).

$t$ = time in months, i = 0, ..., 11 months.

$P_{to}$ = price of one bag stored at harvest, that is, t = 0

I = interest of capital needed for the purchase of one bag of grain for storage; estimated at 1.5 percent per month, which is based upon the rate charged by banks for short-term advances.

L = amount of grain losses over time.

D = depreciation of storage structures used in storing one bag of grain.

The net seasonal rise in price (the rise above that considered consistent with storage costs) for any period would be: (Hays and McCoy, op. cit.).

$$NSRP_{ti} = P_{ti} - E(P_{ti}) \qquad (4.2)$$

where

$NSRP_{ti}$ = the net seasonal rise in price in $i^{th}$ month.

$P_{ti}$ = parallel market price of one bag of maize stored in $i^{th}$ month.

$E(P_{ti})$ = expected price per bag of grain stored in $i^{th}$ month (that is, including storage costs).

Assuming perfectly competitive conditions the net seasonal increase in prices will equal zero, which means the seasonal price rise just equal to the computed storage cost.

In most analyses maize loss estimates are based on physical weight loss, that is quantitative loss. Weight loss is used because it provides the most comprehensive comparable measure of food loss. Weight loss is the most important category of storage loss, not least because it can be accurately measured and valued.

For this study, the losses in store were determined by taking a representative sample from each store and sorting out the damaged and the healthy grains. The percent damage was then arrived at as follows: (Mphuru and Maro, 1975).

$$\% \text{ Damage} = \left(\frac{n_1}{n_2}\right).100 \qquad (4.3)$$

where

$n_1$ = total number of unhealthy grains in the sample.

$n_2$ = total number of seeds in the sample

This method of estimating damage was chosen because it was the easiest to carry out, especially with maize. Thus no account was taken for weight loss or nutritive quality loss because such assessment was very difficult to do in the field. Indeed determination of weight loss can only be done if the weight of every unit of produce at the beginning of storage and time of sampling were known, a thing which could not be done in this survey. Estimates of rodent damage were not possible and so reliance had to be placed on the farmer's word.

Farmers sell their produce in the parallel market in volume units of measurement. However, for purposes of this study a bag will be assumed to weigh 90 kilograms. Similarly the percentage loss of grain will be assumed to be on weight basis.

### 4.4.3 Economic and Financial Analysis of Farm Storage Improvements

The third and final aspect of this study deals with the benefits and costs of improving maize storage in the survey villages. In the analysis the profitability of storing maize under improved conditions and the comparative profitability of using different types of maize storage facilities are determined.

The output of a loss reduction program is measured by the value of food grain saved as a result of the improvements. For the private investor the appropriate price is the market buying price if the product is sold. The saving can also be measured by using the market price assuming food is purchased or the market. For analytical purposes it is assumed that grain is stored for sale in the context of this section.

Costs of a loss reduction program are the direct money costs the farmer incurs as a result of the investment decision. The costs of improving a storage structure include the investment costs of the improved storage facilities and the operating costs during the storage period. Operating costs include the costs of intermittent handling, depreciation of storage structures and interest on working capital.

4.4.3.1 Benefit-Cost Analysis (BCA)

Benefit-Cost analysis is a discounted measure of project worth. The present worth of the benefit stream is divided by the present worth of the cost stream to get the BCR. In this study the method is used as described by Gittinger (1982). The formula used to calculate the benefits of storage improvement is adopted from Boxall, *et al.*, (1978).

Mathematically,

$$BCR = \frac{\sum_{t=1}^{t=n} B_t/(1+i)^t}{\sum_{t=1}^{t=n} C_t/(1+i)^t} \qquad (4.4)$$

and

$$B_t = Q \times \frac{L}{100} \times \frac{(100 + Y)}{100} \times P_{to} \qquad (4.5)$$

where

BCR = benefit-cost ratio.

$B_t$ = financial benefit obtained in year t as a result of the storage improvement program.

Q = quantity of maize stored by farmer, taken to be 1 (90 Kilogram) bag.

L = percent of loss (at lean period) saved through improvements of storage facility.

Y = percent by which prices are higher in the lean season.

$P_{to}$ = farm harvest prices, taken to be TShs. 600 per (90 Kilogram) bag.

$C_t$ = financial costs (both fixed and variable) incurred in the improvement program.

i = discount factor, assumed to be 18 percent (that is, 1.5 percent per month) based upon the rate charged by bankers for short term advances.

t = the year when the benefit and costs are evaluated, that, t = 1,...,n.

n = number of years the project is assumed to last, that is, the life span of the improved storage structure.

The decision or selection criteria in benefit-cost analysis is usually to accept all independent projects with a BCR of greater than one when discounted at a suitable discount rate, most often the opportunity cost of capital.

4.4.3.2 Internal Rate of Return (IRR)

Internal rate of return is another discounted measure of projects' worth. It is the discount rate that just makes the Net Present Value (NPV) of the incremental cash flow equal to zero. IRR is the maximum interest that a project can pay for the resources used if the project is to recover its investment and operating expenses and still just break even.

Mathematically, IRR is calculated as: Gittinger (1982).

$$IRR = i_L + d_i \left[ \frac{PV_L}{PV_L + PV_u} \right] \qquad (4.6)$$

equals the discount factor, i, such that

$$\sum_{t=1}^{t=n} \frac{B_t - C_t}{(1 + i)^t} = 0 \qquad (4.7)$$

where

$i_L$ = Lower discount factor where the NPV is just negative. This is determined by an iterative method (see Gittinger, 1982, pp.332-339).

$d_i$ = difference between the discount factors. (To get this difference there must be on upper discount factor, $i_u$, where the NPV is just positive).

$PV_l$ = NPV at lower discount factor.

$PV_u$ = NPV at upper discount factor.

$B_t$ = financial benefit obtained in year t.

$C_t$ = financial cost incured in year t.

t = time factor, t = 1,...,n.

n = number of years, that is life span of the storage structure.

i = interest (discount) rate/factor.

The decision criteria, in the analysis of IRR is to accept all independent projects with an IRR greater than the opportunity cost of capital, also called the cut-off rate. In this study a cut-off rate of 18 percent- the rate charged by banks for short term advances is adopted.

4.4.3.3 <u>Sensitivity Analysis</u>

To test systematically what might happen to the earning capacity of storage projects if events differ from the estimates made about them in planning, sensitivity analysis was carried out. This involved mainly the communal village godown. Parallel market prices and grain loss levels of traditional storage after average periods of storage were assumed. This test is justified to allow for a sound comparison of the communal storage financial performance to the private farmers' storage. This is due to the fact that farmers often prefer to sell their produce at parallel market prices rather than the relatively lower official prices.

## 4.5 Limitations of the Methodology

Ideally an evaluation of storage systems should include widespread coverage of the industry as well as changes over time. However, the necessity for the researcher to collect the data requires a compromise between widespread coverage of the industry and detail in data collected.

Due to time and financial constraints the selection chosen in this study was to consider a small segment of the industry for a study in 4 months (December, 1986 to March, 1987). The study was then supplimented by secondary data. This study is limited to Kilosa district of Morogoro region. Costs of farm grain storage in this area may not be the same as in all other parts of the cash-grain production regions of the country. The accuracy of the data collected is also limited as much of the data depended on the farmers memory. Thus, the extent to which findings of this research can be generalized is limited. However, it is believed that the objectives of the study were met.

Perhaps the greatest value of this report is the guidelines that it provides for computing costs of farm storage and other suggestions that may be valuable in deciding whether to build improved on-farm grain storage. Suggestions for effective pricing policies are also a valuable observation from this text.

# CHAPTER V

# EMPIRICAL EVIDENCE

## 5.1 Introduction

This analysis is based on 100 farmers of 2 villages. In this chapter the survey results on maize storage at farm level are presented. Prior to the discussion of storage patterns, temporal price movements and farm storage improvements, the importance of maize in the study area is explored. This is intended to show the existing farming practices and the socio-economic circumstances that determine maize post-harvest practices in Kilosa district. This forms the basis of evaluating the subsequent analysis of price variations over time as related to storage costs and farm storage improvement aspects.

## 5.2 Importance of Maize in the Survey Villages

The major food crops grown in Kilosa district and indeed the survey villages are maize, rice, sorghum, millet, plantains, sugarcane and beans. The average areas under maize cultivation were 1.82 hectares and 2.12 hectares for Ulaya Kiboani and Ukwamani respectively. The respective average total arable land owned by farmers per season in the two villages were 2.36 hectares and 2.33 hectares. This implies that maize hectarage is the highest of the crops grown by farmers per season in the survey villages.

The proportion of farmers practicing maize cultivation in the two villages indicates that there are three major categories of producers. Table 5.1 shows that the majority of farmers (65 percent) grew less than 2 hectares of maize per season. These are the small producers. About 23 percent grew between 2 hectares and 5 hectares. These are the medium producers. Large scale producers are those farmers who had more than 5 hectares under maize cultivation. These constituted 12 percent of all producers.

Table 5.1: Distribution of Households in Survey Villages by Size Class of Land Under Maize Cultivation

| Size of land | Survey Village | | | | Total | |
|---|---|---|---|---|---|---|
| | Ukwamani | | Ulaya Kiboani | | | |
| Ha | No | % | No | % | No | % |
| < 2 | 30 | 60 | 35 | 70 | 65 | 65 |
| 2-5 | 12 | 24 | 11 | 22 | 23 | 23 |
| 5-10 | 5 | 10 | 3 | 6 | 8 | 8 |
| >10 | 3 | 6 | 1 | 2 | 4 | 4 |
| Total | 50 | 100 | 50 | 100 | 100 | 100 |

Source: Own survey data, 1987.

The area under cultivation indicates the importance of maize both as a cash crop and a food crop. Tables 5.2 and 5.3 show that about 84 percent of farmers in Ukwamani and 60 percent of farmers in Ulaya Kiboani reported maize as the most important food crop. About 10 percent of farmers in Ukwamani and 22 percent farmers in Ulaya Kiboani reported sorghum and rice as the respective major staple food crops. Maize is also reported as the major cash earner by 80 percent and 52 percent of farmers in Ukwamani and Ulaya Kiboani respectively. Sorghum was indicated as a major cash crop by 8 percent of farmers in Ukwamani. About 30 percent of farmers in Ulaya Kiboani indicated cotton as the major cash crop while 12 percent reported rice.

Table 5.2 Most Important Food and Cash Crops to Farmers in Ukwamani

| Crop | Important food crop | | Important cash crop | |
|---|---|---|---|---|
| | No | % | No | % |
| Maize | 42 | 84 | 40 | 80 |
| Sorghum | 5 | 10 | 4 | 8 |
| Other | 3 | 6 | 6 | 12 |
| Total | 50 | 100 | 50 | 100 |

Source: Own survey data, 1987.

Table 5.3: Most Important Food and Cash Crops to Farmers in Ulaya Kiboani

| Crop | Important food crop | | Important cash crop | |
|---|---|---|---|---|
| | No | % | No | % |
| Maize | 30 | 60 | 26 | 52 |
| Rice | 11 | 22 | 6 | 12 |
| Cotton | - | - | 15 | 30 |
| Other | 9 | 18 | 3 | 6 |
| Total | 50 | 100 | 50 | 100 |

Source: Own survey data, 1987.

Maize is the major staple food crop in Kilosa district because of the more favourable climate for maize production than the other crops. The flat low-land plains and the valley bottom lands with sandy loams and sandy clays governs the productivity levels sufficient for maize production. An average annual rainfall amount of 1026 millimetres and temperatures ranging between 23 degrees centigrade and 30 degrees centigrade for most parts of the year in Kilosa district are quite sufficient for maize production. In the district local maize varieties take an average of three to four months to mature. This implies that it is readily available for domestic utilization within a short growing season. Besides, there is a minor maize crop which preceeds the major harvest. This coupled with effective maize storage decisions ensures availability of maize for the larger part of the year.

Of recent maize has been replacing cotton as a major cash crop in Ulaya Kiboani and indeed other parts of the district. This is due to lack of market outlets for cotton. Cotton farmers can only sell their cotton to the Tanzania Cotton Authority (TCA) which offers low and delayed payments. Farmers responded by shifting to other crops which pay highly and immediately at time of selling. Ukwamani farmers on the other hand do not grow any of Tanzania's main cash crops. Alternatively they have for long been growing maize and sorghum which also serve as the cash sources in addition to food needs. As a result maize has become the major cash crop in both Ulaya Kiboani and Ukwamani villages.

## 5.3 Pattern of Maize Storage and Utilization of Stored Maize

The pattern of maize storage and use of stored produce is greately influenced by size of output, types of crops grown, market availability and expectations of better prices during the lean season. In this section patterns of maize storage in the survey villages are explained. The utilization of stored produce with emphasis on the marketing decisions by farmers with marketable surplus are explored to asses the prices and duration of selling of stored marketable surplus.

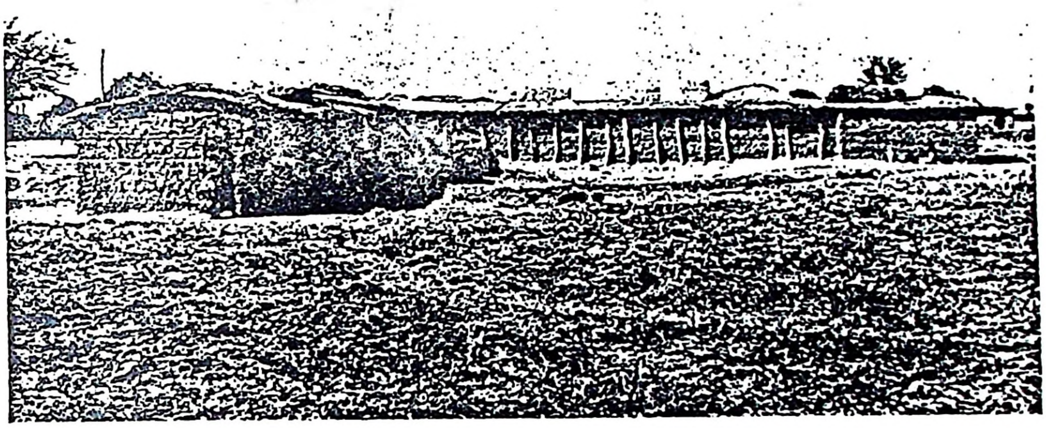
5.3.1 Harvesting and Pre-Storage Practices

Maize is harvested in March and April in Ulaya Kiboani and in April and May in Ukwamani. The cereal cobs are stored with husks in Ulaya Kiboani. Ukwamani farmers, however, thresh the maize before storing it. Maize cobs are generally removed from the standing stalks when they are physiologically mature. They are then bundled in the field and carried home where they are dried either with husks or without husks but unshelled. The drying is done on tops of houses or in special temporary structures as shown in figures 5.1 and 5.2 below. Where maize is shelled before being stored the shelling is done a month after harvesting.

5.3.2 Incidence of Storage

Table 5.4 shows the percentage of households and of producers storing maize and the percentage of production stored in the survey villages. The need of paying more attention to farm level storage is vivid because 72.5 percent of grain was stored. On a non-market economy some non-producers, for example teachers and clerks, also store for consumption later on. They get this mainly through purchases.

Figure 5.1: DRYING MAIZE ON ROOF PRIOR TO STORAGE



Source: Own survey, 1987.

Figure 5.2: DRYING MAIZE IN A SPECIAL STRUCTURE PRIOR TO STORAGE

Source: Own survey, 1987.

Table 5.4: Percentage of Households and of Producers Storing and Percentage of Production Stored in Survey Villages

| Village | Households storing | Producers storing | Produce stored |
|---|---|---|---|
| | % | | |
| Ukwamani | 86 | 76 | 60.8 |
| Ulaya Kiboani | 78 | 70 | 84.2 |
| Average | 82 | 73 | 72.5 |

Source: Own survey data, 1987.

Tables 5.5 and 5.6 show the percent of households storing maize in the villages by size of land and the distribution of produce stored by size of land respectively. These tables show where the need for improvement of storage is more pressing. The correlation between farm size and percent of households storing is clearly high. It is observed that farmers with an average area of less than 2 hectares store most share of stored output, that is 44.1 percent.

