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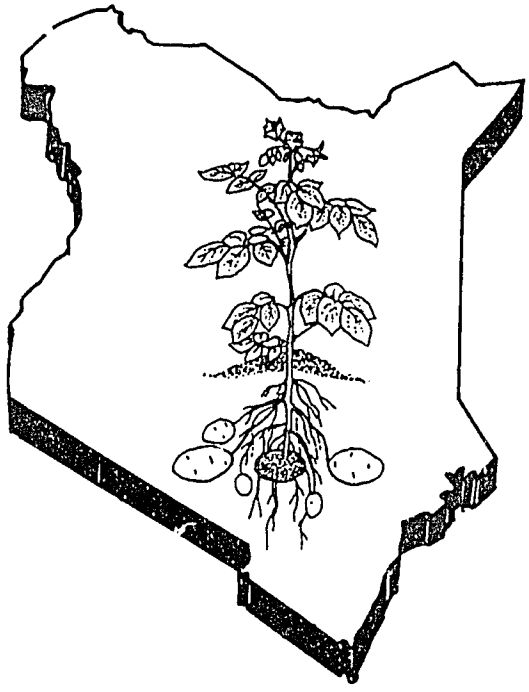

Seed Potato Systems in Kenya: A Case Study

by
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Acronyms

ADC	Agricultural Development Corporation
CIP	International Potato Center
DAO	District Agricultural Officer
EAAFRO	East African Agriculture and Forestry Research Organization
FAO	United Nations Food and Agriculture Organization
GTZ	German Technical Assistance Agency
ISNAR	International Service to National Agricultural Research
KARI	Kenya Agricultural Research Institute
KGGCU	Kenya Grain Growers Cooperative Union
KSC	Kenya Seed Company
NAL	National Agricultural Laboratories
NPQS	National Plant Quarantine Service
NPRS	National Potato Research Station
NSQCS	National Seed Quality Control Service
ODA	Overseas Development Administration of Great Britain
SFT	Settlement Fund Trustees
SIDA	Swedish International Development Agency

Contents

Acronyms i
List of Tables iv
List of Figures iv
List of Appendix Tables iv
Abstract v
Summary vi

1. **Introduction** 1
   Objectives and Methodology 1
   Seed Potato Programs 2
   Issues 3
   A Note on Potato Physiology and Pathology 3
      Physiology 3
      Pathology 3
      Implications for Official Seed Programs and Farmers' Informal Seed Systems 4

2. **Potatoes and Potato Farmers in Kenya** 5
   Agroeconomic Setting 5
      Physical 5
      Socioeconomic 6
   Area, Production and Yield 6
   Marketing 8
   Consumption 9
   Farmer Seed System 9
      Seed Sources 9
      Seed Management 10
      Farmer Knowledge of and Attitudes Toward Certified Seed 10
      Farmer Evaluation and Choice of Potato Varieties 11
      Variety Rejection and Loss 12
   Meru 12

3. **The Formal Seed System** 14
   Policy Setting 14
   Development of the National Potato Research Station 14
   Plant Quarantine Services 16
   Seed Certification Services 16
      Seed Potato Certification 17
      Changes in the Seed Potato Rules 17
   Seed Multiplication 18
   Shifting Responsibilities Among Institutions 18

4. **Breeding and Variety Distribution** 20
   Variety Introduction and Breeding 20
   Evaluation and Release of New Varieties 22
   Distribution of Potato Varieties 23
   Perception of Variety Qualities 24

5. **Initial Multiplications** 27
Background and Definitions 27
Clonal versus Rapid Multiplication 27
The Kenya-GTZ Seed Potato Project 28
Germplasm Maintenance 28
Multiplication Techniques at NPRS 29
Clonal Multiplication 29
Rapid Multiplication 29
Basic Seed Production 29
Trends in NPRS Seed Production 30
Basic Seed Production by ADC 31
NPRS and the Research System in Kenya 31
Budget 31
Staff 32
Impact of the Kenya-GTZ Project 32

6. **Building Seed Supplies** 33
The ADC Seed Potato Project 34
Administration 35
Seed Potato Production 35
Contract Seed Growers 35
Storage 40
Marketing and Promotion 36
Demonstration Trials 36
Seed Prices 37
Certified Seed Production and Distribution in Kenya 38
Distribution 38
Production 39

References 40
Appendices 43

List of Tables

1. Potato Area in Selected Districts 1975, 1985 8
2. Institutional Developments Related to the Kenyan Potato Program 15
3. Disease Tolerance Levels for Seed Certification 1976-1988 18
4. Changes of Institutions Responsible for Seed Potato Related Activities 19
5. Officially Released or Important Introduced Potato Varieties: Kenya 21
6. Numbers of Sites and Entries in the National Performance Trials for Potatoes, Kenya Long Rains 1979-88 23
7. Potato Varieties in Farmers' Fields, 1976/77 and 1988 24
8. Frequency of Potato Variety Characteristics Mentioned by Farmers for All Varieties 25
9. Varieties in Seed Production and Varieties Preferred by Farmers 1976/77 25
10. Varieties in Seed Production and Varieties Preferred by Farmers 1988 25
11. Seed Production Capacity at NPRS Stations 30
12. Seed Produced by NPRS, 1976-88 31
13. ADC Long Rains Potato Demonstration Trials 37
14. ADC Seed Production 39

List of Figures

1. Basic Elements of the Kenyan Certified Seed Potato System 2
2. Provinces of Kenya 5
3. Potato Production and Potato Area 1961-1985 7
4. Areas of Concentrated Potato Production 7
5. Sources and Flows of Breeding and Screening Material at Various Times in Kenya 20
6. Basic Seed Production Techniques in Kenya 27
7. ADC Certified Seed Potato Scheme 35

List of Appendix Tables

1. Potato Varieties Named by Potato Growers: 1976/77 43
2. Potato Varieties Named by Potato Growers: 1988 43

Abstract

Seeds and seed systems provide a vital link between cropping seasons. While systems of botanical seed reproduction have been extensively studied, the seed systems of vegetatively reproduced crops are relatively undocumented although vegetatively reproduced crops are a major food source in many countries.

This research report, one of a series of case studies of seed potato programs in developing countries, examines the seed potato systems in Kenya. These systems are dominated by farmer-based informal seed systems. One informal system has a rapid turnover of a large number of varieties in an apparent substitution for normal seed renovation. Another system has the expected seed flows from advantaged areas and a stable selection of varieties.

The formal system is a single organized seed production program of which the major components are split between several Ministry of Agricultural agencies and a parastatal firm. The government of Kenya has skillfully managed special development projects to establish major portions of the official seed system. Quality control elements are especially well organized. However not all projects have had a sustainable impact and the tenuousness of core government funding has weakened several key elements of the system, notably pre-basic seed production.

The formal system has not been able to match varieties in seed production with varieties popular among farmers. The history of development of the formal sector has emphasized production aspects of certified seed. Until recently, the development of seed distribution and promotion has been neglected. Currently, there is a commercially oriented marketing system that does not reach the majority of farmers.

Summary

In Kenya the area devoted to potato production has been expanding steadily for the last several decades, principally on small holder farms. Kenyan potato farmers cultivate potatoes in numerous production areas and utilize a large number of potato varieties, many of which are of uncertain origin. Meru District is distinct from other areas in the degree of commercialization of production and the consistent popularity of a single variety, Kerr's Pink. The farmer-based seed system is characterized by self supply and provides the vast majority of seed used each season.

In the farmer-based seed system, seed renewal is often accomplished by changing varieties when farmers perceive that a given variety has become "tired". As farmers change varieties, volunteer tubers remain from old varieties and these are used as a reserve should the farmer decide to reintroduce that variety. The seed renewal/variety changing pattern has produced significant shifts in variety distribution and popularity. During a span of ten years the two most popular varieties changed in all of the major producing areas except Meru. The current most popular variety was unknown a decade ago and is of uncertain origin. It is not on the list of official varieties. The changing mix of varieties has led to inconsistencies between the farmer-based seed system and the official potato program. Varieties included in the official seed program are frequently not popular with farmers and those popular varieties are frequently not in the seed production program.

Official activity in the potato seed sector occurs within a coordinated program for certified seed production. Ministry of Agriculture research, plant quarantine and seed certification agencies and the Agricultural Development Corporation, a parastatal firm, are the principal entities involved. The government has successfully employed special projects during a period of 20 years to strengthen key institutions concerned with quarantine, quality control and seed production.

Not all projects had lasting impact. During the 1970's a comprehensive seed potato project in collaboration with the National Potato Research Station developed facilities and established quality control, production, distribution and extension procedures for a program of certified seed production. Without special project funds, the station was unable to adequately maintain the facilities or reliably produce seed or supervise seed production and distribution. Gradually all the program elements except pre-basic seed production were dispersed to other agencies.

Involvement of ADC, the parastatal firm, in seed production and distribution is a significant shift in philosophy concerning the certified seed production. The previous model had relied on contracted farmer seed producers for production and distribution.

ADC provides for commercially oriented, centralized production and distribution via agricultural supply stores. This commercial orientation, which by its nature is concerned with the preferences of the seed consumer, has provided the incentive for the development of the first ever comprehensive seed promotion and distribution plan in Kenya.

Specific Conclusions

1. Potato production in Kenya is dominated by small holder production dispersed in highland areas utilizing a large and changing mix of varieties.
2. The farmer seed system is dominated by self-supply with seed renewal coming primarily from the local community.
3. Farmers assume yield declines are due to varietal degeneration not seed degeneration. Thus varieties are often changed when seed is renewed.
4. Nayo, unknown until recently, is the current most popular variety. It is of uncertain origin, is not on the official list of recognized varieties and is not part of the official seed production program.
5. Over the years, the introduction of improved varieties has been the official activity with the largest impact on the seed potato system.

6. On an annual basis, certified seed production has never exceeded more than one percent of seed requirements.
7. The selection of varieties in the certified seed program have consistently not included those varieties most popular with farmers. This has seriously limited the impact of certified seed by limiting the potential for informal diffusion of quality seed from those farmers that do purchase certified seed.
8. The present system of certified seed bulking on the farm of the Agricultural Development Corporation instead of relying on individual seed growers as was done previously greatly improved the ability to control quality and the final use of the seed.
9. The involvement of a parastatal company with profit motives in seed bulking and distribution improves the viability of the certified seed program by the initiatives for improvement created by the profit seeking behavior of the firm. This is in contrast to the activities of government agencies that frequently face budgetary and staffing constraints.
10. The National Potato Research Station remains a weak element in the official seed system and the pre-basic seed production done there can probably be more efficiently accomplished by ADC. This would release funds in the station for research, an activity it is better prepared to do.

1. Introduction

Seed potato health and physiological age can be major limiting factors in potato production, and seed occupies a large share of production costs. Many potato sector projects in developing countries attempt, therefore, to relieve constraints to production caused by poor quality seed. However, the results of these projects have been highly variable. The International Potato Center (CIP) and other organizations have been involved in seed systems work in numerous countries, both in the development of technologies for the production and multiplication of seed (seed schemes) and the development of coordination among institutions which are concerned with the production and distribution of seed on a commercial scale to meet farmers' needs (seed programs). Foreign assistance to developing countries has taken many forms, including direct placement of scientists in seed programs, technical backstopping; short-term assignments; financial support; training; and provision of supplies, equipment and genetic material. Results of these activities, however, are widely dispersed throughout the developing world and their current status is largely unknown.

The term 'seed system' encompasses the set of physical, technological, political, institutional and economic conditions that give shape to the process of the production and utilization of seed. With an emphasis on institutional factors, this report examines two systems --formal and informal-- of seed potato production and use in Kenya. The informal system consists of seed production, distribution, and information exchange which are farmer based rather than government directed.

The Kenyan formal system of seed potato production consists of a government seed program within which the various stages of seed production and distribution are delegated to several institutions. Recent governmental efforts in the formal seed system centered on a cooperative project between the Agricultural Development Corporation (ADC)[1], a large parastatal firm, and the Dutch government to establish a commercially-oriented certified seed program. Ending in 1989, this project made significant advances, in part by acknowledging and reacting to the needs of the informal seed system.

Potato production in Kenya has grown steadily during recent decades. During the 1980's, the government's objective to diversify food production away from an excessive dependence on maize has focused even more attention on this crop. Production has also been enhanced by the ability of the Kenyan government to consistently attract foreign funding to develop its agricultural sector.

For selected crops such as wheat and maize, Kenya has a well developed seed industry which produces a substantial percentage of its domestic seed needs and exports seed produced by both domestic and foreign firms. However, the development of a modern seed potato industry has generally lagged behind development of the seed industry for these other crops. The ADC potato project represents the most recent of a series of initiatives spanning several decades to put in place an effective system of producing and delivering to farmers seed potatoes of reliably high quality.

Objectives and Methodology

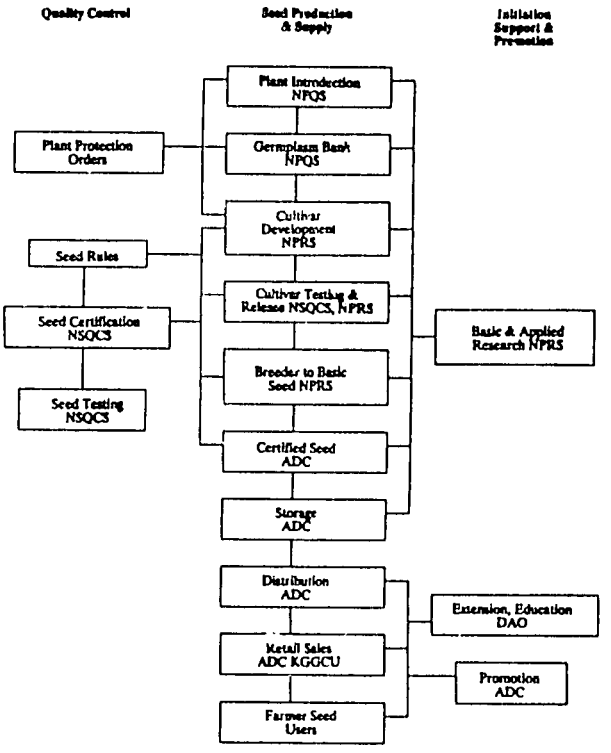
This report is one of a series of case studies on seed potato systems in selected countries. The main objectives of the case studies are to identify strengths and weaknesses in organized seed potato programs, to document the characteristics of informal seed systems and to determine how seed projects can be designed to complement or augment both the formal and informal systems. The intent is also to analyze the performance of different technical and institutional schemes in seed potato projects and to document the importance of improved formal seed systems to increased production as compared with informal systems. To do this effectively, organized potato programs must be viewed within the context of their particular agroecological and institutional environments.

Analysis is based on available information, interviews, publications and direct observation.