Table 5.5: Percentage of Households Storing Maize by Size of Land

| Size of land | Survey village | | Total (Average) |
|---|---|---|---|
| | Ukwamani | Ulaya Kiboani | |
| Ha | % | | |
| <2 | 46 | 48 | 47 |
| 2-5 | 24 | 22 | 23 |
| 5-10 | 10 | 6 | 8 |
| >10 | 6 | 2 | 4 |
| Total | 86 | 78 | 82 |

Source: Own survey data, 1987.

Table 5.6 Distribution of Maize Stored by Size of Land

| Size of land | Survey village | | Total (Average) |
|---|---|---|---|
| | Ukwamani | Ulaya Kiboani | |
| Ha | % | | |
| <2 | 39.1 | 49.0 | 44.1 |
| 2-5 | 31.3 | 33.6 | 32.5 |
| 5-10 | 17.0 | 12.2 | 14.6 |
| >10 | 12.6 | 5.2 | 8.9 |
| Total | 100.0 | 100.0 | 100.0 |

Source: Own survey data, 1987.

5.3.3 Size/Number of Storage Stuctures

The choice of size of store or number of stores is highly dependent on amount of grain stored. Table 5.7 gives the quantity of maize stored per household by size of land. The quantity varies from 6.5 (90 kilogram) bags to 21 bags. As expected, quantity of maize stored increases with the increase in farm size. Appendix III explains how the average capacities of the traditional structures evaluated in this study were determined.

Table 5.7: Quantity of Maize Stored per Household by Size of Land

| Size of land | Survey village | | Total (Average) |
|---|---|---|---|
| | Ukwamani | Ulaya Kibaoni | |
| Ha | Bags[1] | | |
| <2 | 8.5 | 6.5 | 7.5 |
| 2-5 | 13.0 | 9.8 | 11.4 |
| 5-10 | 17.0 | 13.0 | 15.0 |
| >10 | 21.0 | 16.5 | 18.8 |
| Average (weighted) | 11.6 | 8.2 | 9.9 |

Source: Own survey data, 1987.

[1] The bags are estimated at a weight of 90 kilograms each.

### 5.3.4. Storage Structures Found in Survey Villages

Although the type of storage structures is partly determined by amount to be stored, it also depends on the availability of local construction materials and life styles. Where local construction materials are scarce, the materials can be bought from nearby villages. A few farmers store their produce in small units like pots. However, quantity stored determined the size of store directly. It was revealed in the study that the same types of storage structures are not of equal importance in the whole of Kilosa district. Table 5.8 shows that farmers in Ukwamani village in Northern Kilosa use predominantly the "chidong'a" type of structure, while those of Ulaya Kibaoni in Southern Kilosa use the "chanja" type of stucture. Most storage granaries were erected within the household premises.

Ukwamani peasants are semi-pastoralists and they often shift to places of better pasture for their livestock. This compels them to use the "chidong'a" which can be shifted easily. Unlike for Ulaya Kibaoni, local construction materials are scarce and so is space enough for constructing separate storage structures outside the main living houses.

Table 5.8: <u>Percent Distribution of the Total Quantity of Maize Stored in the Survey Villages by Type of Storage Structure</u>

| Type of structure | Survey village | |
|---|---|---|
| | Ukwamani | Ulaya Kibaoni |
| | % | |
| Chidong'a | 80.5 | 14.5 |
| Chanja | 15.3 | 81.6 |
| Other | 4.2 | 3.9 |
| Total | 100.0 | 100.0 |

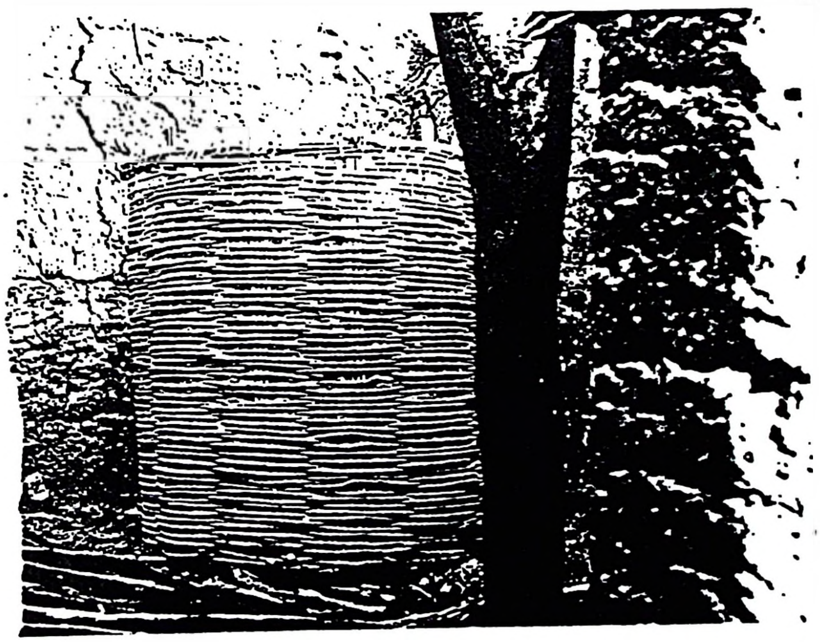
Source: Own survey data, 1987.

The "chidong'a" is a cylindrical shaped structure and is usually made of interwoven reeds, or bamboo splits depending on the availability of materials. It is sometimes daubed with thin layer of mud or cowdung. It may stand on the ground but often times it is built on platform. The "chidong'a" has no roof. Food is taken from the top which may or may not be covered. The capacity is very variable but most of the granaries observed in the area varied from one to two tons (that is 10 to 20 bags). An average capacity of 16 bags was calculated from the survey (see Appendix III). The average life span is 12 years.

The "chanja" is a rectangular hut about 5 metres long and 4 metres wide. The height can be anything between 4 and 5 metres. The huts are built of strong timber. The bed (or ceiling) may be constituted of bamboo splits or other stakes. The house can of course last for about 11 years but the bed is normally replaced every 4 to 6 years.

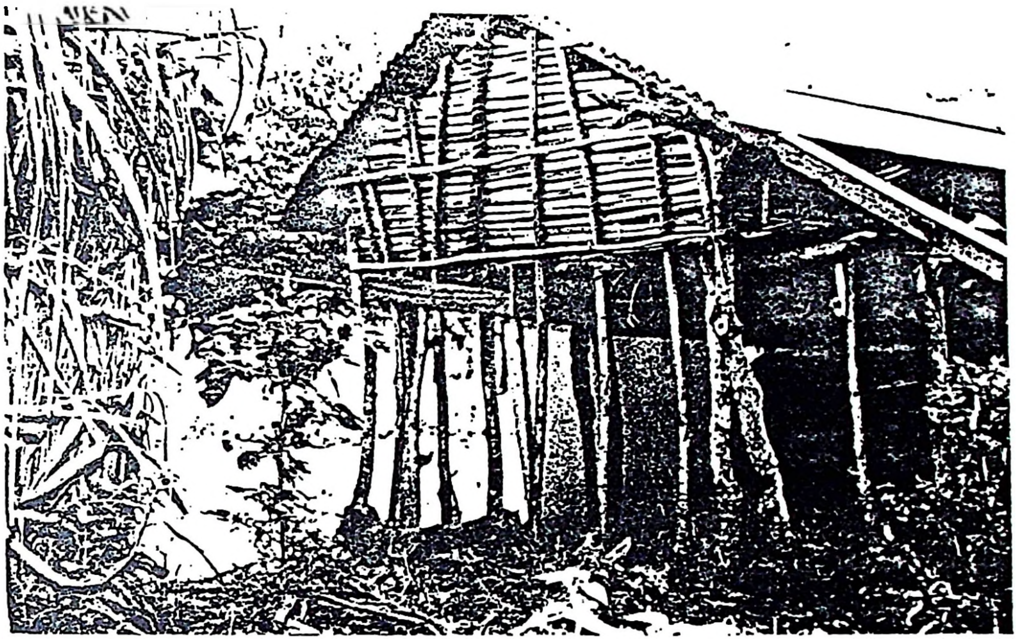
Following the decision to build village godowns, both villages now have their own modern communal godowns. Figures 5.3, 5.4 and 5.5. show these three major types of storage structures met in the survey villages and which are the basis of this survey.

Figure 5.3: THE "CHIDON'GA" TYPE OF STORAGE STRUCTURE USED IN UKWAMANI VILLAGE



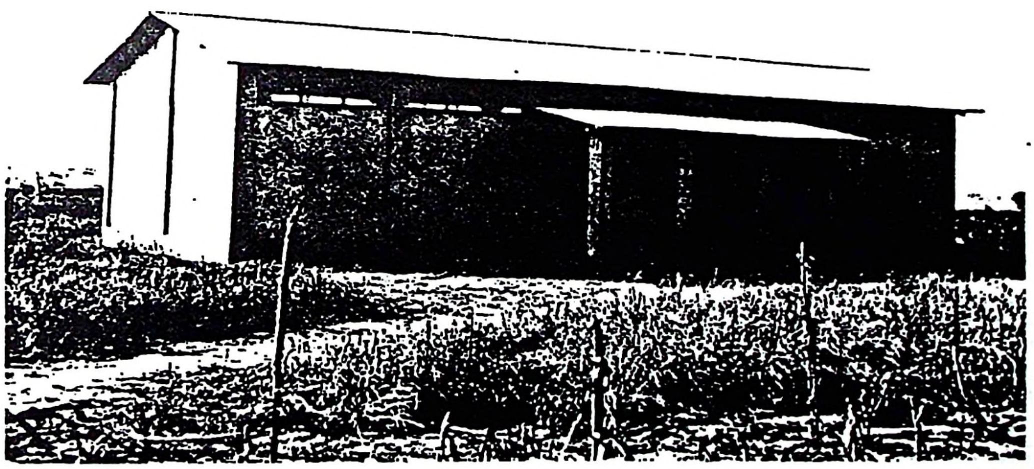
Source : Own survey, 1987.

Figure 5.4: THE "CHANJA" TYPE OF STORAGE STRUCTURE USED IN ULAYA KIBAONI VILLAGE



Source: Own survey, 1987.

Figure 5.5: THE MODERN GODOWN



Source: Own Survey, 1987.

### 5.3.5 Utilization of Stored Produce and Marketing Decisions of Farmers With Marketable Surplus

#### 5.3.5.1. Purpose of Storage

In addition to the need for consumption during the year and for seed at the next sowing season, there are other social and economic obligations that are spread over the year and these make it necessary to store grain. Table 5.9 shows that farmers stored grain mainly for food, seed and sale. This observation finds support from Boxall, et al, (1978). For small farmers a high percent of total quantity stored was for consumption; it declined with the increase in the size of farm. For example farmers with an average of less than 2 hectares stored an average of 5.5 bags for food out of their total production level of 8.3 bags. The respective figures for farmers with an average area of more than 10 hectares were 7.3 bags and 28.92 bags.

From table 5.9 and figure 5.6 it can be seen that consumption was a major reason for almost all households storing grain. In total about 25.50 (48 percent) of the quantity stored was for food. The sales share was 16.23 bags (31 percent). Seed and other socio-economic purposes accounted for a small quantity; the relative shares being 4.92 bags (9 percent) and 6.00 bags (11 percent).

Table 5.9: Average Quantity of Maize Produced and Stored by Land Size[1]

| Land Size | Quantity per household | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Produced | Sold Immediately | Stored for seed | Stored[2] for food | Stored for sale | Stored for other uses | Total stored produce[1] | |
| Ha | Bags | | | | | | | % |
| <2 | 8.30 | 0.80 | 0.23 | 5.50 | 1.37 | 0.40 | 7.50 | 90.0 |
| 2-5 | 14.80 | 3.40 | 0.79 | 6.20 | 3.21 | 1.20 | 11.40 | 77.0 |
| 5-10 | 20.60 | 5.60 | 1.68 | 6.50 | 5.02 | 1.80 | 15.00 | 72.8 |
| >10 | 28.92 | 10.17 | 2.22 | 7.30 | 6.63 | 2.60 | 18.75 | 64.0 |
| Total | 72.62 | 19.97 | 4.92 | 25.50 | 16.23 | 6.00 | 52.65 | - |

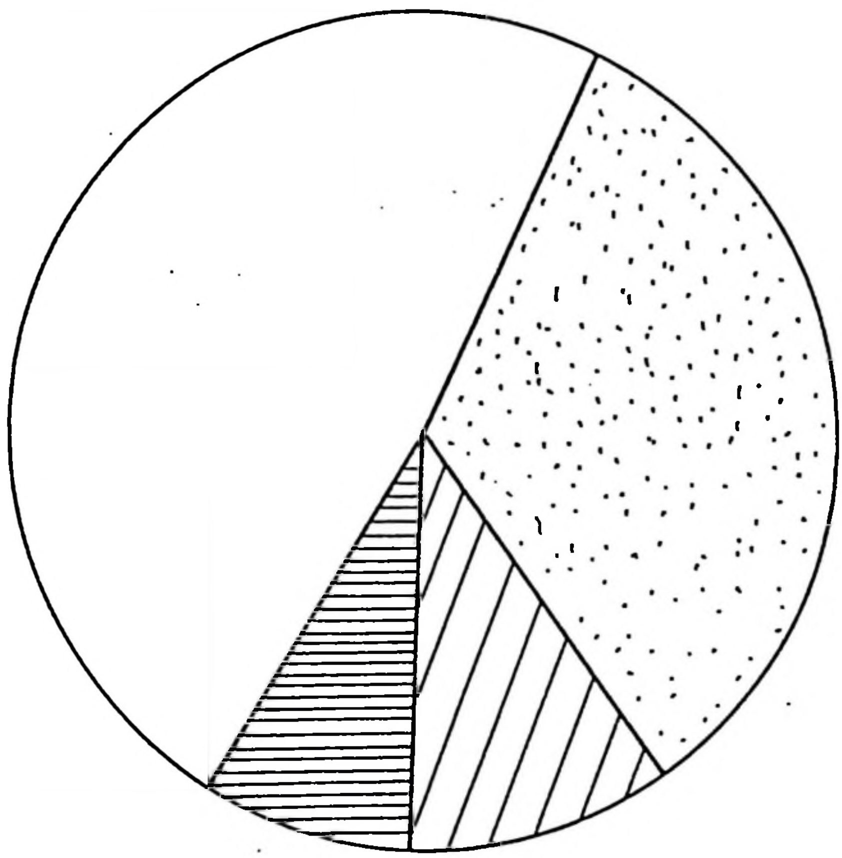
Source: Own survey data, 1987.

1 Total amount stored is 72.5 % (table 5.4) of total production (that is 52.65/72.62) and 27.5 % is sold immediately.

2 Although the quantity stored for home use increases relative to the quantity stored for sale it was not tested whether there is a correlation between larger area and family sizes.

Figure 5.6: UTILIZATION OF STORED MAIZE

IN SURVEY VILLAGES



Source: Derived from table 5.9, p. 118.

Sale (31 percent)
Other uses (11 percent)
Seed (9 percent)
Food (48 percent)

Table 5.9 also shows the different reasons for which grain has been stored by owners of different land size. For example 1.37 bags (18 percent) of the total quantity stored by small holders was for sale; similarly the share of consumption out of total stored produce drops from 5.5 bags (73 percent) of smallholders to 7.3 bags (39 percent) in case of large land owners. Consumption is the principle purpose of storage only in case of smallholders and it is overshadowed by sale in case of large farmers.

5.3.5.2. Period of Storage

Due to seasonality of production the grain stored on farms remain in store for fairly long periods. The average period of storage for the two survey villages worked out to be 8 months in Ukwamani and 9 months in Ulaya Kibaoni. Because of time limitations this study did not assess the rate of removals in the case of grain stored for purposes other than consumption. The rate of removals for grain stored for consumption was worked out from average amounts taken per month for household requirements.

Even though the rate of removals could depend on many variables like size of family, income earned outside farm activities and level of education no attempt was made in this study to assess the (individual) effects of these parameters on rate of removals. Many farmers (about 70 percent) accepted that the rate of removals are faster in the case of grain stored for purposes other than consumption as compared with the rate of removals for grain stored for consumption. This suggests perhaps as also suggested by Baxall et al., (1978) and Hays and McCoy (1978) that farmers, aware of the risk of failure in next harvest, store for consumption quantities larger than necessary.