1 All acronyms and initialisms are listed in the glossary.

Data collection for this study was carried out during several months of field work in various locations in Kenya during the second half of 1988 and complimented by periodic updates since then. Field work was completed with the assistance and cooperation of the National Seed Quality Control Service, the National Potato Research Station, ADC, and the Eastern and Southern Africa Regional office of CIP and was carried out in conjunction with a separate study on the distribution of potato varieties and farmer attitudes toward varieties[2]. More than 150 interviews were conducted with potato farmers in the major potato producing areas and other locales. Other informants included marketers, government workers in the various institutions which have mandates in the potato sector and with representatives of ADC. Where possible, the descriptive analysis is supplemented by quantitative documentation. This was not often possible as the paucity of documentation and time constraints on field work eliminates more complete documentation. This lack of information precluded more empirical impact analysis of the projects.

FIGURE 1. BASIC ELEMENTS OF THE KENYAN CERTIFIED SEED POTATO SYSTEM



Seed Potato Programs

Formal programs producing certified seed are comprised of several basic categories; 1) quality control, 2) variety selection and introduction, 3) seed production and distribution, and 4) support and promotion activities.

A schematic representation of the formal seed system in Kenya is illustrated in Figure 1. Certified seed is a legal concept and requires a body of regulations and an agency with oversight power to assure quality. In Kenya this is the responsibility of the National Seed Quality Control Service (NSQCS).

Since potatoes are not native to Kenya, there have been periodic imports of varieties or germplasm for breeding. Careful importation requires quarantine services. Once imported, these materials should be maintained in disease free condition to be available for future research or seed production. In Kenya these services are provided by the National Plant Quarantine Service (NPQS).

Seed production schemes consist of several basic steps where an initial disease-free source of planting material is multiplied for several generations. In Kenya, NPQS maintains germplasm in vitro and delivers breeder seed to the National Potato Research Station (NPRS) which produces basic seed. The ADC potato project receives the basic seed from NPRS and produces certified seed. Seed distribution is the responsibility of ADC. The majority of retail sales are through ADC warehouses or Kenya Grain Growers Cooperative Union (KGGCU) agriculture supply stores.

Seed production and distribution schemes are supported by research and promotion activities. NPRS is in charge of research and the Ministry of Agriculture extension agents, the District Agriculture Officers (DAOs) and ADC provide most education, extension and promotion of seed.

2 The results of the variety distribution study have been published as a CIP Social Science Department Working Paper by McArthur Crissman (see references)

Issues

There are several issues concerning the performance and structure of the formal and informal seed potato systems in Kenya raised in the course of this study. The informal seed system is discussed in chapter 2. Notable here are the distinctions between the seed potato system in Meru District and the rest of the country. In the rest of the country the proclivity of potato farmers to frequently change varieties is examined. These systems require different distribution models. The response of the formal system to this is discussed in chapter 6. In chapter 3, the institutions comprising the formal seed system are examined via a brief history which highlights the large number of special projects since independence. Analyzed are the variable impact of those projects and the shifting institutional structure of the formal system.

A large number of potato varieties are cultivated in Kenya, what these varieties are and factors affecting their present distribution are examined in chapter 4. The response of the formal system to this is analyzed. The first steps in the seed production process are detailed in chapter 5. The appropriateness of the site of the NPRS station and the selection of seed multiplication techniques for basic seed production are examined. In chapter 6 the production of certified seed by ADC is presented. The efficiency of a parastatal firm and the model of utilizing centralized instead of decentralized production are discussed.

A Note on Potato Physiology and Pathology

The functions of a seed potato system are in part governed by certain aspects of potato physiology and pathology. This section, relying on Horton (1987b), introduces some of these aspects and how they can be managed.

Physiology

The potato is a member of the plant family *Solanaceae* which also includes tobacco, tomato, eggplant and pepper. The potato tuber is an enlarged portion of an underground stem containing about 80% water. The plant can reproduce sexually through seed from its tomato-like fruits but the vast majority of the world's potato farmers select tubers to use as "seed." Tuber-based multiplication is slow, averaging a 10:1 ratio of product to seed. Thus numerous generations are needed to produce large quantities of seed -- an important consideration for seed programs as each generation of this perishable tuber must be properly stored and protected from diseases.

The tuber has dormant buds called "eyes" and passes through several physiological stages that affect the number of eyes that will sprout. Dormant tubers do not sprout; physiologically young tubers sprout only from the apical buds; mature tubers show evenly distributed sprouting and old tubers produce only a few thin sprouts. Sprouting is important since yield is related to the number of stems produced by sprouts. The rate of physiological aging is controlled by several factors, including variety and storage conditions. Storage temperature and exposure to light strongly affect sprouting and subsequent yields. Temperatures higher than about 4°C induce sprout growth and, in dark conditions, long thin sprouts develop. If exposed to light, sprouts remain short and are more sturdy and vigorous.

Usually smaller whole tubers are preferred as seed. Undamaged tubers have fewer entrances for disease. Per unit of weight, smaller seed produce larger yields than large seed of equal health and physiological condition.

The environment in which seed tubers are grown and stored strongly affects the subsequent crop. All else being equal, seed grown and stored under cool, humid conditions will behave as young seed for a longer period. Young seed tends to be later maturing and thus higher yielding than old seed. Earliness or lateness of maturity is also dependent on variety.

Pathology

Seed tubers can transmit many yield-reducing diseases. The most important of these are virus diseases, some of which may reduce yields by as much as 50%. One of the principal objectives of certified seed programs is the production of virus-free seed. Aphids are the principal vector for virus transmission. Thus seed farms are in cool, rainy and windy areas that inhibit the development and movement of aphid

populations. In the tropics this means highland areas.

Bacterial wilt (*Pseudomonas solanacearum*) is a soil-borne disease that can also be transmitted by infected seed. This serious disease is one of the most damaging to potato crops in developing countries. Farmers try to avoid it by purchasing seed from fields that have not been inoculated by the bacterium. Nematodes are an important pest that also reside in the soil.

A fungal disease, late blight (*Phytophthora infestans*), is one of the most important potato diseases. Capable of spreading rapidly and destroying entire fields, this disease accounts for the majority of pesticide costs incurred by many potato farmers, as repeated spraying is necessary to control infestation.

There are few varieties with effective resistance to these pests and diseases. Careful management and good controls are thus necessary to produce a good crop. An important part of good management is starting with healthy seed of the correct physiological age.

Implications for Official Seed Programs and Farmers' Informal Seed Systems

The intent of official seed programs is to produce true-to-type seed judged free of or with tolerable amounts of diseases or pests. The physiology and pathology of the potato define several basic parameters of these programs. Seed programs need access to fields and water free of disease and pests in a zone suitable for inhibiting crop infection whether in the field or store. Access to facilities or institutions capable of handling large volumes of a bulky perishable commodity for several multiplication cycles is required. The slow multiplication rate places a premium on any technology which can speed the process, thus the value of rapid multiplication techniques.

For farmers, the gradual build-up of diseases among their own seed stocks requires their periodic replacement. In the absence of widespread certified seed, the source of the replacement seed requires careful consideration. In developing countries this usually means that seed from higher altitude zones is preferred because the climatic conditions there slow the spread of pests and diseases. Thus there often exists a distinctive flow of seed from one location to another. On the farm, the farmer can manage his own seed in various ways to slow its rate of degeneration. These include proper post-harvest handling and storage, field or post-harvest selection, and pre-planting treatment.

2. Potatoes and Potato Farmers in Kenya

Agroeconomic Setting

Physical

Kenya, an equatorial East African country of about 24 million people, covers approximately 575,000 square kilometers of which 19% is arable land. There are four broad geographical regions: coastal plains, arid low plateaus, highlands and Lake Victoria borderlands. Of these four regions, most of the arable land is found in the relatively compact highlands area. The highlands are a series of high plateaus and volcanic surfaces ranging in altitude from 1500-3000 m. The highlands are bisected by the Rift Valley, the escarpments and floor of which are higher and receive heavier rainfall than elsewhere in East Africa.

Within the highlands, most soils are volcanic and fertile. The fine-grained texture of the soil makes it moisture retentive and it remains moist even during periods of drought (Moore and Dunbar, 1968). Most potato production occurs in the highlands of Central, Eastern and Rift Valley provinces[3] in the Mau Range, Aberdare Range and the slopes of Mt. Kenya (Figure 2).

Also within the highlands, the rainfall pattern varies greatly according to region and generally increases with altitude. However, in almost all of the zones rainfall occurs in every month and during certain seasons is relatively predictable. On the northeast side of Mt Kenya in the important Meru producing zone, the intensity of the rainfall peaks is reverse that of the other zones (Durr & Lorenzl, 1980).

Land in Kenya has been classified by the Ministry of Agriculture according to its agricultural potential into agroecological zones, depending on climate, soils, and topography and in connection with the major commercial crops. Above an altitude of 2,100 m the growth period for potatoes is faster than for maize and the total energy and protein production per hectare per day is higher. Over 70% of potato production is in this zone (Wambugu & Murithi, 1984). At these altitudes the net revenue per hectare for potatoes is more than double that of maize (Durr & Lorenzl, 1980). Thus for land-restricted Kenya, potatoes are a logical and important crop to promote in the highland areas.

Potato producers in Kenya have to contend with a wide variety of potato pests and diseases. Bacterial wilt, late blight and several types of viruses are considered problems. Expenditure on chemical control of late blight is especially heavy as the cool, moist conditions excellent for spread of the fungus occur frequently.

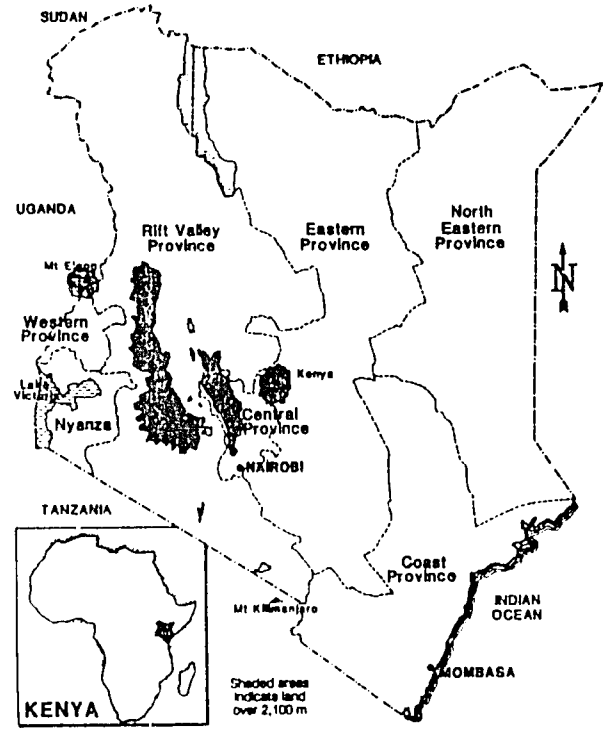


FIGURE 2. PROVINCES OF KENYA

3 Political divisions in Kenya from largest to smallest are: province, district, division, location and sublocation.

Socioeconomic

Kenya is predominantly an agricultural country with agricultural gross domestic product accounting for 31% of total gross domestic product in 1989. Agricultural exports -- mainly coffee and tea -- contribute almost 70% of the total value of exports. Kenya is self sufficient in several crops including maize, millet, sorghum, beans, sugar and root crops as well as animal products such as beef and other meats. Cassava and sweet potato are the other important root crops which together with potatoes accounted for over 170,000 ha in the mid 1980's. In comparison, maize was planted on 1.2 million ha in 1984 (World Bank, 1986).

A large population and one of the world's highest population growth rates exert high and growing pressure on the land. An average of 231 persons per arable square kilometer has resulted in continued subdivision of smallholdings (World Bank, 1986). In the highlands, the smallholdings were acquired by many farmers shortly after independence in 1964. During the field work for this study, consequences of generational transfer were observed: in some cases children inherit a single hectare from what had once been a small but sustainable farm unit. The highlands of Central Province and the borders of Lake Victoria are among the most densely populated areas in the country. In Central Province, traditional homeland of the Kikuyu tribe, the result has been outmigration of Kikuyu, who take their potato production preferences with them.

Potatoes are found on an estimated half million farms in the Kenyan highlands. Most of these farms are smallholdings, defined by the government as farms of less than 20 ha, although the approximate average holding is 2 ha (World Bank, 1986). On individual farms potatoes range in importance from the principal commercial crop to cultivars produced for home consumption in household garden plots. One study showed marketed share of production ranged from 61% in Meru to as low as 14% in Kiambu (Durr and Lorenzl, 1980). The high degree of home consumption reflects in part the very small hectarage planted to potatoes on individual farms. In a study of Kinangop potato farmers, Nyangitu (1986) found that area planted to potatoes was independent of farm size. In a sample of 60 farms ranging in size from 1-5, 6-10, and over 10 ha, the average potato plot size on all farm groups was 0.7 ha. The utilization of this production was 19% for seed, 22% for home consumption, 9% stored for later sale with the remaining half for immediate sale.

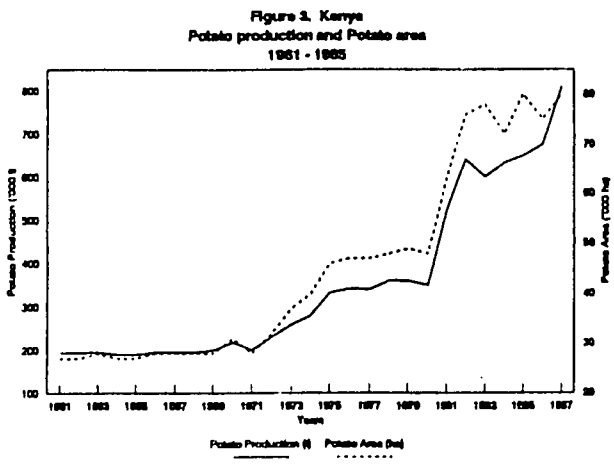
In Kenya, potato farmers are female. Men tend to cultivate commercial crops such as tea or coffee or frequently work off the farm. Farm women are engaged in agricultural production for the household. Thus it is women who are more knowledgeable about potato varieties, production technology, and marketing. Despite this dominant role in food production, women have less access to formal channels of information such as farmer training, contact with extension officers or opportunity of attending agricultural fairs.

Area, Production and Yield

During the last several decades the area planted to potatoes in Kenya has risen steadily, nearly doubling from 1979 to 1985. Reported total production has risen proportionately more than area, aided by a marginal increase in yields. The government of Kenya does not publish yearly totals: the data presented in Figure 3 from the Food and Agriculture Organization of the United Nations (FAO) should be viewed as estimates only. For example, a widespread drought in 1984 seriously reduced potato area and production. Data collected directly from Provincial Agricultural Officers -- ministry officials in charge of reporting crop statistics -- indicate that in 1984 only about 40,000 ha were planted which produced 270,000 tons (Bos et al, 1987). These numbers are in sharp contrast to those in the figure, thus any data purporting to represent aggregate totals should be viewed with caution.