5.3.5.3. Marketing of Maize

Farmers sell some maize soon after harvesting. About 28 percent (20 bags) of grain was sold immediately after harvest (recall table 5.9 above). All farmers who sold soon after harvest gave immediate cash needs as the reason for selling. However, most farmers (about 78 percent), indicated that they store maize for sale later. On the average about 16.23 bags (31 percent) of the crop is stored for sale later. The farmers' maize market outlets are shown in table 5.10. About 86 percent of the farmers sell maize on the farm to fellow villagers with deficits or traders and about 50 percent sell to the NMC through the primary co-operative societies.

Table 5.10: Market Outlets for Maize Growers in Survey Villages

| Market Outlet | Sample farmers[1] | |
|---|---|---|
| | No | % |
| on-farm/parallel | 43 | 86 |
| NMC/official | 25 | 50 |

Source: Own survey data, 1987.

[1] An individual farmer can sell through more than one market outlet.

From table 5.10, the main market outlet for farmers is on the farm. The main buyers are deficit families and traders. Nyangito (1986) deduced the same inference with reference to Kenyan potato market. The sale of maize in the official market outlet is limited. Farmers gave low prices and delayed payments as the reasons for the limited sales to the NMC. Farmers sell maize in the local market in small quantities wherever the need for cash to meet subsistance requirements is pressing.

Parallel market prices for maize are not controlled as is the case with the official NMC prices. Prices are determined by supply and demand forces and the price at which maize is sold is set through negotiations between the buyer and the farmer. To assess the behaviour of maize grain prices in the parallel market, price data for the two survey villages obtained from the EWMU were utilized.

For Ulaya Kibaoni monthly price data for the period between July 1982 and June 1987 were available. For Ukamani village data were available for the duration of 4 years, that is July 1983 to June 1987. These price data were used to calculate the monthly price indices for maize grain in the two survey villages. Table 5.11 and Figures 5.7 and 5.8 present these indices. For details of the calculation of these indices see Appendix II.

Maize prices are usually lowest in June (index 62) and April (index 73) for Ukwamani and Ulaya Kibaoni respectively. This is the time immediately after harvest. From harvest prices start rising as supplies decrease until January-February (index 145) for Ukwamani and January (index 146) in Ulaya Kibaoni. At that time farmers will evaluate their stock and make a first assessement of expected harvest in the current production year. Eventually farmers will start releasing old stocks from January onwards and as supplies improve again, prices start falling back as the harvest comes nearer. The following section relates the seasonality in parallel market prices of maize in relation to selling decisions of farmers with marketable surplus in line with study hypothesis number (1).

Table 5.11: Monthly Price Indices for Dried Maize on the Open Market in Survey Villages

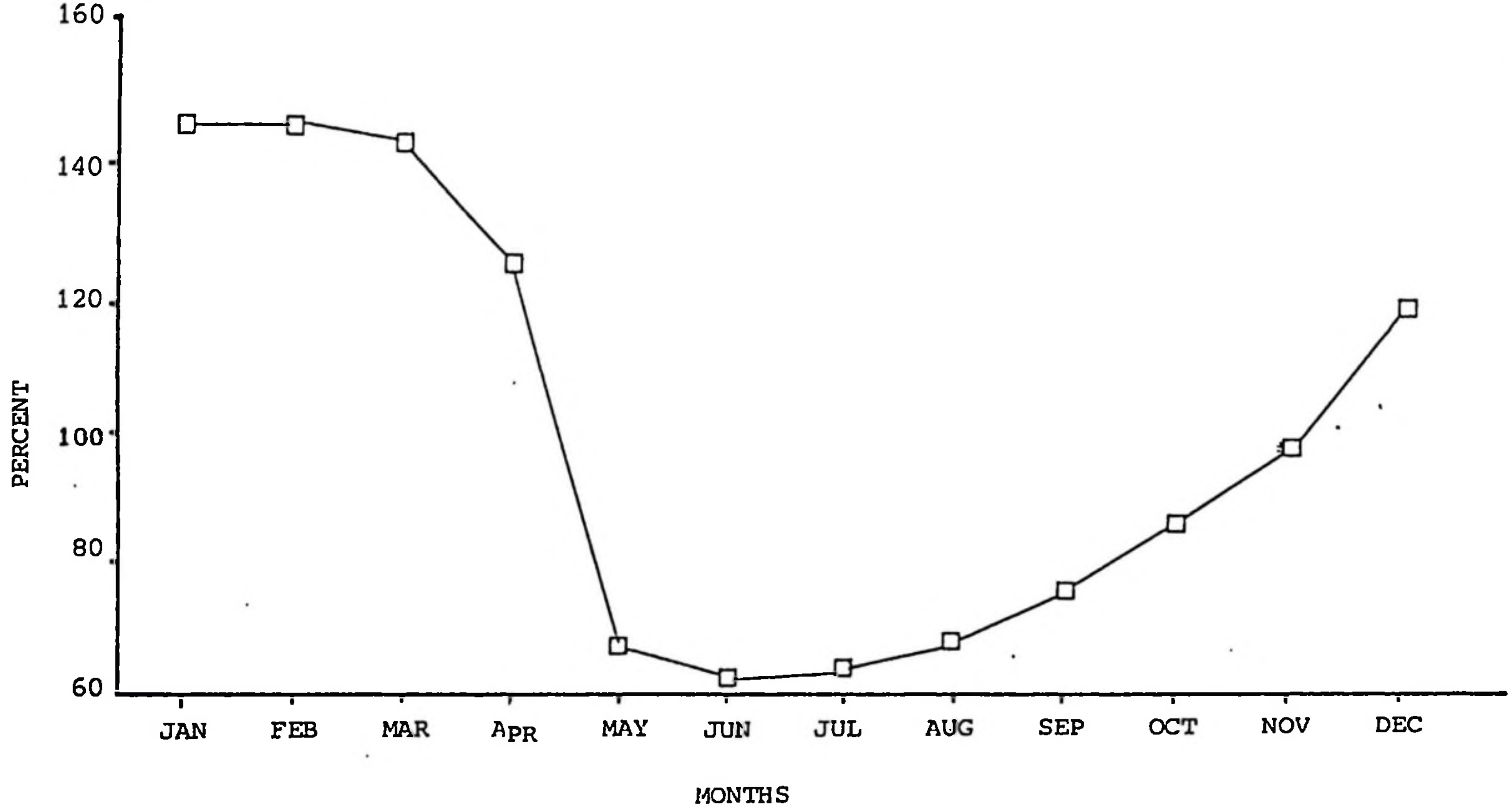
| Month | Survey village | |
|---|---|---|
| | Ukwamani | Ulaya Kibaoni |
| | % | % |
| January | 145 | 146 |
| February | 145 | 118 |
| March | 143 | 92 |
| April | 126 | 73 |
| May | 67 | 79 |
| June | 62 | 93 |
| July | 64 | 79 |
| August | 68 | 79 |
| September | 76 | 92 |
| October | 86 | 98 |
| November | 98 | 119 |
| December | 120 | 132 |

Source: Calculated from montly price data from DADO Office, Kilosa, 1987.

#### 5.3.5.4. Decision Criteria for Hypothesis Number (i)

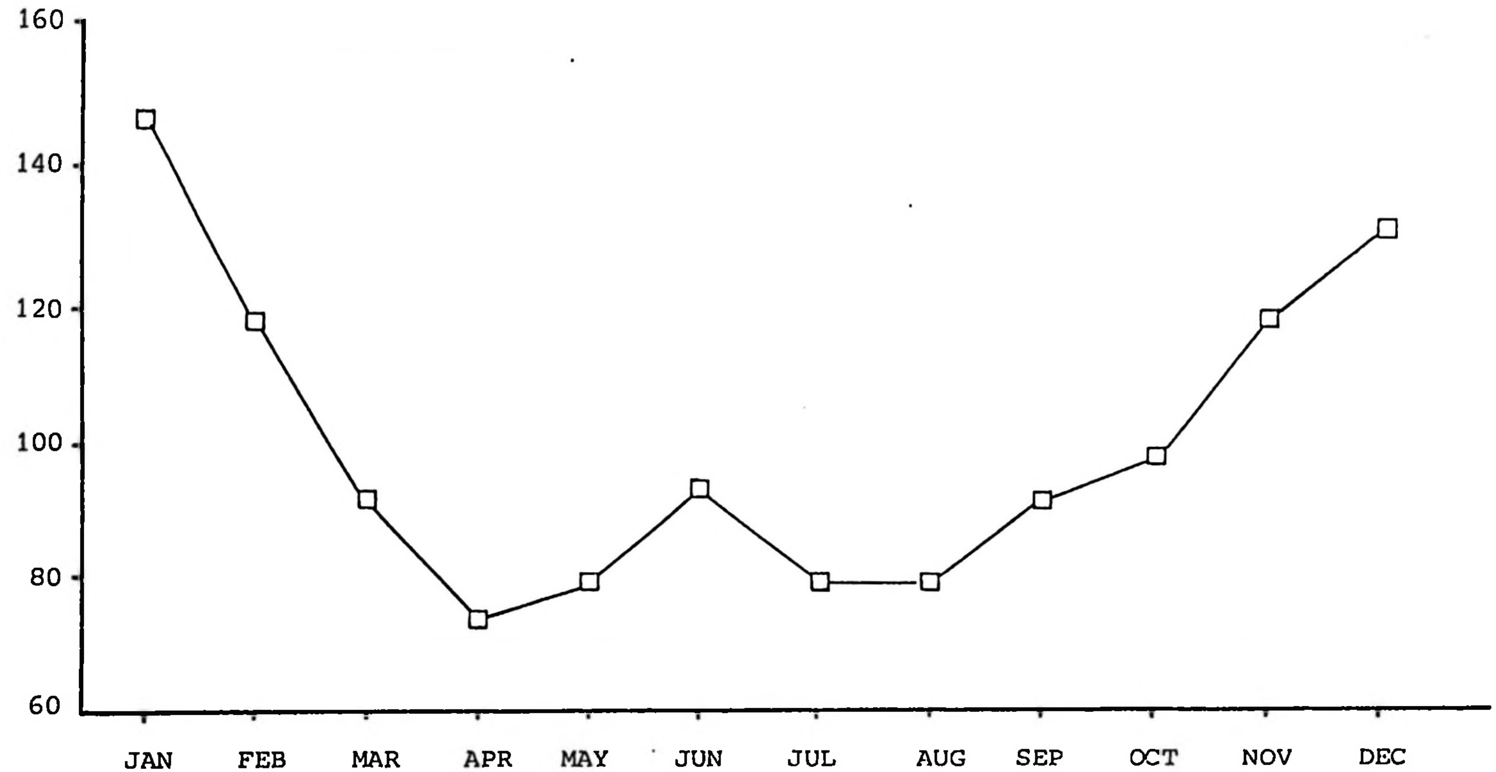
This hypothesis states that farmers with marketable surplus store grain to take advantage of high prices in the lean season. Almost all farmers with marketable surplus (94 percent) indicated that they sell their stored produce between December and

Figure 5.7: UKWAMANI VILLAGE: MONTHLY PRICR INDICES OF DRIED MAIZE, 1983/84 - 1986/87




Source: Derived from Table 5.11, p. 124.

Figure 5.8: ULAYA KIBAONI: MONTHLY PRICE INDICES OF DRIED MAIZE, 1982/83 - 1986/87




Source: Derived from table 5:11, p. 124.

January. Of the 94 percent, 86 percent gave high parallel market prices later in the season as the reason for the delayed sale. The remaining 8 percent indicated that they do so to dispose of the previous crop to be able to prepare and/or repair stores ready for the next harvest.

There is thus sufficient evidence from this study that farmers in fact dispose of their marketable grain in a manner consistent with sound economic behaviour. In other words the stronger the effective market demand as expressed by high prices, the greater the volume of maize supplied. Hypothesis one is therefore accepted.

The above price analysis did not consider the aspect of storage costs incurred by farmers storing grain. Section 5.4 below establishes the relationship between the costs of storage and the temporal price variations. This gives the nature of the profits/losses experienced by farmers practising farm storage aimed for future sales.

## 5.4. Temporal Price Relationships and Returns to Storage

Pricing efficiency can be measured by examining the increase in the seasonal price of grain in relation to the costs of storing grain over the season. In an attempt to test the second hypothesis of the study, that is, parallel market prices of maize grain varies directly with storage costs, the seasonal price changes in typical storage practices were analysed for the survey villages during the period between 1985/1986 and 1986/1987.

### 5.4.1 Cost of Storage in Traditional Storage Structures.

Information on the costs of storing grain was obtained by interviewing farmers in the survey villages. Storage costs are comprised of depreciation of storage structures, annual repair costs, interest rate of money tied up in the stored grain, and material losses of grain. No attempt was made to calculate a return to farmers for entrepreneurial ability. Furthermore, since only 6 percent of farmers indicated using chemicals to protect the crop in granaries, costs of chemicals are not considered as part of the costs of traditional storage. Instead they are taken as part of the costs of improved storage.

#### 5.4.1.1 Depreciation Costs

Tables 5.12 and 5.13 details the costs of storage in the "chanja" and "chidong'a" respectively. The total costs of constructing a 12 bags "chanja was Tshs. 1500, if it is done by a special craftsman. The respective amount for a 16 bags "chidonga" was Tshs. 500. If the farmer builds the structure himself, the explicit materials cost will be Tshs. 1130 for the "chanja" and Tshs. 315 for the "chidong'a". Taking the total costs of construction to be Tshs. 1500 and Tshs 500 and assuming life spans of 11 years for the " chanja " and 12 years for the

Table 5.12: Ulaya Kibaoni: Storage Costs and Component Costs of Constructing a 12 Bags "Chanja", 1985/86 - 1986/87

| Determinant of storage costs | | Component costs | |
|---|---|---|---|
| Determinant | Measure | Item | Cost |
| | Bags | | TShs. |
| Storage capacity[1] | 12 | Pillars | 300.00 |
| | | Rafters | 200.00 |
| | | Stakes | 360.00 |
| | Yrs | Twine | 120.00 |
| | | Thatching grass | 150.00 |
| Ave. life expectancy | 11 | Labour[5] | 370.00 |
| | | Total | 1500.00 |
| | TShs. | | |
| Annual depreciation | 136.40 | | |
| Annual repairs | 77.00 | | |
| Annual cost of store | 213.40 | | |
| Annual storage cost per bag | 17.80 | | |
| Annual value of storage losses per bag[2] | 152.10 (140.10) | | |
| Annual interest per bag[3] | 90.00 (108.00) | | |
| Annual total storage cost per bag | 259.90 (265.90) | | |
| Total monthly storage cost per bag | 21.70 (22.20)[4] | | |

Source: Own survey data, 1987.

[1 For details of capacity calculation see appendix III.

[2 Based at 17.3 percent annual loss as per section 5.4.1.3. above and an average annual parallel market price of TShs. 879.00 per bag for 1985/86 and TShs. 810.00 for 1986/87. See appendix II for price data.

[3 Based at an interest rate of 15 percent (1985/86) and 18 percent (1986/87) per annum and harvest price of TShs. 600.00 for both seasons.

[4 Figures in parenthesis are for the 1986/87 season.

[5 Labour cost is for construction including roofing, plastering and thatching. Based at TShs. 37.00 for a 10 hour manday.

Table 5.13: Ukwamani: Storage Costs and Component Costs of Constructing a 16 Bags "Chidong'a", 1985/86 - 1986/87

| Determinant of storage costs | | Component costs | |
|---|---|---|---|
| Determinant | Measure | Item | Cost |
| | Bags | | TShs. |
| Storage capacity [1] | 16 | Pillars | 60.00 |
| | | Crossbars | 30.00 |
| | | Stakes | 180.00 |
| | Yrs | Twine | 45.00 |
| Ave. life expectancy | 12 | Labour [5] | 185.00 |
| | | Total | 500.00 |
| | TShs. | | |
| Annual depreciation | 41.70 | | |
| Annual repairs | 37.00 | | |
| Annual cost of store | 78.70 | | |
| Annual storage cost per bag | 4.90 | | |
| Annual value of storage losses per bag [2] | 131.70 (131.70) | | |
| Annual interest per bag [3] | 90.00 (108.00) | | |
| Annual total storage cost per bag | 226.90 (244.60) | | |
| Total monthly storage cost per bag | 18.90 (20.40) [4] | | |

Source: Own survey data, 1987.

[1 For details of capacity calculation see appendix III.