The most important regions along the Mau Range are Molo and Mau Narok in Nakuru District (Figure 4). Around the Aberdare Range, Ol Kalou and Kinangop in Nyandarua District, Kiambu in Kiambu District, and Muranga and Nyeri Districts are sites of concentrated production. Finally, there is Meru District on the slopes of Mt. Kenya. In these areas potatoes are found on nearly every farm and are often the most important food and cash-earning crop on the farm (Nyangitu, 1986). In addition to the zones of concentrated potato

production, numerous other zones have small or diffuse production. Examples of these zones include the Taita Hills, between Nairobi and Mombasa and the slopes of Mt. Elgon, the second highest peak in Kenya (Figure 2).



supplemented by several farm surveys which have recorded yields. As example, several studies of Meru in the mid-1970's found yields there to range from 9 to 15 t/ha (Fischer et al, 1976, Mbogh, 1976, Durr & Lorenzl, 1980). This is well over the FAO-reported national average. Durr and Lorenzl also survey other areas in Central and Rift Valley Provinces and found yields in 1976/77 averaging 5 t/ha. They caution however that their averages are skewed by a few very high observations where yields were over 20 t/ha. Most farmers had yields below the average. In 1979, farmers in different areas of Kiambu District reported average yields from good production years ranging from 12 to 17 t/ha with bad year yields averaging 2 to 8 t/ha (Munene, 1979). In 1985, Nyangitu (1986) questioned a sample of farmers in Kinangop and found yields to be 6 t/ha.

The location of production has been, and remains, concentrated in Central Province. During a span of ten years area doubled from an already high level (Table 1). In Central Province, farms are smaller than the national average and potatoes often compete for farm land with coffee, tea and pyrethrum, limiting the potential for potato area growth. In contrast, there is ample area suitable for potato production in the highlands of Western Province. The spread of production mirrors the migration of the agriculturally-inclined Kikuyu tribe out of their heavily populated traditional home areas in Central Province to other areas, especially Rift Valley Province. Production from this province has increased four fold from 1975 to 1985. Meru District has long been a potato production zone and the area devoted to production has apparently stabilized, fluctuating mainly due to climatic factors.

FAO reports national average potato yields at 7 t/ha in 1975 moving up to 10 t/ha in 1987[4] (FAO, 1991). It is difficult to generalize about yields -- the national averages reported by FAO are clearly only very rough estimates. Information provided by these estimates can be

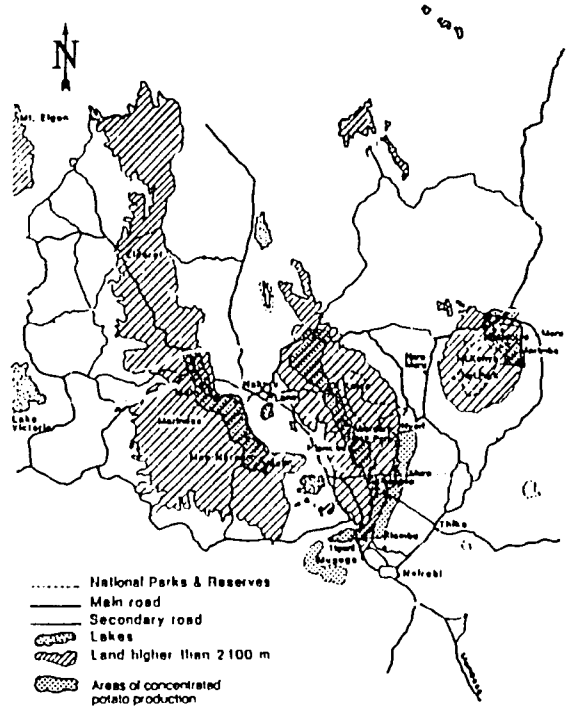


FIGURE 4.

4 To put this in perspective, FAO reports national average yields between 30-40 t/ha in the main European producing countries.

Table 1 Potato Area in Selected Districts 1975, 1985

District	Estimate of Potato Area ('000ha) 1975	1985/86
Central Province		
Nyandarua	7.2	12.7
Nyeri	2.3	10.2
Kiambu	6.2	9.1
Muranga	3.3	7.9
Kirinyaga	0.2	1.3
Sub-total	19.2	41.2
Eastern Province		
Meru	13.2	11.6
Embu	2.0	3.0
Machakos	0.3	-
Sub-total	15.5	14.6
Rift Valley Province		
Nakuru	1.5	6.0
Narok	0.7	3.0
Kericho	0.7	2.7
Laikipia	-	2.3
Elgeyo/Marakwet	0.5	2.0
Uasin Gishu	0.3	1.2
Kajiado	-	0.8
Nandi	0.3	0.3
Trans Nzoia	-	0.2
West Pokot	-	0.1
Baringo	-	0.1
Sub-total	4.0	18.8
Western and Nyanza Provinces	0.2	0.7
Total	38.7	75.3

Sources: Republic of Kenya, Annual District Agricultural Reports, various districts, 1975 data cited in Durr and Lorenzl (1980), 1985/86 data cited in Bos et al, 1987).

Based on this patchy evidence, the commonly held observation that farmers in Meru district produce at nearly double the national average appears reasonable. The rest of the country's farmers produce at much lower levels, some harvesting only slightly more than the seed they planted. Many farmers measure yields in terms of bags of production per bags of seed. During the field work for this study, average returns measured in this fashion varied widely among areas from a low of 4:1 in Mau Narok to a high of 13:1 in Meru district.

Marketing

Potato marketing in Kenya is characterized by the distinct seasonal patterns of supply and the dominant role of the interregional trader. The government is not involved in potato marketing. In most zones potatoes are typically marketed in small amounts during many months of the year with a distinct peak during July and August. There are no well-developed rural assembly points, the principal link between the producing areas and the urban markets is the interregional trader who typically purchases potatoes directly from the field. Durr and Lorenzl (1980) contend that a fairly small group of traders dominate a large share of the interregional trade while entry into the remaining trade is open to anyone. One result is the farmers' suspicions that the trader has better market information and can therefore take advantage of the seller. The price concerns of the farmer are caused in part by the considerable weekly variation found in the major Nairobi market that serves as price leader for most transactions. However, in an analysis of trade margins, trader profits ranged from only 5 to 30 percent after accounting for marketing costs (Durr & Lorenzl, 1980).

Farmers interviewed during field work for this study often stated that the timing of plantings and the varieties selected were influenced by traders. Conversely, potato traders respond to economies of scale which dictate that they travel to an area in which there is a sufficiently high concentration of the variety or groups of varieties with common skin colors which they wish to buy. Because most farmers have only small plots, traders must often visit several farms in order to fill their trucks. Wishing to minimize the time needed to assemble a truckload, traders are reluctant to venture into zones without assured supplies. Thus, traders identify certain areas which produce white or red skinned potatoes and travel there to purchase the preferred colors. Whether traders influence farmer variety planting decisions or are simply responding to the presence of particular varieties in an area was not discernible in this study.

Consumption

Potatoes in Kenya are primarily consumed in the areas where they are produced. These are areas populated by the Kikuyu and related tribes. With the exception of Meru, areas suitable for potato production but populated by tribes other than the Kikuyu produce few potatoes. Located in traditional Kikuyu country, Nairobi is a major market for potatoes.

Because of the highly differentiated consumption patterns, national averages mask more information than they reveal. The FAO food balance estimates (Horton, 1987) indicate that 80% of Kenyan potato production is used for food -- 640,000 tons in 1987. Dividing this by the population gives an annual per capita consumption of 27 kg in 1987. However, Durr and Lorenzl report survey results showing annual per capita potato consumption in production areas of 116 kg. Market patterns indicate that virtually no potatoes move to non-producing rural areas so the remainder is consumed in urban areas. Taking into account that the Kenyan population is over 80% rural, this implies that the urban consumption is much higher than the calculated national average.

Maize is the most important calorie source for all consumer groups in the country. Consumed as a thick cooked meal paste called *ugali* or as a stock for soup, maize accounts for over 50% of daily calories. Beans are another important source of calories and protein. To supply similar amounts of calories or protein, potatoes would be much more costly. Potatoes are included in the basic diet of maize and beans as a vegetable to add variety and flavor (Shah & Frohberg, 1980).

Farmer Seed System

The farmer-based or informal seed system is the only option for obtaining seed for most potato farmers in Kenya. Within this are two distinct subsystems; one serving the farmers of Meru District and the lower production areas of Muranga and Nyeri and the other encompassing the rest of the country. The Meru subsystem is sufficiently different that it is described later in this chapter.

Seed Sources

The most fundamental characteristic of either system is self-supply: the vast majority of small farmers select and store small tubers from their own production to use as seed. Several studies have described components of this system, (Nyangitu, 1986, Durr & Lorenzl, 1980, Mbogh, 1976, and Fischer et al, 1976).

Except in Meru, farmers use their own seed and do not renovate (use clean seed from sources other than their own fields) on a regular basis. Renovation does occur, however, when farmers do not have enough of their own seed or when their crops become so badly diseased that yields are seriously affected. In these cases, farmers usually purchase new seed from friends and neighbors in their own community where the proximity of potato fields allows them to monitor the progress of each others' crops and to evaluate the agronomic characteristics and health of different varieties. Neighbors whose potato crops look healthy may be requested to reserve seed to sell to other farmers after the harvest.

A notable aspect of the informal seed system in Kenya is that changing varieties has become a substitute for seed renovation for many potato growers. Although farmers are familiar with major potato diseases, there is limited understanding of disease transmission through degenerated seed. Farmers often blame diseases on lack of robustness in the variety itself rather than on poor health of the seed. For this reason, farmers tend to change varieties when they change seed when crop yields fall to intolerable levels due to disease.

Nearby market towns or traders are seed sources from outside the community where new varieties or new seed for varieties currently under production can be purchased. Traders describe the agronomic characteristics of the varieties they are selling to interested farmers. If a farmer decides to try a new variety, a small amount of seed will usually be purchased and planted to ascertain the suitability of the variety to the farmer's needs and fields. Seed is sold in 20 liter tins or in 50 kg jute sacks. If favorably evaluated more may be purchased or the existing seed is multiplied over successive seasons by saving most or all of the harvested crop as seed. Field work for the study shows about one fifth of all potato farmers use the

market as a source of information about new varieties.

A similar but less common transfer of seed occurs through sales made by truck traders who primarily buy table potatoes but may also sell seed potatoes from other areas which they service. This, however, is incidental to ware potato marketing and is an occasional, irregular activity. One notable exception to this is the regular sale of Kerr's Pink seed by truck traders who purchase that variety in Meru. Supplementary to consumer potato sales in Thika or Nairobi, the seed are sold to growers along the route between Meru and Nairobi.

Seed Management

Since most farmers produce their own seed, management practices have a direct impact on subsequent production. Nyangitu (1986) found that South Kinangop farmers preferred their own seed to locally purchased seed because it saved on cash expenses, they had greater confidence in their own seed preparation, and the seed was readily available for use.

The bimodal rainfall pattern in this area allows most farmers to plant potatoes twice per year. Seeds are retained from each harvest to be used in the next planting. Farmers indicate that seed are selected primarily on the basis of size -- most farmers prefer egg-sized seed. Selection on the basis of plant health is not practiced. Seed and ware potatoes are selected and separated during or immediately after harvest.

There are four common seed storage methods: (1) in heaps in the fields, (2) in heaps indoors, (3) in a pit which has been lined with leaves or straw and covered with more leaves or straw, and (4) in gunny sacks indoors. The farmer sometimes covers the seed stored outdoors with manure or dirt to stop ventilation and produce heat to speed sprouting. Storage of seed indoors in heaps on the ground is the most popular method, but all four methods are widely distributed. A few farmers leave tubers in the ground during harvest to serve as seed for the next crop, but this method is uncommon.

Durr and Lorenzl (1980) found that average storage period ranged from three weeks in Meru to nine weeks in Ol Kalou. Average losses in Meru were 8% and in Ol Kalou, 12%. In Molo where potatoes are stored on average for six weeks, losses averaged 19%.

In 1978, FAO and the Swedish International Development Agency (SIDA) began an East African regional project to develop and assist the diffusion of improved low-cost rural structures such as water tanks, grain stores and barns. To reach these objectives, Rural Structures Units (RSU) were established in the appropriate ministries of the participating countries (Thorshaug, 1986).

In 1985 the RSU in Kenya included ware and seed potato stores in its promotion program. Though they have been demonstrated to significantly reduce storage losses (Wiersema, 1980) and are now part of the FAO-SIDA rural structures development program, improved seed stores based on the diffused light principal are not common on Kenyan farms.

Farmer knowledge of and attitudes toward certified seed

The Kenya Grain Growers Cooperative Union, ADC, the extension service, district agricultural shows, Farmer Training Centers, agricultural research stations and other institutions provide information about new potato varieties to a third of Kenyan farmers according to field work for this study. However, only a small percentage of farmers actually purchase seed -- either certified or non-certified -- from institutional sources. Although many farmers have heard of certified seed, their information is often inaccurate. For example, the information that certified seed is "better" often becomes distorted to mean that certified seed requires no use of fungicides, that all "new" varieties originate as certified seed, or that all seed sold through institutional networks is certified.

There are several reasons why farmers seldom purchase certified seed from formal institutional sources. Limited availability and high cost are the most common reasons. Certified seed is more expensive than seed purchased from neighbors or the market. Farmers, being cash poor, do not want to spend money for an input which they can produce themselves. Those who cultivate primarily for home consumption are not willing or able to renovate (buy) seed when they can produce a crop without using capital inputs. Credit is generally not available.

Those farmers who understand the advantages of using clean seed and are willing to

buy it may still find it difficult to do so. Farmers complain that certified seed is often not available at designated distribution centers or is not available at the proper planting time. In addition, the varieties for which certified seed exist do not correspond well to the most popular varieties found in farmers' fields.

Farmer Evaluation and Choice of Potato Varieties

Concurrent with the field work for this study was a survey of variety diffusion and farmers' evaluation of those varieties reported in McArthur Crissman (1989). The following section provides a summary of portions of that report relevant to the present study.

Because of the rotation of varieties as part of farmers' seed management, in this section we discuss farmers' evaluation, choice, rejection and loss of potato varieties. There are a large number of potato varieties being grown in Kenya. The specific varieties will be discussed in Chapter 4. Potato farmers typically grow more than a single variety and change the mix of varieties frequently.

Confronted with many potato varieties, farmers must evaluate and choose among them. The words evaluation and choice are deliberately used to distinguish separate processes. Evaluation describes the process of developing information and then judging the characteristics of a variety. Choice describes the decision to incorporate that variety among those grown on the farm. A farmer may evaluate a particular variety while it is growing in a neighbor's field and then choose to try it for herself, or she may consciously choose to try a variety about which she knows little so that she can evaluate it based on its performance in her own field. In the latter case, the experimental variety will not be used to replace an established variety until the farmer is satisfied that it suits her needs.