[2 Based at 13.3 percent annual loss as per section 5.4.1.3. above and an average annual parallel market price of TShs. 990 per bag for 1985/86 and TShs. 810.00 for 1986/87. See appendix II for price data.

[3 Based at an interest rate of 15 percent (1985/86) and 18 percent (1986/87) per annum and harvest price of TShs. 600.00 for both seasons.

[4 Figures in parenthesis are for the 1986/87 season.

[5 Labour cost is for construction including roofing, plastering and thatching. Based at TShs. 37.00 for a 10 hour manday.

"chidong'a" respectively (as estimated from the survey), the annual straight line depreciation expenses turns out to be Tshs. 136.40 and Tshs. 41.70 for the "chanja" and the "chidong'a" respectively.

5.4.1.2. Annual Repair Costs

The annual repair costs were reported to be Tshs. 77 for a "chanja" and Tshs. 37 for a "chidong'a". Adding these costs to the depreciation costs gives the annual storage costs as Tshs. 213.40 and Tshs. 78.70 for the "chanja" and the "chidong'a" respectively. The annual storage costs per bag of grain stored thus turns out to be Tshs. 17.80 for a "chanja" and Tshs. 4.90 for a "chidong'a".

5.4.1.3. Storage Losses

Annual storage losses were determined by two methods. For losses due to rodents the farmers estimate was adopted. For losses caused by insects and other agents the proportionate method described under section 4.4.2 was utilized. This method of loss estimate has its own limitation because of two aspects; first rodents may take away food grains from the store, it is thus very difficult to know the exact loss figure due to rodents. Secondly, rodents may eat part of the grain and leave the remaining portion in the granary. For purposes of completeness these seeds were included in the sample analysis.

Table 5.14 shows that in total rodents contributed most of the damage, that is 8.85 percent.

Adding to the annual costs the value of respective annual storage losses per bag of Tshs. 152.10 and Tshs. 131.70 (Table 5.12 and 5.13) gives Tshs. 169.90 and Tshs. 136.60 as the real costs of the "chanja" and the "chidong'a" storage techniques for a bag for a year. It is worth noting that the loss figures are taken as a loss per bag of maize assumed for analytical purposes to weigh 90 kilograms.

Table 5.14: <u>Annual Grain Losses by Type of Storage Structure and by Agents Causing Losses</u>

| Type of Storage Structure | Loss agent[1] | | Total Loss |
|---|---|---|---|
| | Rodents | Other | |
| | % | | |
| Chanja | 10.40 | 6.90 | 17.30 |
| Chidong'a | 7.30 | 6.00 | 13.30 |
| Average | 8.85 | 6.45 | 15.30 |

Source: Own survey data, 1987.

[1] Loss figures for other agents were estimated after nine months of storage. Figures were linearly interpolated to get the 12 months value.

5.4.1.4. <u>Interest (Rates) on Tied Capital</u>

The cost of borrowed funds required for financing the investment in grain stored have to be included in the storage costs. In this study, the opportunity cost of funds tied up in holding the grain was included as the cost of borrowed funds. The rate of interest of 15 percent per year is used for the 1985/1986 marketing season. The respective rate for the 1986/1987 marketing season was 18 percent. These rates are based upon the rates charged by banks for rural short term loans and overdrafts (see Bank of Tanzania, BoT, 1987). Considering the price of one bag of Tshs. 600.00 at time of harvest as the principal, the interest charges turned out to be Tshs. 90 for the 1985/1986 seasons and Tshs. 108 for the 1986/1987 season.

Adding these costs to the total costs of storing one bag of maize for a year gives new totals of Tshs. 259.90 for the "chanja" and Tshs. 226.90 for the "chidong'a" for the 1985/1986 season. This is equivalent to per month rates of Tshs. 21.70 and TShs. 18.90 respectively. For the 1986/1987 season the annual rates were Tshs. 265.90 per year (that is, Tshs. 22.20 per month) for the "chanja" and Tshs. 244.60 per year (TShs. 20.40 per month) for the "chidong'a". In the subsequent section these per month costs are assumed to vary linearly over the marketing season. This implies that expected prices from one month to another varied with a constant margin.

### 5.4.2. <u>Seasonal Price Variations in Survey Villages</u>

The basis for the analysis of price variations over the two seasons is as outlined in section 4.4.2. above. Details of the calculations of the net price increases are explained in Appendix IV. The results of this analysis can be seen in tables 5.15 and 5.16 and also in figures 5.9 and 5.10, as the net seasonal rise (NSRPti) in maize prices expressed as a percentage greater than (or less than) expected price, E(Pti) for crop years 1985/1986 and 1986/1987.

For example in table 5.15 it can be seen that in the case of Ulaya Kibaoni for 1985/1986 the years net average increase in maize price was 31 percent greater than the expected price increase (consistent with storage costs). The highest per-unit profits would have been obtained by selling in January.

There is as also observed by Hays and McCoy (1978) a considerable amount of variation in seasonal price increases both between the two villages and between months within a given year. Maize is usually harvested in April-May in Ulaya Kibaoni and in May-June in Ukwamani and seasonal price movements show that high price and low price points are consistent with the harvest periods. However, in all instances

Table 5.15: Ulaya Kibaoni: Net Seasonal Rise in Maize Price Expressed as Percentage Greater Than or Less Than Expected Price, 1985/86 - 1986/87

| Marketing year | May [1 | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | Years average (over or below expected price) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | | | | | | | | | | | | |
| 1985/86 | * | 16 | -7 | -10 | 38 | 52 | 64 | 60 | 133 | 51 | -27 | -29 | 31 |
| 1986/87 | * | 16 | -7 | -10 | -13 | -16 | 23 | 59 | 54 | 50 | 10 | -29 | 12 |

Source: Own survey data, 1987.

[1 Harvest month

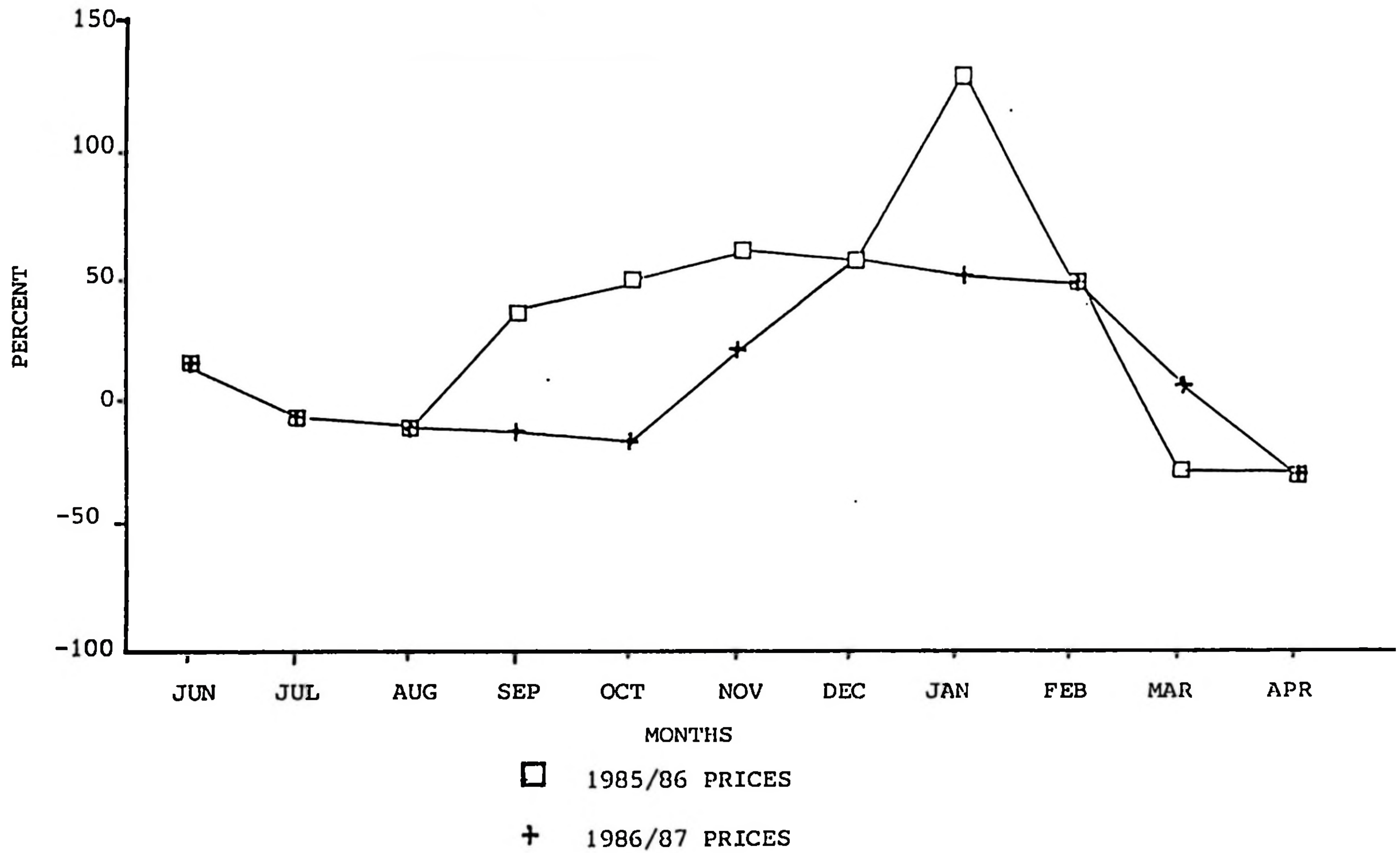
Table 5.16: Ukwamani: Net Seasonal Rise in Maize Price Expressed as Percentage Greater Than or Less Than Expected Price, 1985/86 - 1986/87

| Marketing year | June [1 | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Years average (over or below expected price) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | | | | | | | | | | | | |
| 1985/86 | * | -3 | 3 | 10 | 24 | 38 | 60 | 105 | 100 | 95 | 44 | -11 | 42 |
| 1986/87 | * | 6 | 12 | 18 | 23 | 37 | 58 | 86 | 89 | 91 | 49 | -20 | 41 |

Source: Own survey data, 1987.

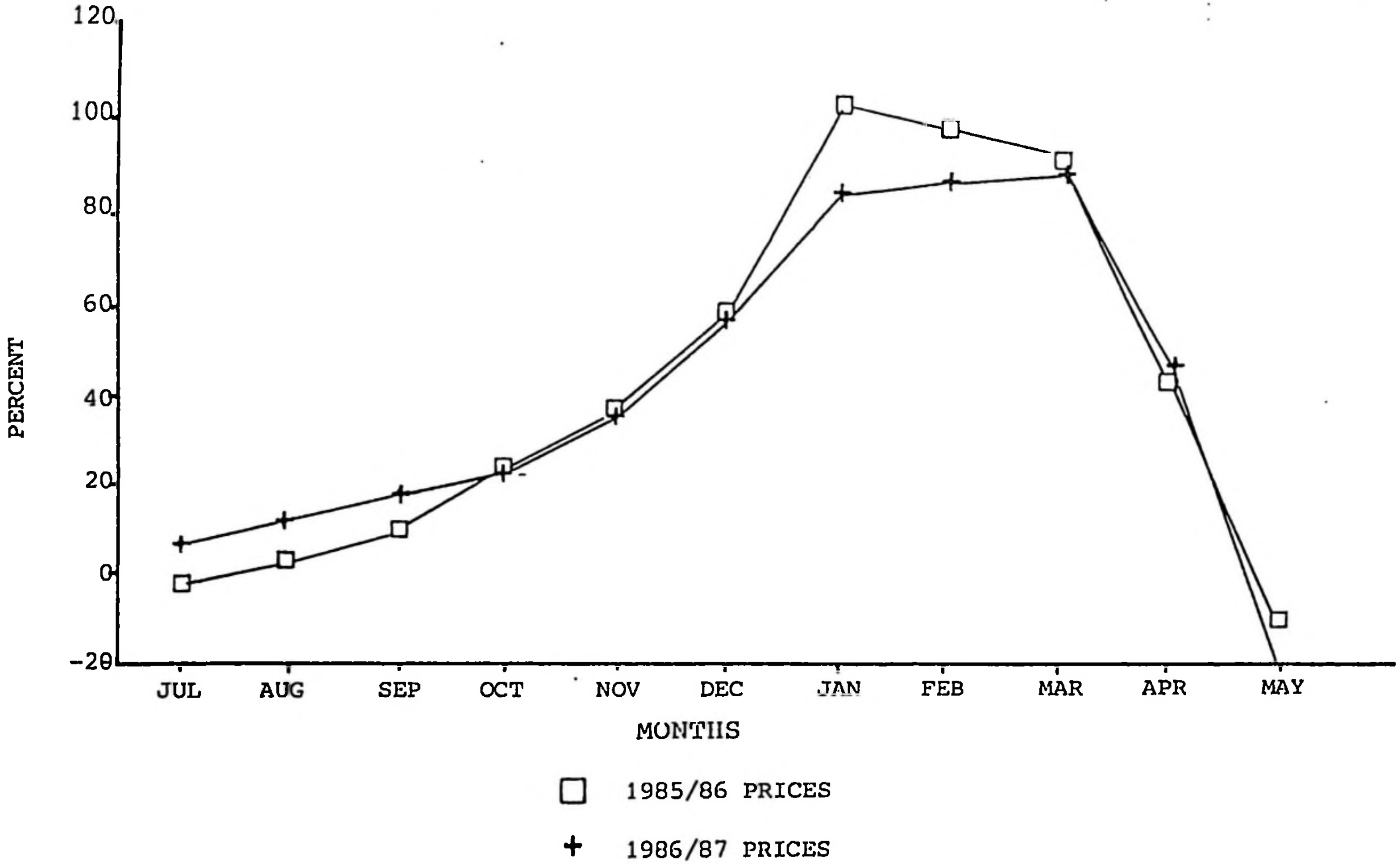
[1 Harvest month

Figure 5.9: ULAYA KIBAONI: NET SEASONAL RISE IN MAIZE PRICE EXPRESSED AS A PERCENTAGE OF EXPECTED PRICES, 1985/86 AND 1986/87




Source: Derived from table 5.15, p. 135.

Figure 5.10: UKWAMANI: NET SEASONAL RISE IN MAIZE PRICE EXPRESSED AS A PERCENTAGE OF EXPECTED PRICES, 1985/86 AND 1986/87




Source: Derived from table 5.16, p. 135.

for the two markets studied during the two seasons, the yearly average seasonal increase in maize prices were in excess of the calculated expected increase.

It is of interest to note that the seasonal high prices generally occurs before maize harvest (that is between December and February in Ulaya Kibaoni and between January and March in Ukwamani). This occurs because some foods like rice, bananas and beans are by then also available in peoples' diets. Another explanation is (as explained in section 5.3.5.3. above) that depending on the performance of the crop in the farms, farmers can estimate the forthcoming maize crop and if the prospects are good, farmers market their surplus maize. The important question is whether intertemporal price increases were a result of farmers having monopolistic power to influence prices through their storage operations and thus earn profits. However, since the majority of farmers are small scale it would seem unlikely that they have such a power.

### 5.4.3. Decision Criteria for Hypothesis Number (ii)

The temporal price analysis presented in this section indicates that the net seasonal rise in prices exceeds the expected price rise. There is thus an opportunity for farmers practicing storage to make profits. The implication of this conclusion is very obvious-post harvest price increases in the private market exceed cost of storage.

Hypothesis two states that post-harvest price rises equal storage costs. On the basis of this study we reject this hypothesis. It can thus perhaps safely be suggested that the price changes observed over time are more of a reflection of forces of supply of and demand for grain acting on the parallel local grain markets than a result of storage costs incured by the storer.

So far the empirical evidence presented here considered farm storage as traditionally practised by farmers.. However, farm storage losses compels the government to look for means of reducing these losses at the least possible cost. The following sections present the economic and financial analysis of the suggested improvements. Whether or not the suggested improvements are profitable is explored. Naturally the expected profitabilities of such improvement programs have a direct impact on the farmers decision to adopt the system he considers to be more profitable.

## 5.5. Economic and Financial Appraisal of Farm Storage Improvements

Losses can be reduced to a "negligible" proportion if farmers store their grain in improved storage structures and by practicing proper management of stores. However, farmers' acceptance of a storage improvement program, by and large, depends on the rate of return anticipated from the adoption of an improved storage program. It is therefore necessary to examine the rates of return of an improved storage program.

### 5.5.1. Improvements Needed in a Traditional Storage Structure

Boxall *et al*., (1978) suggests that an ideal store should; afford maximum possible protection against insects, rodents and bird pests; allow adequate ventilation yet be capable of being made reasonably air tight for fumigation; afford protection against excessive moisture content and temperature favourable for insect and mould development; provide for convenient loading and unloading; give protection against fire and theft; allow facilities for inspecting grain; and facilitate cleaning.

Most of the stores in the survey area are traditional in development over time. For example farmers have long realized the importance of a raised platform to prevent migration of ground water into the store. However, absence of rat guards and roofs were remarkable shortcomings. Misuse of chemicals for protecting grain was also noticed. The improvements suggested in this text, therefore are aimed at meeting the requirements of a good store as suggested by Boxall *et al*., (op.cit) above.

The improvements required for the traditional stores are of two types. Firstly there are constructional improvements which involve additions to and/or modifications of the existing structure. Secondly there are operational improvements. For rodent control for example, rat guards are recommended in addition to the use of rodenticides like zinc phosphate.

Insect pests in the tropics may infest grain in the field before harvest. It is therefore often necessary to fumigate the grain at or soon after storage. Fumigation confers no lasting protection and grain may become re-infested if insects move into the store from fields or from infested produce stores nearby. It is therefore recommended that the stores be sprayed or dusted with insecticide as well as fumigating the grain to the risk of cross infestation. For fumigation and spraying against insect pests and termites a broad spectrum insecticide pirimiphos methyl (actelic 2.0 percent dust), or a mixture of pirimiphos methyl (1.6 percent dust) and permethrin (0.5 percent dust) at a rate of 100 grams per 90 - 100 kilogram bag of maize is recommended. The fumigation of grains compels that the grain be shelled. In the context of this study therefore shelling of grain in places where maize is stored unshelled with husks will be considered as an improvement practice.

### 5.5.2. Benefit (Output) of a Loss Reduction Program

Agents causing losses in traditional stores include moisture, fungi, insects and other vertebrate pests. Insects and rodents are the most damaging in the study area. These major pests of stored grains attack and consume the produce, thus any significant level of infestation will result in a direct (weight and/or volume) loss.

The benefits of a loss reduction program are based on two parameters, that is, the level of grain losses which are saved through the improvements, and the price difference between the harvest period and the lean season. The benefit to the farmer is thus measured by the value of food grain saved and the price of grain at selling time. Although the majority of farmers (about 76 percent) agreed that the nature of grain damage was not directly reflected in the selling price of grain, this valuation is necessary for analysis purposes.

#### 5.5.2.1. Storage Losses Saved Through Storage Improvements

For purposes of this study the losses incurred in traditional stores are assumed to be reduced to a "negligible" (zero) level following a loss reduction program. This assumption is adopted from (Boxall *et al*., 1978). The assumption is rather rigid but due to lack of literature with loss figures following storage improvements in the study area there was no other basis for choosing any other loss figures.

From Table 5:14 (section 5.3.5.3.) the annual maize loss figures for the "chidong'a" and the "chanja" are 13:3 percent and 17:3 percent respectively. However in this analysis the loss figures, that is, the "L" values (as per equation 4.5, section 4.4.3.1.) of 9:0 percent and 13:0 percent are used for a "chidong'a" and a "chanja" respectively. These are loss parameters after respective periods of 8 months and 9 months of storage of grain in Ukwamani where the "chidong'a" is used most and Ulaya Kibaoni where the "chanja" is more prominent.

5.5.2.2. Price Effect on Valuation of Reduced Storage Losses

Eight months and 9 months are the respective lean seasons in Ukwamani and Ulaya Kibaoni when the parallel market prices for maize grain are highest. It is after these times of storage when most farmers with marketable surplus are willing to sell their grain in order to take advantage of the high prices. We noted earlier that in Ukwamani village prices are lowest in June (index 62 and are highest in January and February (index 145). This gives the percent by which prices are higher in the lean season, that is, the "Y" value after 8 months of storage as 134 percent (see equation 4.5). For Ulaya Kibaoni, the lowest prices are experienced in April (index 71) with highest prices being observed in Janaury (index 146). This give a "Y" value of 100 percent after 9 months of storage.

### 3.5.2.3 Combined Result of Loss Levels and Price Effect in Determining the Value of Reduced Losses.

The harvest price "Pto" for both Ukwamani and Ulaya Kibaoni is taken as Tshs.600 per (90 kilogram) bag. The quantity "Q" of maize stored by the farmer per season is assumed to be 1 bag. Therefore, utilizing equation 4.5 gives the benefits "Bt" of storage improvement program as TShs. 126 for the "Chidong'a and Tshs 156 for the "Chanja". Appendix VI shows how equation 4.5 was used to calculate "Bt" values. It is worth noting that computation of the benefits of a loss reduction program in the village communal godown is straightforward due to the fact that prices are constant throughout the season. In this case the loss figure is just multiplied by the government price to arrive at the "Bt" value. However, for the godown parallel market prices are assumed in the sensitivity analysis. In this case the procedure for determing the "Bt" value adopted for the traditional granaries is utilized.

5.5.3. Costs (Inputs) of a Loss Reduction Program

Costs of a loss reduction program are the direct money costs the farmer incurs as a result of the investment decision. As for the benefit side, the discounted costs are compared to the benefits to get parameters for the investment decision criteria. For purposes of comparison the benefits and costs of the two typical improved structures and the village or co-operative godown are also presented.

The discounted value of scraps for each of the traditional stores were calculated and subtracted from the cost figures to arrive at a net cost. No attempt was made to attach the scrap value for the village communal storage in the calculations since according to Gittinger (1982) communal/civil works are assumed to have no residual value. Further, banks usually offer different interest rates for long term projects (that is, over 20 years life span). However, for purposes of effective comparison, the same rate of 18 percent is utilized for the village godown calculations.

Tables 5.17 and 5.18 shows the discounted financial benefits of the improved traditional structures and the village godown respectively. Appendix V shows the determinants of costs of constructing the village godown and improvement costs

Table 5.17 Present value of finacial benefits accruing to the farmer following improved storage practices [1

| Year | Discount [2 Factor $1/(1.18)^n$ | Money benefit [3 | | Discounted benefit | |
|---|---|---|---|---|---|
| | | "Chanja" | "chidong'a" | "Chanja" | "Chidong'a" |
| | (1) | (2) | (3) | (1)*(2)=4 | (1)*(3)=5 |
| 1 | .847 | 156 | 126 | 132 | 107 |
| 2 | .718 | 156 | 126 | 112 | 90 |
| 3 | .609 | 156 | 126 | 95 | 77 |
| 4 | .516 | 156 | 126 | 80 | 65 |
| 5 | .437 | 156 | 126 | 68 | 55 |
| 6 | .370 | 156 | 126 | 58 | 47 |
| 7 | .314 | 156 | 126 | 49 | 40 |
| 8 | .266 | 156 | 126 | 41 | 34 |
| 9 | .225 | 156 | 126 | 35 | 28 |
| 10 | .191 | 156 | 126 | 30 | 24 |
| 11 | .162 | 156 | 126 | 25 | 20 |
| 12 | .137 | - | 126 | - | 17 |
| Total | 4.792 | 1716 | 1512 | 725 | 604 |

Source: Own survey, 1987.

[1 All computations are based per 1 bag of stored grain.

[2Based at 18% discount factor for the 1986/87 marketing year.
values adopted from compounding and discounting tables; In Gittinger (1982).
Tables 6 and 7, pp.434-435.

[3 Based at respective losses of 13% for the "chanja" and 9% for the "Chidong'a after 9 months and 8 months of grain storage respectively, see section 5.2.2.

Table 5.18: Present value of finacial benefits accuring from an improved village/cooperative godwn (Tshs)

| Year | Discount factor $1/(1.18)^n$ | Money benefit [2 | | Discounted benefits | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1)x(2)=4 | (1)x(3)=5 |
| 1 | .847 | 75 | 52 | 64 | 44 |
| 2 | .718 | 75 | 52 | 54 | 37 |
| 3 | .609 | 75 | 52 | 46 | 32 |
| 4 | .516 | 75 | 52 | 49 | 27 |
| 5 | .437 | 75 | 52 | 33 | 23 |
| 6 | .370 | 75 | 52 | 28 | 19 |
| 7 | .314 | 75 | 52 | 24 | 16 |
| 8 | .266 | 75 | 52 | 20 | 14 |
| 9 | .225 | 75 | 52 | 17 | 12 |
| 10-30 | 1.215 [1 | 75 [3 | 52 [3 | 91 | 63 |
| Total | 5.517 | 2250 | 1560 | 416 | 287 |

Source: Own survey data, 1987.

[1 Present worth of an annuity factor for years 10 through 30 inclusive, calculated by taking the sum of the discount factors (that is, present worth factors ) and multiplying by the annual income to be received, to obtaint the present worth, see Gittinger (1982), pp.309-313.

[2 Losses of 13% for a "chanja" and 9% for a "Chidong'a " area ssumed to get columns (2) and (3). The Goverment price of Tshs. 576 per bag is used.

[3 Annual amount for years 10 through 30 inclusive. To reach this columns total, these amounts must be included 21 times.

for the traditional structures. Table 5.19 and 5.20 show the respective discounted costs of the improved structures and the village godown.

5.5.4 Benefit-Cost Ratios of Improved Storage

Table 5.21 shows the financial BCR values of improved storage. If parallel market prices are used, it is observed that both traditional structures have BCR values of more than one. The "chidong'a" gave the highest BCR value of 4:0:1 The "chanja" on the other hand gave a ratio of 1:5:1 This is perhaps due to the high costs of an improved "chanja" estimated at TShs. 557.

The village godown gave the least BCR values of 0:7:1 and 0.5:1 when losses of 13:0 percent for the "chanja" and 9:0 percent for the "chidong'a" are used as the basis for the calculations. The low BCR values can perhaps be explained by the low government price of [illegible].00 per bag offered by the NMC. This implies that the benefit from an improved village godown is only from the saved losses. The parallel market price component is not included since the government (low) price is constant throughout the marketing seasons. The effect of changed prices on the BCR values is discussed under section 5.5.6 below. This section explores the sensitivity analysis which looks into financial analysis as a result of changes in events from estimates made about

Table 5.19: Present Value of Costs Incured by Farmer Following Improved Storage Practices

| Year | Discount factor | Money cost | | Discounted money cost | |
|---|---|---|---|---|---|
| | | "chanja" | "chidong'a" | "chanja" | "chidong'a" |
| | | -------- | -------- TShs. | -------- | -------- |
| | (1) | (2) | (3) | (1)x(2)=(4) | (1)x(3)=(5) |
| 0 | 1.000 | 125 | 31 | 125 | 31 |
| 1 | .847 | 102 | 50 | 86 | 42 |
| 2 | .718 | 89 | 26 | 64 | 19 |
| 3 | .609 | 89 | 26 | 54 | 16 |
| 4 | .516 | 89 | 26 | 46 | 13 |
| 5 | .437 | 89 | 26 | 39 | 11 |
| | | [1 | [2 | | |
| 6 | .370 | 102 | 50 | 38 | 19 |
| 7 | .314 | 89 | 26 | 28 | 8 |
| 8 | .226 | 89 | 26 | 24 | 7 |
| 9 | .225 | 89 | 26 | 20 | 6 |
| 10 | .191 | 89 | 26 | 17 | 5 |
| | | [1 | [2 | | |
| 11 | .162 | 102 | 50 | 16 | 8 |
| 12 | .137 | - | 26 | - | 4 |
| Total | 5.792 | 1143 | 415 | 557 | 189 |

Source: Own survey data, 1987.

[1 The bed is assumed to be replaced after every 5 years at a cost of TShs. 15.00 per bag.

[2 The roof and grain outlet are assumed to be replaced after every 5 years at a joint cost of TShs. 24.00 per bag.

Table 5.20: Present Value of Costs Incured in Improved Village Godown

| Year | Discount factor | Money cost | Discounted money cost |
|---|---|---|---|
| | | ----------------ISHs. | ----------------- |
| | (1) | (2) | (1)x(2)=(3) |
| 0 | 1.000 | 206 | 206 |
| 1 | .847 | 69 | 58 |
| 2 | .718 | 69 | 50 |
| 3 | .609 | 69 | 42 |
| 4 | .516 | 69 | 36 |
| 5 | .437 | 69 | 30 |
| 6 | .370 | 69 | 25 |
| 7 | .314 | 69 | 22 |
| 8 | .226 | 69 | 18 |
| 9 | .225 | 69 | 15 |
| | | [2 | |
| 10-30 | 1.215 | 69 | 84 |
| Total | 6.517 | 2276 | 586 |

Source: Own survey data, 1987.

[1 Present worth of an annuity factor for years 10 through 30 inclusive, calculated by taking the sum of the discount factors (that is, present worth factors) and multiplying by the annual income to be received, to obtain the present worth, see Giltinger (1982), pp. 309-313.

[3 Annual amounts for years 10 through 30 inclusive. To reach these columns total, these amounts must be included 21 times.

Table 5.21: Financial Benefit-cost Ratios of Improved Storage

| Type of Structure | Initial Cost[1] | Costs | | | | Benefits | Ratios |
|---|---|---|---|---|---|---|---|
| | | PV of recurring costs[2] | Total Costs | PV of Scrap value[3] | Net costs | | |
| | TShs | | | | | | |
| "chanja" | 125 | 432 | 557 | 63 | 494 | 725 | 1.5:1 |
| "chidong'a" | 31 | 158 | 189 | 37 | 152 | 604 | 4.0:1 |
| Godown | 206 | 360 | 566 | - | 566 | 416 (267)[4] | 0.7:1 0.5:1[4] |

Source: Computed from tables 5.15 through 1.18

1 Initial cost calculated by dividing the total cost of structure by the capacity of store in bags.

2 Recurrent costs were estimated excluding the initial construction cost in year zero.

3 Scrap value of structures taken as loads of firewood from pillars, rafters, crossbars and stakes sold at a price of TShs. 30.00 per load. No scrap was attached to the village godown which is assumed to be a civil property.

4 Figures in paranthesis indicate the godown benefits and benefit-cost ratios when the 9 percent loss incured in a "chidong'a" after 8 months of storage is assumed. Figures outside paranthesis are values on assumption of 13 percent "chanja" losses.

them in planning. The NMC uses prescribed constant prices for major staples including maize. For exhaustive comparison with the traditional structures, which are hereby mainly evaluated using parallel market prices, it is inherent that the same prices are attached to the village godown analysis.

5.5.5. <u>Internal Rate of Return of Improved Storage</u>

From table 5.21 it is clear that the village godown project leads into a loss if official (NMC) prices are used to value the losses saved through the storage improvement program. The BCR values of 0:7:1 and 0.5:1 imply that such a program be abandoned according to the decision criteria used to choose a project when the BCR method of evaluation is used. With this method only projects with BCR of equal to or greater than one need be considered. Furthermore, the flow of undiscounted benefits and costs for the godown lead to negative net benefits throughtout the project life (tables 5.18 and 5.20 refers). According to Gittinger (1982) the internal rate of return for such a project is definitely below the cut-off rate. However, on the assumption that the parallel market prices are used to value the saved losses, the IRR for the godown is presented under the sensitivity analysis section 5.5.6 below.

For the "chidong'a" structure the BCR is 4:1 The calculations of the NPV at 45 percent and 50 percent discount rates gave respective NPV values of Tshs. 169 and Tshs. 149 This implies that the IRR for this seemingly profitable project is well above 50 percent.

For the "chanja" the benefits and costs from the project are netted against each other over the project life and discounted at 45 percent and 50 percent discount factors to obtain the NPV figures. By successive trials, the flow of benefits and costs as shown in table 5.22 are discounted at the two rates. As was stated earlier, the IRR is the rate at which the NPV is zero. The trials led us to derive an IRR of 49 percent for the "chanja". When the discount factor was raised to 50 percent, the NPV was negative (that is, Tshs. -2.45 ). At 45 percent, the net present value was still positive (Tshs. 10.81 ). Therefore using formula 4.6 (section 4.4.3.2) an IRR of 49 percent was obtained.

It follows therefore that the "chidong'a" and the "chanja" are financially profitable if the true cost of capital is 18 percent which is the cut-off rate. Since the IRR values are above 18 percent, the projects are considered as acceptable.