Some farmers maintain a reserve of varieties as an informal germplasm collection. When asked to enumerate the varieties they grow, many farmers list only those produced for the market or those which they consciously make an effort to reproduce. Additional varieties may be discounted as being "only" for home consumption or, more often, they may be labelled volunteers. Many of these volunteer varieties, however, remain in the fields for years, neither tended nor eliminated. Farmers may later turn to these volunteer tubers when their other seed stocks are diminished and they seek a change of varieties. Farmers speak of "bringing back" varieties which they have grown in the past by multiplying the volunteers. By leaving the volunteers in the fields, farmers maintain a buffer stock which can be activated when needed. While this is not the principal method of changing varieties, it is especially important in terms of genetic maintenance and variability.

Evaluation and choice depend on characteristics of the farmer as well as the variety itself. Farmer attributes salient to the decision-making process include:

- Gender
- Socioeconomic status
- Size of household
- Level of education
- Knowledge of effective husbandry
- Access to channels of communication about potato production and varieties and
- Production objectives (home consumption or market sales)

Potato variety characteristics which farmers list as relevant to their needs include:

- Late blight resistance
- High yields
- Good preparation, cooking and taste qualities
- Storability
- Marketability (includes color)
- Early maturing
- Short dormancy period and good germination
- Production of sufficient quantities of seed
- Resistance to drought and heavy rains
- Production of edible tubers in spite of disease
- Production of large tubers, but not so large as to encourage hollow heart
- Sufficiently firm to withstand handling
- Minimal growing space requirement and
- Suitability to the local soil and climate.

Farmers newly migrated into an area often bring seed potatoes of the varieties they were previously cultivating. If that variety does not interest other farmers, it is usually dropped by the migrant. In the meantime, new migrants also try to obtain seed for the varieties being

grown locally because they know their neighbors have found them to be acceptable. The relative isolation of many potato production areas limits opportunities to learn about new varieties.

Variety Rejection and Loss

Farmers often voluntarily reject the older varieties when newer varieties become available. While evaluation of the older varieties is not uniform, they are generally felt to be less resistant to late blight and lower yielding than the new ones. During the Kenya-GTZ and Kenya-ODA projects, because agronomic practices were changing, the first wave of improved varieties had the advantage of being introduced at about the same time that more inputs were being used. The elimination of a variety is accomplished either by selling off all the tubers from a harvest or by eating all of the variety. Either way, no seed is left to plant the following season. Elimination of older varieties usually occurs after the older and new varieties have been cultivated together for a number of seasons to allow comparison.

Older varieties are voluntarily dropped most often because of low yields and susceptibility to late blight. Many of the older varieties also produced a high percentage of small tubers. Farmers indicate, however, that some of the older varieties "just disappeared" and that they would like to have them back. Perhaps indicative of the recent development of the potato as a commercial crop, few farmers reject the older varieties because of their non-marketability, although a great deal of importance is given to marketability of the newer varieties. The older varieties are described as having been "pushed out" by newer, superior varieties. Some farmers show a propensity to innovate, likening new varieties to womens' fashions and wanting to try whatever is new.

Farmers also lose varieties through disease, seed degeneration and market pressures. Many farmers recognize the need to use fungicides, but either cannot afford to do so, try to save money by spraying less often than recommended or they use fungicides incorrectly (often by spraying only the topside of the apical leaves, thereby reducing its effectiveness).

Meru

Meru District, the main commercial potato production area in Kenya, is distinct in several aspects. Most importantly is that a single variety, Kerr's Pink, has remained most popular for more than four decades. Yields in Meru are better than in other production areas due to the combination of better husbandry and resources--the average yield is twice the national average with better producers attaining levels of 20 t/ha). In addition, compared to other areas men are more involved in potato production in Meru since it is primarily a commercial activity. Meru farmers also invest more in potato production than do farmers in other areas as reflected in their greater use of fungicides for the control of late blight and are more financially solvent as reflected in their ability to hold potatoes off the market in order to speculate on price rises.

Dates for planting and harvesting are more concentrated than in the rest of the country, and with larger quantities marketed, many Meru farmers find it advantageous to deliver their production to the local market instead of selling directly to traders from their fields. Over half of the volume for the Meru market serves the local area with the remainder taken by traders to Nairobi.

Like other areas, self-supply is the most important source of seed for Meru farmers, however, unlike other areas there also exists a distinct flow of seeds. As discussed in the first chapter there are clear agronomic and health advantages to obtaining seed potatoes from higher altitudes. There are two distinct flows with the characteristic high to low altitude direction. The first flow is within Meru. Potato producers in lower portions of Meru maintain the quality of their planting material by obtaining seed from producers in higher production zones on the slopes of Mt. Kenya. This pattern was first noted by Fischer et al (1976) and reconfirmed during field work for this study.

The second flow consists of sales of Kerr's Pink seed from Meru to other areas, and illustrates the only significant interregional seed flow in Kenya. The principal users of seed from Meru are growers in lower regions of Muranga where seed storage is not practical due to higher temperatures. Additionally, the different long rains planting season in Meru makes the seed

from that zone available during planting season in Muranga. The location of Muranga between Meru and Nairobi adds few additional costs to the marketing activities of the truck traders.

3. The Formal Seed System

The performance of the formal seed potato system in Kenya has been greatly enhanced by the number and strength of support institutions in the agricultural sector resulting from the degree of development of the seed sector in the country. The formal seed potato system consists of the government seed program. The development of the seed program has been assisted by a long series of foreign-funded special projects. This chapter provides an overview of the development of the formal system with an emphasis on the role of special projects. A more detailed look at breeding and varieties and several phases of seed production within the formal seed system are provided in the following chapters.

Policy setting

Policy decisions by the Ministry of Agriculture have positively affected potato research and seed production in Kenya. A summary list of institutional developments discussed here and in subsequent sections is presented in Table 2. Maize shortages in 1979 influenced a basic decision of the government to diversify food production away from overdependence on maize while maintaining food self-sufficiency. The government's desire to establish food security and a minimum acceptable level of nutrition for the population has led to an emphasis on alternative crops, among them, the potato.

During the period 1978-1983, the government launched an Integrated Agricultural Development Program with policy objectives to stimulate agricultural growth, improve agricultural trade, decrease unemployment and rural poverty, and to conserve natural resources. Thus production of labor intensive crops (including potatoes) and livestock was emphasized. Policy studies (Kuto, 1982, Siror, 1981), determined that the supply of quality seed potatoes was limiting production and, in response, the government sought to expand the availability of certified seed potatoes.

To reach policy goals, the government has skillfully employed special development assistance projects to establish the physical facilities, train staff and implement programs relating to the potato research and seed production programs of the government. With the exception of ADC, the Kenyan government institutions involved with the formal seed potato system are all member institutions of the Kenyan Agricultural Research Institute (KARI), which originated from the East African Agriculture and Forestry Research Organization (EAAFRO). In line with stated objectives of the Fifth Development Plan (1984-1988) and based on an evaluation report commissioned from the International Service to National Agricultural Research (ISNAR), KARI has become a broadly-focused research organization which coordinates, manages and executes agricultural research. Reorganization during 1988 made all agricultural research officers of the Ministry of Agriculture members of KARI.