The above analyses of BCR and IRR made use of different prices of maize grain, that is, the parallel market prices for the traditional structures and the official price for the village godown.

Table 5.22: Internal rate of return, IRR, improved "chanja' strorage structure

| Year | Increamental costs | | | Gross | Net | Disc. | Precent | Disc. | precent |
|---|---|---|---|---|---|---|---|---|---|
| | Capital items | Operation and maintan. | Gross | benefit | benefit | factor 45% | worth 45% | factor 50% | worth 50% |
| | Tshs. | | | | | | Tshs | | Tshs. |
| 0 | 125 | 0 | 125 | 0 | -125 | 1.000 | -125 | 1.000 | -125 |
| 1 | 0 | 102 | 102 | 156 | 54 | .690 | 37.26 | .667 | 36.02 |
| 2 | 0 | 89 | 89 | 156 | 67 | .476 | 31.89 | .444 | 29.75 |
| 3 | 0 | 89 | 89 | 156 | 67 | .328 | 21.98 | .296 | 19.83 |
| 4 | 0 | 59 | 89 | 156 | 67 | .226 | 15.14 | .198 | 13.27 |
| 5 | 0 | 89 | 89 | 156 | 67 | .156 | 10.45 | .132 | 8.84 |
| 6 | 0 | 102 | 102 | 156 | 54 | .108 | 5.83 | .088 | 4.75 |
| 7 | 0 | 89 | 89 | 156 | 67 | .074 | 4.96 | .059 | 3.95 |
| 8 | 0 | 89 | 89 | 156 | 67 | .051 | 3.44 | .039 | 2.61 |
| 9 | 0 | 89 | 89 | 156 | 67 | .035 | 2.35 | .026 | 1.74 |
| 10 | 0 | 89 | 89 | 156 | 67 | .024 | 1.61 | .017 | 1.14 |
| 11 | 0 | 102 | 102 | 156 | 54 | .017 | 0.92 | .012 | 0.65 |
| Total | 125 | 1018 | 1143 | 1716 | 573 | 3.185 | 10.81 [1] | 2.978 | -2.45 [1] |

IRR=45+5(10.81/(10.81+2.45))=49.08%

Source: Own survey data, 1987.

[1] These values are the NPV's at the appropiate discount rates.

Hereunder the BCR and IRR values for the village godown analysis are recalculated utilizing the parallel market prices. Section 5.5.6 outlines these computations.

5.5.6. <u>Sensitivity Analysis</u>

In this section the village godown project is tested for its sensitivity to a rise in the price of maize. Assuming the same level of losses ( 13 percent for the "chanja" and 9.0 percent for the "chidong'a" after respective 9 months and 8 months of storage) we note from table 5.17 that the annual benefits derived from a loss reduction program are Tshs. 156 for the "chanja" and Tshs 126 for the "chidong'a". Table 5.20 and appendix V show the capital and operation and maintenance costs of the village godown and the two traditional sturctures. By utilizing these flows of benefits and costs, table 5.23 presents the BCR of the village godown at the parallel market prices. It is clear from this table that the project is positively sensitive to increased prices in that the BCR values of 1:4:1 and 1:2:1 are obtained at respective 13 percent and 9 percent losses.

Tables 5.24 and 5.25 presents the sensitivity analysis calculations of the IRR assuming respective losses of 13 percent and 9 percent for the "chanja" and the "chidong'a". As in the BCR

Table 5.23: Sensitivity analysis, benefit cost ratio for a village godown: assuming parallel market prices (Tshs).

| Year | Incremental cost | | | Discount factor | Present worth | Gross benefit | | Discount factor | Present worth 18% | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Capital items | Oper.and maint. | Gross | 18% | 18% | "Chanja"loss 13% | "Chidong'a"loss 9% | 18% | 13%loss | 9%loss |
| 0 | 206 | 0 | 206 | 1.000 | 206 | 0 | 0 | 1.000 | 0 | 0 |
| 1 | 0 | 69 | 69 | .847 | 58 | 156 | 126 | .847 | 132 | 106 |
| 2 | 0 | 69 | 69 | .718 | 50 | 156 | 126 | .718 | 112 | 90 |
| 3 | 0 | 69 | 69 | .649 | 42 | 156 | 126 | .609 | 95 | 77 |
| 4 | 0 | 69 | 69 | .516 | 36 | 156 | 126 | .516 | 80 | 65 |
| 5 | 0 | 69 | 69 | .437 | 30 | 156 | 126 | .437 | 68 | 55 |
| 6 | 0 | 69 | 69 | .370 | 25 | 156 | 126 | .370 | 58 | 47 |
| 7 | 0 | 69 | 69 | .314 | 22 | 156 | 126 | .314 | 49 | 40 |
| 8 | 0 | 69 | 69 | .266 | 18 | 156 | 126 | .266 | 41 | 34 |
| 9 | 0 | 69 | 69 | .225 | 15 | 156 | 126 | .225 | 35 | 28 |
| 10-30 | 0 | 69 (1 | 69 (1 | 1.215 (2 | 84 | 156 (1 | 126 (1 | 1.215 (2 | 190 | 153 |
| Total | 206 | 2070 | 2276 | 6.517 | 586 | 4680 | 3780 | 6.517 | 860 | 695 |

Benefit cost ratio (13%loss)=860/586=1.45:1
Benefit cost ratio (9%loss) =695/586=1.18:1

Source: Own survey data, 1987.

(1 Annual amounts for years 10 through 30 inclusive. To reach column totals these amounts must be included 21 times.

(2 Present worth of annuity factor for years 10 through 30 inclusive.

Table 5.24: Senstivity analysis, IRR for a village godown: assuming Ukwamani parallel market prices and 9% "Chidong'a" grain losses (Tshs)

| Year | Incremental cost | | | Gross benefit | Net benefit | Discount factor | Present worth | Discount factor | Present worth |
|---|---|---|---|---|---|---|---|---|---|
| | Capital items | Oper.and maint. | Gross | | | 40% | 40% | 45% | 45% |
| 0 | 206 | 0 | 206 | 0 | -206 | 1.000 | -206 | 1.000 | -206 |
| 1 | 0 | 69 | 69 | 156 | 87 | .714 | 62.12 | .690 | 60.03 |
| 2 | 0 | 69 | 69 | 156 | 87 | .510 | 44.37 | .476 | 41.41 |
| 3 | 0 | 69 | 69 | 156 | 87 | .364 | 31.67 | .328 | 28.54 |
| 4 | 0 | 69 | 89 | 156 | 87 | .260 | 22.62 | .226 | 19.66 |
| 5 | 0 | 69 | 69 | 156 | 87 | .186 | 16.18 | .156 | 13.57 |
| 6 | 0 | 69 | 69 | 156 | 87 | .133 | 11.57 | .108 | 9.40 |
| 7 | 0 | 69 | 69 | 156 | 87 | .095 | 8.27 | .074 | 6.44 |
| 8 | 0 | 69 | 89 | 156 | 87 | .068 | 5.92 | .051 | 4.44 |
| 9 | 0 | 69 | 89 | 156 | 57 | .048 | 4.18 | .035 | 3.08 |
| 10-30 | 0 | 69 [1 | 69 [1 | 156 [1 | 87 [1 | .125 [2 | 10.88 | .079 [2 | 6.87 |
| Total | 206 | 2070 | 2276 | 4680 | 2810 | 3.223 | 11.78 | 3.503 | -12.6 |

IRR=45+5(11.78/(11.78+12.6)=47.42%

Source: Own survey data, 1987.

[1 Annual amounts for years 10 through 30 inclusive. To reach column totals these amounts must be included 21 times.

[2 Present worth of an annuity factor for years 10 through 30 inclusive.

Table 5.25: Sensitivity analysis, IRR for a village godown: assuming Ulaya Kibaoni parallel market prices and 13% "Chanja" grain losses (Tshs).

| Year | Incremental cost | | | Gross benefit | Net benefit | Disc. factor 26% | Present worth 26% | Disc. factor 28% | Present worth 28% |
|---|---|---|---|---|---|---|---|---|---|
| | Capital items | Oper. and maint. | Gross | | | | | | |
| 0 | 206 | 0 | 206 | 0 | -206 | 1.000 | -206 | 1.000 | -206 |
| 1 | 0 | 69 | 69 | 126 | 57 | .794 | 44.26 | .781 | 44.52 |
| 2 | 0 | 69 | 69 | 126 | 57 | .630 | 35.91 | .610 | 34.72 |
| 3 | 0 | 69 | 69 | 126 | 57 | .500 | 28.50 | .477 | 27.19 |
| 4 | 0 | 69 | 69 | 126 | 57 | .397 | 22.63 | .373 | 21.26 |
| 5 | 0 | 69 | 69 | 126 | 57 | .315 | 17.96 | .291 | 16.59 |
| 6 | 0 | 69 | 69 | 126 | 57 | .250 | 14.25 | .227 | 12.94 |
| 7 | 0 | 69 | 69 | 126 | 57 | .198 | 11.29 | .178 | 10.15 |
| 8 | 0 | 69 | 69 | 126 | 57 | .157 | 8.95 | .139 | 7.92 |
| 9 | 0 | 69 | 69 | 126 | 57 | .125 | 7.13 | .108 | 6.16 |
| 10-30 | 0 | 69 [1 | 69 [1 | 126 [1 | 57 [1 | .477 [2 | 27.19 | .384 [2 | 21.89 |
| Total | 206 | 2070 | 2276 | 3780 | 1504 | 4.847 | 13.07 | 4.568 | -2.61 |

IRR=26+2(13.07/(13.07+2.61))=27.67%

Source: Own survey data, 1987.

[1 Annual amounts for years 10 through 30 inclusive. To reach column totals these amounts must be included 21 times.

[2 Present worth of an annuity factor for years 10 through 30 inclusive.

calculations the parallel market prices are made use of. It is revealed that the IRR at 13 percent loss is 27:67 percent while the IRR at 9 percent loss is 47.42 percent. Both these rates are above the cut-off rate of 18 percent. At the parallel market prices therefore, the village godown project can be accepted as being profitable.

5.5.7. Decission Criteria for Hypothesis Number (iii)

Table 5.26 summarizes the BCR and IRR estimates for the improved traditional storage structures and the improved village godown at both the NMC and parallel market prices. The table clearly indicates that all the three structures are profitable if the parallel market prices are used for the analysis. On the other hand use of NMC prices leads to financial losses as tested by the village godown project. Implicatively the same losses would be experienced if the private farmers made use of the MNC prices to sell their stored grain.

Basing on these measures of project worth at parallel market prices hypothesis number (iii) which states that locally produced improvements in traditional structures are economically profitable is accepted. At NMC prices however, the hypothesis is rejected.

Table 2.26: Benefit Cost Ratios (BCR) and Internal Rates of Return (IRR) for Improved Storage Structures at NMC and Parallel Market Prices.[1]

| Measure of Project worth | Storage Structure | | | | | |
|---|---|---|---|---|---|---|
| | Chanja | | Chidong'a | | Village godown | |
| | Parallel Prices | NMC Prices | Parallel Prices | NMC Prices | Parallel Prices | NMC Prices |
| BCR (Ratio) | 1:5:1 (1) | - | 4.1:1 (1) | - | 1:4:1(1.2:1) (2) | 0.7:1(0.5:1) (1) |
| IRR (%) | 49.08 (3) | - | >50 (4) | - | 27.67 (5) (17.42) (6) | |

Sources: (1) Table 5.21, p.151
(2) Table 5.23, p. 156
(3) Table 5.22, p. 154
(4) Section 5.5.5., p. 152
(5) Table 5.24, p. 157
(6) Table 2.25, p. 158

[1] Figures in Paranthesis indicate the measures at 9% "Chidong'a" losses at Ukwamani parallel market prices. Those outside paranthesis are measures at 13 percent "Chanja" losses at Ulaya Kibaoni prices.

Perhaps the sensitivity analysis underscores the fact that when Tanzania pursue price stabilization policies it is difficult, in the absence of reliable data to establish to what extent their effects are transmitted to the level of producers. In general government monopolistic tendencies and fixing artificially low prices result in stifling market supply and demand.

# CHAPTER VI

## SUMMARY OF RESULTS AND CONCLUSIONS

Tanzania, like many other developing countries, is experiencing expanding population which makes increased demand on production and marketing systems. for food crops. This has prompted concern about the efficiency and performance of its agricultural product marketing systems and resulted in suggestions for instituting changes in some of these systems. However, there is little knowledge of economic value available concerning traditional storage systems, their performance and obstacles to their reform. This study on the most important food grain in Tanzania was undertaken to provide insight into the functioning of on-farm storage system and thus provide information for formulating more effective storage policy. The conclusions of this study suggest a number of measures that might be taken as part of more effective government storage pricing and marketing policies.

### 6.1 Summary of Results

Before outlining the policy implications of the study of farm level maize storage in Tanzania, a brief summary of the results is provided.

### 6.1.1 Pattern of Maize Storage in the Survey Villages

A majority of the farmers interviewed in this study were smallholders. Their pattern of grain storage is greately influenced by size of output, family food requirements and expectations of better prices in the lean season. The need for emphasis on farm storage is obvious because the smallholder majority stored most share of the stored produce. The quantity of maize stored varied from 6.5 bags to 21 bags representing about 72.5 percent of the individual farmers' total production. The quantity stored increased with increase in farm size. The quantity stored also determined the size (or number) of stores directly.

Although domestic consumption was the major reason for storage other social and economic obligations also made storage necessary. However, consumption was the principle purpose of storage for smallholders. Sale overshadowed consumption in case of larger farmers. Farmers store their produce for an average of 9 months after harvest. By then the lean period prices are highest. Farmers also know the prospects for the next crop by then and therefore they dispose most of the stored produce.

All farmers interviewed in the survey informed that they are aware of storage losses caused by rodent and insect pests. However, they confessed that traditional methods of loss prevention seem to be less effective especially to the notorious large grain borer Prostephanus trancatus (Horn) insect pest which invaded the country recently and the vulnerability of the new High Yielding Varieties (HYV) of maize to pests. As a result use of rodenticides and insecticides is slowly dawning upon the farmers. At average storage losses were found to be 15.3 percent for maize stored for a year. It can therefore be concluded that, technically, maize storage is feasible because with fairly mechanical methods, the stores can be modified, so that losses due to rodent and insect pests are reduced.

### 6.1.2 Temporal Price Changes in Relation to Storage Costs

The nature of temporal price relationships in the two survey villages during the 1985/86 and 1986/87 marketing seasons revealed that seasonal price increases were in excess of the costs of storing grain. This, according to Helmberger and Weaver (1977) is due to non-competitive storage and provided the opportunity for farmers storing grain for future sales to make profit.

However, the extent of farmers' profits depended upon the farmers' skill in storing decisions. This was so because there was a considerable risk involved in storage operations as demonstrated by the large degree of variability required in the timing of marketings in order to acheive high profits.

### 6.1.3 Economic and Financial Appraisal of Farm Level Storage Improvements

An analysis was conducted to determine the benefits farmers could derive from improving storage structures in order to bring losses to a "negligible" level. For purposes of comparison, the same analysis was also carried out for a village (communal) godown. Sensitivity analysis regarding produce price variation was conducted to allow for rational conclusions. This was necessary to accomodate both the parallel market prices (used for the NMC communal sales). It was observed that farm storage improvements are generally profitable with BCR values of between 1:2:1 and 4:0:1 and IRR values ranging between 27:67 percent and over 50 percent. The IRR values were well above the cut-off rate of 18 percent. The communal godown was found to be beneficial only when the parallel market prices were used in the BCR and IRR calculations. This punctuates the importance of parallel market prices in storage decisions and provides a strong support for a major expansion of rural storage.

Improved storage of surplus grain at the farm level will lead to increased market supply of maize during the lean season (at least in proportion to the average propensity to sell). This will in the long run tend to restrain prices or certainly reduce their variability.

## 6.2 Policy Implications and Direction of Future Research

To acheive food self sufficiency in Tanzania through effective on-farm storage, some policy changes are necessary. From this study the following policy reforms are suggested.

### 6.2.1 On Farm Level Storage

The farmers' goal in maize production is to get sufficient quantities of grain for domestic utilization and for sale to get cash needed for non-farm requirements. Stored grain intended for domestic use fills in their food supply gap during the non-production periods.

We note, however, that farm storage losses are very substantial, and can be greately reduced by solving the on-farm storage problems through effective improvements. These are cost-effective means of acheiving food self sufficiency in Tanzania compared to the cost of food importations. On the other hand cost of storing grain at the national level is prohibitive. Cost of hiring storage structures have often forced the government to export grain which could have been used in the nation during supply shortages. More often the intention to build larger godowns in surplus regions like Iringa, Mbeya, Rukwa and Ruvuma have been shelved for lack of funds. The good traditional structures are quite cheap to construct as they can be constructed by using locally available materials and slack season labour. This could be a great saving on government expenditure which is needed for other uses like education and health.

As for use of chemicals to protect grain, farmers need to be educated on the use of modern chemicals. It was observed in this study that farmers need to know the use of the right chemicals on the right products at the right time. In addition to this, farmers should be trained to understand the general principles of storage, that is, drying and cleaning the stores, through effective extension work.

This work clearly indicates that incentives to farmers to make use of farm-level storage could reduce seasonality of market arrivals. This could in turn ease public stock management problems. A prior concern would therefore, be to improve the quality of farm-level storage.

### 6.2.2 On Grain Marketing and Food Pricing

We noted previously that some farmers sell their maize soon after harvest to get cash to meet their domestic and farm expenses. It was also indicated that the amount of grain sold soon after harvest was about 28 percent of total production. Farmers would thus prefer to sell their grain later in the season when parallel market prices are high. Inadequacy of the official (NMC) market as an outlet in addition to the price fluctuations acts as an incentive for farmers to store maize for speculative purposes. Maize sales on the farm to needy farmers and traders is the major market outlet for farmers. This compels some farmers to market their produce soon after harvest when the buyers (traders) are readily available. Therefore marketing forces also influence the farmers' selling and storage decisions.

At national level the present structure of the NMC renders it unable to meet food requirements of the rural and part of the urban population. This is basically due to the high operational costs and inefficiencies, hence it is not possible for it to offer as competitive prices as those offered in the parallel markets. To improve efficiency, the NMC should be operated on a cost recovery basis. This would include among other things, streamlining of its operations, particularly in regions/districts where the low business volume makes the NMC operations uneconomical. Proper and standardized accounting procedures should be established as a measure to ensure efficiency and profitability.

To ensure an optimal allocation of resources, prices should be made to vary over time, space and form, so as to reflect the actual costs of storage, transport and processing. As noted in section 3.2.1 however, the spatial price differentiation in Tanzania has already been adopted for some crops including maize. Differental pricing will ensure availability of food supply throughout the year and throughout the country. Price levels will also be relatively stable. As for interregional food transfers the administrative restrictions need to be limited to allow for a more free flow of foodstuffs in the nation.

### 6.2.3 Direction of Future Research Work

It is recognized now that problems of food shortages, undernutrition and malnutrition that beset Tanzania can be solved only as part of a well organized approach to overal social and economic development and not in isolation from it. In any effort to overcome stagnation and stimulate progress toward economic development, the growth of post-harvest conservation and processing industries can make a valuable contribution recommends Jones (1972) and Hulse (1977). These industries can increase food supply at little additional cost in natonal resources.. They can also stimulate production, open new oportunity for investments, provide alternative employment and improve rural income. All these will result in a better quality of food consumption, change trade balance significantly and encourage agro-industrial development so vital for the transformation of the subsistence economy of the country.

As far as rural storage losses are concerned, it was pointed out earlier that there is doubt as to whether there is a sufficiently accurate idea of what the magnitude of losses is. It depends on how one defines losses. Thus as also suggested by Hulse (op.cit.) systems approach to improve rural storage need to be favoured over the symptomatic approach. This is because the symptomatic approach is the one in which the single scientist goes out and very often identifies the primary constraint in terms of his own discipline. For example, the engineer sees the post-harvest problem as a need for better drying; the entomologist sees it in terms of killing more insects; the economist sees it in terms of credit availability and government assistance. The food scientist sees it in terms of some nutritional edict. All these aspects are important, but so are many others and no single one can be considered out of context with the whole system.

A systematic approach entails essentially studying the system as it exists right now, then devising, as a concept, the best system, one that is free of constraints. It may be too ideal to be fully realized but it is likely to be significantly better than what exists.

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# APPENDIX I

## FARMER QUESTIONNAIRE ON ECONOMICS OF ON-FARM MAIZE STORAGE STUDY IN TANZANIA: THE CASE OF KILOSA DISTRICT.

### SECTION A: HOUSEHOLD IDENTIFICATION

Respondents Code Number ............ Date .........

Division ............. Ward .........

Village ..............

1. Sex: 01 Male

   02 Female

2. Farmers age in years: ..............

3. Respondents Classification: .................

   01 Head of household: Man

   02 Head of household: Female

   03 Son of household

   04 Daughter of household

4. Respondents level of education: ................

| None | Adult Education | Std 1-4 | Std 5-8 | Form 1-6 | College | Other (specify) |
|---|---|---|---|---|---|---|
| 01 | 02 | 03 | 04 | 05 | 06 | 07 |

5. How many people live in household: ............

6. Do you do any other kind of work other than farming? .............

   01 Yes

   02 No

   If yes, what kind: ..........

<u>SECTION B:</u> <u>CROP PATTERNS AND INCOME</u>

7. What is the staple food of the family: ........

| | | | |
|---|---|---|---|
| 01 | Maize | 05 | Beans |
| 02 | Rice | 06 | Bananas |
| 03 | Millet | 07 | Other (specify) |
| 04 | Sorghum | | |

8. How many hectares of cultivatable land do you own? .....................

9. What five major cash crops did you grow last season?

| | Ha |
|---|---|
| Maize | — |
| Rice | — |
| Millet | — |
| Sorghum | — |
| Beans | — |
| Bananas | — |
| Cotton | — |
| Other (specify) | — |

## SECTION C: MAIZE STORAGE

10. How do you know that the crop is dry and ready for harvesting

    01 When the grain is completely dry

    02 at physiological maturity

    03 experience

11 When did you harvest your maize crop? ....month

12 How do you dry your grain

    01 On the floor

    02 Smoking

    03 Sun drying

    04 Other (Specify)

13. In what form do you dry your grain

    01 ear with sheath

    02 ear only

    03 shelled/threshed

14 If shelled (a) How did you shell it

    01 hand

    02 beat in a sack

    03 beat on threshing floor

    b) How many hours does a male need to shell 1 bag

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

## SECTION D: MAIZE STORE RECORD SHEET

(For those who have a storage facility)

Description of Storage Structure:

15. How far is the farm from storage structure

......... km

16. Name the type of store

01 Chidong'a

02 Chanja

03 Kihenge

04 Other (Specify)

17. Name the structure of store (If structure is outside the household area)

01 Prismatic

02 Cyclindrical

03 Rectangular

04 Other (Specify)

18. What is the type and source of the materials

01 local

02 industrial

19. What is the life span of the store ............ years

20. What type of repairs do you carry out?

01 thatching

02 coating

03 other (specify)

21\. (a) Diameter of store ......................m

(b) Circumference of store..................m

(c) Length of store.........................m

(d) Width of store..........................m

(e) Volume of store (to be determined by researcher) ......m

(f) Capacity of store in bags ...............

22\. What was the initial cost of structure (if bought from contractor)................ Shs.

23\. When did you buy/build it................ (month)

24\. What is its replacement cost................ Shs.

<u>Breakdown of material costs</u>:

25\. Materials:

| Materials | Value (shs.) |
|---|---|
| Stakes | - |
| Pillars | - |
| Raflers | - |
| Rope | - |
| Straw | - |
| Other (specify) | - |
| Total Material Cost | - |

26\. Labour

| Labour | Value in Tshs. |
|---|---|
| Family labour: male | - |
| female | - |
| Hired labour: | - Total ...... |

27. Repair Cost: per year.................. Shs.

28. Other annual recurring costs:.......... shs.

SECTION E: MAIZE STORAGE LOSSES AND PEST CONTROL

29 (a) Did the maize which you stored show any sign of damage?

01 Yes

02 No

(b) If yes what were the major causes for damage?

01 Rodents

02 Insects

03 Mould/Fungi

04 Other (specify)

30. At what time of the year did most of this damage occur?

(Probe for month after harvest)...................

31. How much produce did you lose during storage?.......... kg

32. Did you clean the store before putting in your produce?

01 Yes

02 No

33. Did you treat the produce before storage?

    01 Yes

    02 No

If you use chemicals, name the chemicals.........

How much chemicals did you use overall? .........

packs

    01 Industrial

    02 Local

34. Where did you obtain the chemicals and how much do they cost

| Place | Cost in Shs (per pack) |
|---|---|
| 01 From the dealers | - |
| 02 From the shops | - |
| 03 Agricultural extensionist | - |
| 04 Other (specify) | - |

35. How effective was the treatment

    01 not effective

    02 slightly effective

    03 very effective

36. Did you treat your produce after storage?

    01 Yes

    02 No

If yes how many months after storage ............

SECTION F: MAIZE DISPOSAL/PURCHASE PATTERN

37. Explain what you did with your maize soon after harvest

    01 Store for future sales and consumption ............ bags

    02 Sold.................................. bags

    03 Gave to relatives...................... bags

38. After how many months did you start using your stored maize? ..............................

39. After how many months was your produce finished............

40. How often did you take produce out of store ..........................

    01 monthly

    02 every two months

    03 other (specify)

41. How much at average, do you take per withdrawal ...........bags

42. For what purpose did you most frequently withdraw the produce which you stored?

    01 Food

    02 Brewing

    03 Sale

    04 Seed

    05 Other (specify)

43. If maize was taken for sale, explain

(a) To whom sold

01 Cooperative

02 Individual

(b) At what price did you sell the maize

.............. bags

(c) Was the price affected by the quality of the maize?

01 Yes

02 No

(d) When did you sell the maize?.......month

(e) Why did you sell the maize at that time?

01 Procurement

02 Debt repayment

03 Family expenses

04 Invest for next seasons farming activities

05 Good Price

06 Disposal for preparing store for next crop

44. Describe any services provided and costs incured in transacting the sale e.g. gunny bags

| Service type | Costs |
|---|---|
| 01 gunny bags | - |
| 02 other (specify) | - |

45. Did you purchase any maize last season?

01 Yes

02 No

If yes, mention

(a) What quantity was bought .............. bags

(b) From where/whom did you buy

01 National Milling Corporation (NMC)

02 Individual

(c) What price did you pay ............. Shs/bag

(d) For what purpose did you buy maize?

01 Consumption

02 Seed

03 Other (specify)

46. For those without storage: Give reasons for not storing

01 Small harvest

02 Immediate selling

03 Crop failure

04 Other (specify)

## SECTION G: GENERAL QUESTIONS.

47. Do you have any communal storage structures?

01 Yes

02 No

48. (a) What are the two major advantages of maize storage

01 Food security

02 Theft security

03 Damage easily noticed

04 Other (specify)

(b) What are the two major disadvantages/problems associated with storage?

01 Cannot tell amount stored

02 Diddicult treatment

03 Theft

04 Other (specify)

## APPENDIX II

## CALCULATION OF MONTHLY PRICE INDICES FOR MAIZE IN THE SURVEY VILLAGES

Basically this was done by first calculating the centred 12 monthly moving average (that is, by calculating the 12 month moving average and then by calculating the 2 month moving average to centre the averages). This centred monthly moving average reflects the price evolution without seasonal effects. Next the actual average price was divided by the corresponding moving average resulting in unadjusted monthly indices. This calculation produced unadjusted indices for each month. The average of these values was calculated and the resulting series of 12 indices were adjusted in order to have a sum equal to 12.

(a) Calculation of monthly price indices for maize in Ulaya Kibaoni

TSh. per bag

| Month | | Average price (1) | 48 Monthly average (2) | Unadjusted index (1)/(2) | Month | | Average price (1) | 48 Monthly average (2) | Unadjusted index (1)/(2) |
|---|---|---|---|---|---|---|---|---|---|
| 82 | 7 | 360 | | | 85 | 1 | 900 | 695.0 | 1.29 |
| | 8 | 360 | | | | 2 | 900 | 695.0 | 1.29 |
| | 9 | 480 | | | | 3 | 480 | 709.5 | 0.68 |
| | 10 | 600 | | | | 4 | 600 | 741.5 | 0.81 |
| | 11 | 600 | | | | 5 | 600 | 776.5 | 0.77 |
| | 12 | 600 | | | | 6 | 720 | 806.5 | 0.89 |
| 83 | 1 | 600 | 445.0 | 1.33 | | 7 | 600 | 850.5 | 0.70 |
| | 2 | 360 | 467.5 | 0.77 | | 8 | 600 | 906.5 | 0.66 |
| | 3 | 360 | 480.0 | 0.75 | | 9 | 950 | 924.0 | 1.03 |
| | 4 | 360 | 490.0 | 0.61 | | 10 | 1080 | 929.0 | 1.16 |
| | 5 | 360 | 505.0 | 0.71 | | 11 | 1200 | 904.0 | 1.33 |
| | 6 | 420 | 525.0 | 0.80 | | 12 | 1200 | 879.0 | 1.37 |
| | 7 | 480 | 547.5 | 0.88 | | | | | |
| | 8 | 540 | 587.5 | 0.92 | 86 | 1 | 1800 | 909.0 | 1.98 |
| | 9 | 600 | 650.0 | 1.02 | | 2 | 1200 | 939.0 | 1.28 |
| | 10 | 720 | 697.5 | 1.03 | | 3 | 600 | 947.5 | 0.63 |
| | 11 | 840 | 720.0 | 1.17 | | 4 | 600 | 915.0 | 0.66 |
| | 12 | 840 | 737.5 | 1.14 | | 5 | 720 | 857.5 | 0.84 |
| 84 | 1 | 900 | 750.0 | 1.20 | | 6 | 720 | 845.0 | 1.17 |
| | 2 | 1020 | 757.5 | 1.35 | | 7 | 600 | 820.0 | 0.73 |
| | 3 | 1200 | 760.0 | 1.58 | | 8 | 600 | 795.0 | 0.75 |
| | 4 | 600 | 757.5 | 0.79 | | 9 | 600 | 807.5 | 0.74 |
| | 5 | 600 | 752.5 | 0.80 | | 10 | 600 | 820.0 | 0.73 |
| | 6 | 600 | 752.5 | 0.80 | | 11 | 900 | 815.0 | 1.10 |
| | 7 | 600 | 755.0 | 0.79 | | 12 | 1200 | 810.0 | 1.48 |
| | 8 | 600 | 750.0 | 0.80 | | 1 | 1200 | | |
| | 9 | 600 | 715.0 | 0.84 | | 2 | 1200 | | |
| | 10 | 660 | 685.0 | 0.96 | | 3 | 900 | | |
| | 11 | 780 | 685.0 | 1.14 | | 4 | 600 | | |
| | 12 | 900 | 690.0 | 1.30 | | 5 | 600 | | |
| | | | | | | 6 | 720 | | |

| Month | First index (1) | Second index (2) | Third index (3) | Fourth index (4) | Unadjusted index $\frac{(1)+(2)+(3)+(4)}{4}$ | Monthly price index |
|---|---|---|---|---|---|---|
| Jan | 1.33 | 1.20 | 1.29 | 1.98 | 1.45 | 1.46 |
| Feb | 0.77 | 1.35 | 1.29 | 1.28 | 1.17 | 1.18 |
| Mar | 0.75 | 1.58 | 0.68 | 0.63 | 0.91 | 0.92 |
| Apr | 0.61 | 0.78 | 0.81 | 0.66 | 0.72 | 0.73 |
| May | 0.71 | 0.80 | 0.77 | 0.84 | 0.78 | 0.79 |
| June | 0.80 | 0.80 | 0.89 | 1.17 | 0.92 | 0.93 |
| July | 0.88 | 0.79 | 0.70 | 0.73 | 0.78 | 0.79 |
| Aug | 0.92 | 0.80 | 0.66 | 0.75 | 0.78 | 0.79 |
| Sept | 1.02 | 0.84 | 1.03 | 0.74 | 0.91 | 0.92 |
| Oct | 1.03 | 0.96 | 1.16 | 0.73 | 0.97 | 0.98 |
| Nov | 1.17 | 1.14 | 1.33 | 1.10 | 1.19 | 1.19 |
| Dec | 1.14 | 1.30 | 1.37 | 1.48 | 1.32 | 1.32 |
| Sum | | | | | 11.90 | 12.00 |

(b) Calculation of monthly price indices for maize in Ukwamani

TSh. per bag

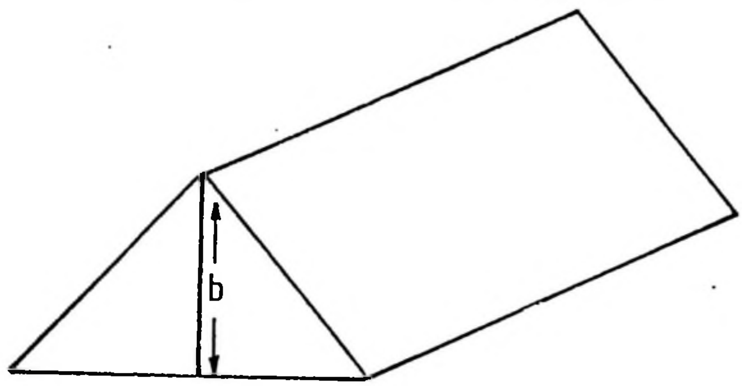
| Month | | Average price (1) | 36 Monthly average (2) | Unadjusted index (1)/(2) | Month | | Average price (1) | 36 Monthly average (2) | Unadjusted index (1)/(2) |
|---|---|---|---|---|---|---|---|---|---|
| 83 | 7 | 400 | | | 86 | 1 | 1500 | 992.5 | 1.51 |
| | 8 | 420 | | | | 2 | 1500 | 997.5 | 1.50 |
| | 9 | 430 | | | | 3 | 1500 | 1002.5 | 1.50 |
| | 10 | 640 | | | | 4 | 1140 | 1005.0 | 1.13 |
| | 11 | 740 | | | | 5 | 720 | 1005.0 | 0.72 |
| | 12 | 900 | | | | 6 | 600 | 1005.0 | 0.60 |
| 84 | 1 | 1100 | 748.3 | 1.47 | | 7 | 660 | 1000.0 | 0.66 |
| | 2 | 1150 | 757.9 | 1.52 | | 8 | 720 | 992.5 | 0.73 |
| | 3 | 1100 | 771.3 | 1.43 | | 9 | 780 | 985.0 | 0.79 |
| | 4 | 1050 | 784.2 | 1.34 | | 10 | 840 | 982.5 | 0.85 |
| | 5 | 500 | 794.2 | 0.63 | | 11 | 960 | 982.5 | 0.98 |
| | 6 | 500 | 807.5 | 0.62 | | 12 | 1140 | 980.0 | 1.16 |
| | 7 | 500 | 820.0 | 0.61 | | | | | |
| | 8 | 550 | 826.2 | 0.66 | 87 | 1 | 1380 | | |
| | 9 | 620 | 832.5 | 0.74 | | 2 | 1440 | | |
| | 10 | 760 | 842.9 | 0.90 | | 3 | 1380 | | |
| | 11 | 860 | 853.3 | 1.01 | | 4 | 1200 | | |
| | 12 | 1100 | 861.7 | 1.28 | | 5 | 660 | | |
| 85 | 1 | 1200 | 870.0 | 1.38 | | 6 | 600 | | |
| | 2 | 1200 | 878.8 | 1.36 | | | | | |
| | 3 | 1200 | 887.5 | 1.35 | | | | | |
| | 4 | 1200 | 895.0 | 1.34 | | | | | |
| | 5 | 600 | 902.5 | 0.66 | | | | | |
| | 6 | 600 | 908.3 | 0.66 | | | | | |
| | 7 | 600 | 922.5 | 0.65 | | | | | |
| | 8 | 660 | 947.5 | 0.69 | | | | | |
| | 9 | 720 | 972.5 | 0.74 | | | | | |
| | 10 | 840 | 982.5 | 0.85 | | | | | |
| | 11 | 960 | 985.0 | 0.97 | | | | | |
| | 12 | 1140 | 990.0 | 1.15 | | | | | |

| Month | First index (1) | Second index (2) | Third index (3) | Unadjusted index $\frac{(1)+(2)+(3)}{3}$ | Monthly price index |
|---|---|---|---|---|---|
| Jan | 1.47 | 1.38 | 1.51 | 1.45 | 1.45 |
| Feb | 1.52 | 1.36 | 1.50 | 1.46 | 1.45 |
| Mar | 1.43 | 1.35 | 1.50 | 1.43 | 1.43 |
| Apr | 1.34 | 1.34 | 1.13 | 1.27 | 1.26 |
| May | 0.63 | 0.66 | 0.72 | 0.67 | 0.67 |
| June | 0.62 | 0.66 | 0.60 | 0.63 | 0.62 |
| July | 0.61 | 0.65 | 0.66 | 0.64 | 0.64 |
| Aug | 0.66 | 0.69 | 0.73 | 0.69 | 0.68 |
| Sept | 0.74 | 0.74 | 0.79 | 0.76 | 0.76 |
| Oct | 0.90 | 0.85 | 0.85 | 0.87 | 0.86 |
| Nov | 1.01 | 0.97 | 0.98 | 0.99 | 0.98 |
| Dec | 1.28 | 1.15 | 1.16 | 1.20 | 1.20 |
| Sum | | | | 12.06 | 12.00 |

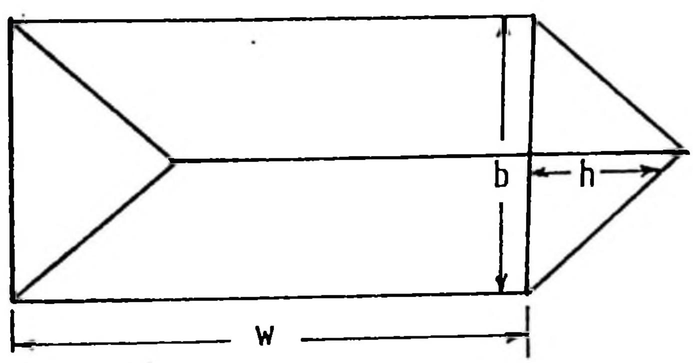
## APPENDIX III

## CALCULATION OF CAPACITY OF STORAGE STRUCTURES IN 90 KILOGRAM BAGS

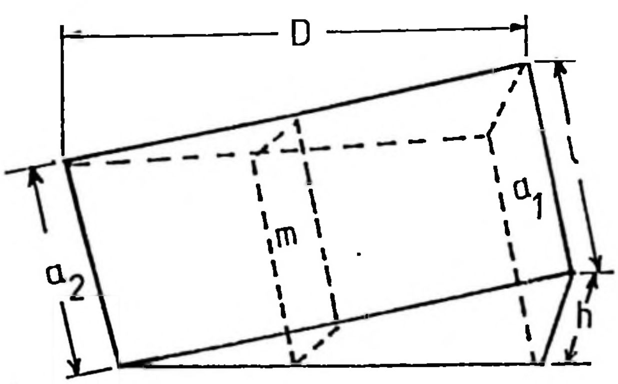
(a) The "Chanja" storage structure




Perspective View




Side View




Top View

The structure is prismatic (or wedge-like): A praismoidal formula is used to calculate the volume (V)

$$V = 1/2\ D.a_1$$
$$= D/6\ (3a_1)$$
$$= D/6\ (a_1 + 4M + a_2)$$

NB: $M = 1/2\ a_1$ ; $4M = 2a_1$ ; $a_2 = 0$; $b=D$;

$a_1$ = base area

= l X h

from the survey; average dimensions were:

D = 1.16m

l = 3.97m

h = 2.38m

$$\therefore V = 1/2\ (1.16m)(3.97m)(2.38m)$$
$$= 5.48m^3$$

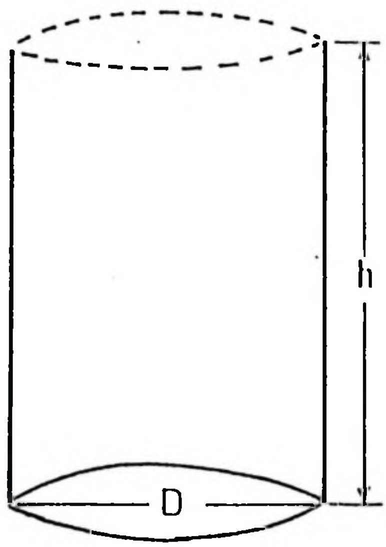
One tin of husked unshelled (mixed variety) maize (equivalent to $0.036m^3$) yielded an average of 7.0 Kilograms of shelled maize.

∴ capacity of structure is given by

$$\frac{5.48m^3 \times 7.0\ Kg}{0.036m^3} = 1065.55\ Kg$$

= <u>12 bags.</u>

The "Chidong'a" storage structure




This is cylindrical in shape; and

$V = \pi r^2 h$

where $r = D/2$

$\therefore V = \pi (D/2)^2 h$

from the survey, average dimensions were;

$D = 1.8m$ i.e $r = 0.9m$

$h = 1.1m$

$\therefore V = \frac{22}{7} (0.9,)^2 (1.1m)$

$= 2.8m^3$

Since 1 tin = $0.036m^3$ carries approximately 18 kilograms the capacity of the store was 1400 kilograms

=16 bags

Appendix IV: DERIVATION OF NET SEASONAL RISE IN PRICE OF MAIZE, 1985/86 - 1986/87

(a) Ulaya Kibaoni

| Months | Marketing year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1985/86 | | | | | 1986/87 | | | | |
| | Obs Price (Pti) | Stor cost [1 t(i+L+D) | Exp Price E (Pti) | Net Price Rise Pti - E (Pti) | | Obs Price (Pti) | Stor Cost [1 t (i+L+D) | Exp Price E (Pti) | Net Priece Rise Pti - E (Pti) | |
| | TShs. | TShs. | TShs. | TShs. | % | TShs. | TShs. | TShs. | TShs. | % |
| May | 600 | - | 600 | - | - | 600 | - | 600 | - | - |
| June | 720 | 22 | 622 | 98 | 16 | 720 | 22 | 622 | 98 | 16 |
| July | 600 | 43 | 643 | -43 | -7 | 600 | 44 | 644 | -44 | -7 |
| August | 600 | 65 | 655 | -65 | -10 | 600 | 67 | 667 | -67 | -10 |
| September | 950 | 67 | 687 | 263 | 38 | 600 | 69 | 669 | -69 | -13 |
| October | 1080 | 109 | 709 | 371 | 52 | 600 | 111 | 711 | -111 | -16 |
| November | 1200 | 130 | 730 | 470 | 64 | 900 | 133 | 733 | 167 | 23 |
| December | 1200 | 152 | 752 | 448 | 60 | 1200 | 155 | 755 | 445 | 59 |
| January | 1800 | 174 | 774 | 1026 | 133 | 1200 | 178 | 778 | 422 | 54 |
| February | 1200 | 195 | 795 | 405 | 51 | 1200 | 200 | 800 | 400 | 50 |
| March | 600 | 217 | 817 | -217 | -27 | 900 | 222 | 822 | 75 | 10 |
| April | 600 | 239 | 839 | -239 | -29 | 600 | 224 | 844 | -244 | -29 |
| Mean | | | | | 31 | | | | | 12 |

Source: Own survey data, 1987.

[1 Cost figures rounded to nearest T. shilling.
Calculations based on cost component described under section 5.4.1.

(b) Ukwamani.

| Month | Marketing Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1985/86 | | | | | 1986/87 | | | | |
| | Obs. price (Pti) | Stor.cost t(I+L+D) | Exp. price E(Pti) | Net price rise Pti-E(Pti) | | Obs.price (Pti) | Stor. cost t(I+L+D) | Exp.price E(Pti) | Net. price rise Pti-E(Pti) | |
| | Tshs | | | | % | Tshs | | | | % |
| June | 600 | - | 600 | - | - | 600 | - | 600 | - | - |
| July | 600 | 19 | 619 | -19 | -3 | 660 | 20 | 620 | 40 | 6 |
| August | 660 | 38 | 638 | 22 | 3 | 720 | 41 | 641 | 79 | 12 |
| September | 720 | 57 | 657 | 63 | 10 | 780 | 61 | 661 | 119 | 18 |
| October | 840 | 76 | 676 | 164 | 24 | 840 | 82 | 682 | 158 | 23 |
| November | 960 | 95 | 695 | 265 | 38 | 960 | 102 | 702 | 258 | 37 |
| December | 1140 | 113 | 713 | 427 | 60 | 1140 | 122 | 722 | 418 | 58 |
| January | 1500 | 132 | 732 | 768 | 105 | 1380 | 143 | 743 | 637 | 86 |
| February | 1500 | 151 | 751 | 749 | 100 | 1440 | 163 | 763 | 677 | 89 |
| March | 1500 | 170 | 770 | 730 | 95 | 1480 | 184 | 784 | 596 | 91 |
| April | 1140 | 169 | 789 | 351 | 64 | 1200 | 204 | 804 | 396 | 49 |
| May | 720 | 208 | 802 | -82 | -11 | 660 | 224 | 824 | -164 | -20 |
| Mean | | | | | 42 | | | | | 41 |

Source: Own survey, 1987.

Appendix V: COMPONENT COSTS OF IMPROVED STORAGE STRUCTURES

(a) Village storage project cost components

| Item | Cost |
|---|---|
| | '000 TShs. |
| I Materials | |
| (i) Sand | 20.00 |
| (ii) Gravel | 19.50 |
| (iii) Stones | 20.00 |
| (iv) Cement | 61.05 |
| (v) Bars | 2.25 |
| (vi) Wire mesh | 9.00 |
| (vii) Timber | 28.00 |
| (viii) Congurate Iron Sheets | 50.00 |
| (ix) Ridge covers | 0.90 |
| (x) Nails (for Iron sheets) | 2.25 |
| (xi) Timber Nails | 5.63 |
| (xii) Locks and contingencies | 5.00 |
| Total material cost | 233.57 |
| II Labour | |
| (i) Construction Technicians | 20.00 |
| (ii) Casual labour | 40.00 |
| (iii) Transport materials to site | 25.00 |
| (iv) Timber treatment | 1.00 |
| Total construction cost | 86.00 |
| III Operation and Mainatainance | |
| (i) Shelling and Handling | 33.30 |
| (ii) Bags and Twines | 59.40 |
| (iii) Fumigation | 8.10 |
| (iv) Guard | 3.38 |
| Total Operation and Maintainance cost | 104.17 |
| Grand Total | 413.74 |

Source: Kilosa District DADO Office.

(b) Costs of Improved Traditional Storage Structure [1]

| Item | Cost |
| --- | --- |
| | TShs. |
| 1. The "Chanja" | |
| (a) Capital costs | 125.00 |
| (b) Variable costs | |
| (i) Fumigation | 5.40 |
| (ii) Rat guards and grain outlet | 23.67 |
| (iii) Bags and twines | 37.60 |
| (iv) Shelling and handling | 20.40 |
| (v) Bed | 15.00 |
| Total variable costs/bag | 102.07 |
| Grand Total costs/bag | 227.07 |
| 2. The "Chidong'a" | |
| (a) Capital costs | 31.00 |
| (b) Variable costs | |
| (i) Fumigation | 5.40 |
| (ii) Rat guards | 18.65 |
| (iii) Roof and grain outlet | 23.63 |
| (iv) Smearing | 2.31 |
| Total variable cost/bag | 49.99 |
| Grand total costs/bag | 80.99 |

Sources: (1) Own Survey data, 1987.
(2) MRCU, 1987.

[1] Costs include labour cost valued at TShs. 37.00 for a 10 hours manday.

## APPENDIX V1

### CALCULATION OF BENEFITS ACCRUING FROM IMPROVED RURAL STORAGE

| Benefit Component | Village | |
|---|---|---|
| | Ulaya Kibaoni | Ukwamani |
| Type of storage structure | Chanja | chidong'a |
| Quantity Stored (Q) | 1 bag | 1 bag |
| Annual Losses | 17.3% | 13.3% |
| Losses at lean season (L) | 13% | 9% |
| Percent by which prices are higher at lean season (Y) | 100% | 134% |
| Harvest price (Pto) | Tsh 600 | Tsh. 600 |
| Benefit (Bt)* | Tsh 156 | Tsh. 126 |

* Worked out by using equation 4.5 (P 97).