Development of the National Potato Research Station

In 1958, a simple seed certification scheme was started at the Horticultural Research Station in Thika and in 1959, a pathologist in the National Agricultural Laboratories (NAL) in Nairobi was assigned quality oversight responsibility. This division of potato work between Thika and Nairobi was destined to cause program coordination problems for another two decades.

After independence in 1964, potato research and seed production lapsed due to the loss of research staff. In an effort to revive and develop organized potato research and seed production, the government proposed a series of special projects to which several development assistance agencies responded (Waithaka, 1976). In 1968, the Kenyan government cooperated with the German Technical Assistance Agency (GTZ) in a development project to establish a viable seed potato industry. The project was completed in 1979 (Homann, 1979).

Another special project was initiated by the Kenyan government in 1969 in cooperation with the Overseas Development Administration of Great Britain (ODA). The principal objectives of this research project were to establish a

breeding program with an emphasis on late blight resistant varieties and to provide information for the control of late blight and virus diseases. The project was completed in 1976 (Robertson, 1976). FAO also provided assistance on bacterial wilt research (Todd, 1972). This project lasted from 1969-1972.

In 1967, the Mthanga Farm near Tigoni was purchased as a quarantine site for seed multiplication. Facilities were developed and the farm was designated as the National Potato Research Station in 1972 (Njoroge, 1986). However, the presence of aphids facilitated by the low-altitude of the station, consistently caused problems in maintaining seed stocks virus free. In 1975, NPRS established high-altitude research substations at Njambini in Nyandarua District and at the Grasslands Research Station, Marindas, Molo Division. In 1976, at the request of the Meru District Agricultural Officer, a final substation was established in the Animal Production Station in Marimba, Meru (Njoroge, 1986, Homann, 1979). With reduced aphid presence, the

Table 2 Institutional developments related to the Kenyan Potato Program

Year	Activity
1954	NPQS-Muguga founded
1958	Initial seed certification scheme started - Thika
1959	Seed quality control initiated - NAL-Nairobi
1961	Potato Advisory Research Committee started
1967	Mthanga Farm purchased as seed multiplication site
1968	Kenya-GTZ seed potato project starts
1969	Kenya-ODA potato research project starts
	FAO assistance in bacterial wilt research starts
1970	Kenya-Dutch project establishes seed quality control service at NSQCS
1972	NPRS created from Mthanga Farm, Tigoni
	FAO bacterial wilt research ends
1974	All projects merge into a Potato Unit
1975	Njambini and Marindas NPRS-substations established
	CIP sponsors first training course in Kenya
	Seed certification staff transferred from Thika to Tigoni
1976	Marimba NPRS-substation established
	ADC and SFT requested to begin seed multiplication
	Seed inspection & certification turned over to NSQCS
	Kenya-ODA potato research project ends
	CIP-NPQS regional germplasm distribution center starts
1978	Kenya-FAO-SIDA Rural Structures Project starts
1979	ADC-Dutch seed potato project starts
	Certified seed bulking & promotion turned over to ADC
	Kenya-GTZ seed potato project ends
	Natl. Performance Trials started by NSQCS
1980	All potato research moved to NPRS-Tigoni
	SFT farms withdraw from seed production
1984	Natl. Performance Trials assigned to NPRS
1985	Kenya-FAO-SIDA project includes farmer potato seed stores
	Kenya-Dutch NSQCS project ends
1988	Kenya-Italian-CIP rapid multiplication project begins
	Natl. Performance Trials return to NSQCS
1989	ADC-Dutch project ends
1991	Kenya-Italian-CIP rapid multiplication project ends

substations are used to multiply seed stocks and have been sites for screening trials.

In 1974, a merger of the GTZ and ODA projects into a single administrative unit with centers in NAL-Nairobi and Tigoni resulted in a high degree of cooperation between the seed potato development and potato research endeavors (Todd, 1976). In 1975, all the seed certification staff previously at the Horticultural Research Station in Thika were transferred to NPRS-Tigoni (Min. of Ag., 1975). At this point, NPRS was responsible for executing most of the activities related to the formal seed system.

At NPRS-Tigoni, the GTZ project had financed the construction of numerous facilities and assisted the implementation of germplasm maintenance and basic and certified seed production with support of a virus testing laboratory and refrigerated storage. Yet after the project finished, the lack of budget and the loss of staff quickly eroded the ability of the station to continue these tasks. The inability of NPRS to perform as planned resulted in the gradual transfer of activities to other related institutions.

Plant Quarantine Services

The National Plant Quarantine Service (NPQS), founded in 1931, established new facilities at Muguga near Nairobi in 1954 and joined the EAAFRO. NPQS is principally concerned with the importation and processing of plant germplasm; it has laboratory and greenhouse facilities in which a variety of disease detection tests can be performed while germplasm is held in isolation. These processes are regulated by a Plant Protection Order. All importation of seed potatoes and clean up of breeding lines for seed production has been carried out by NPQS since the merging of the projects into the Potato Unit in 1974.

In 1976, CIP established a regional germplasm distribution center within the KARI compound near Nairobi in cooperation with NPQS. In 1982, NPQS expanded the agreement with CIP to receive imported material in vitro or as botanical seed in addition to tubers and to check and propagate the material for release as seed stock for field trials in Kenya (Wambugu & Murithi, 1982). With this technical support, the CIP regional germplasm center receives material from Lima and other sites, screens it under local conditions and re-exports it at the request of other countries. All arrivals and departures must possess KARI phytosanitary certificates of health.

NPQS also provides technical support to NPRS-Tigoni. NPQS is capable of cleaning infected plants and has done so for several of the accessions in the germplasm collection after the NPRS germplasm maintenance program experienced problems. Unable to maintain the germplasm collection in good health, NPRS-Tigoni since 1986 has relied on NPQS to provide in vitro plantlets for use in the rapid multiplication scheme for pre-basic seed production.

Seed Certification Services

Prior to independence, government control of quality was guided by the Seed Rules. These covered such aspects as sampling, varietal purity and freedom from disease, and they provided for seed certification. The official seed certification scheme started in 1958 when an Assistant Agricultural Officer in the pathology section of NAL was assigned responsibility for disease control in seed crops, and in 1959 a training course was held for officers charged with seed inspection. The Potato Advisory Research Committee established in 1961 delegated responsibility for seed certification to the Horticultural Crops Research Station at Thika, under the direction of the Assistant Director of Agriculture for Horticulture. Later, the work of inspection was passed on to District Agricultural Officers but difficulties in the certification process arose because these officers were not always well-trained in potato diseases or seed regulations (Todd, 1969). Further problems in seed certification resulted from unclear delineation of responsibilities and the historic division of activities between the GTZ and ODA projects and the Thika (later Tigoni) station and the NAL (Todd, 1976).

After independence, seed certification services began again in 1965 from an improved seed testing laboratory in NAL. A joint project between Kenya and the Government of the Netherlands from 1970 to 1985 converted the services of the laboratory to the Kenya Seed Inspection Service (KSIS). Prior to 1970, seed

inspection was carried out by the individual commodity research stations; potato seed inspection was passed from the potato research station to KSIS in 1976.

The objective of the Kenya-Netherlands project was provision of uniform high quality standards to protect against the loss of existing cultivars and maintenance of farmer confidence in certified seed (Boinnet, 1985). Seed laws and regulations known as the Seed and Plant Varieties Act were enacted in 1972 to support the project. KSIS was renamed National Seed Quality Control Service (NSQCS) in 1978 and currently consists of five units: the variety section, inspection service (field crops section), seed testing, horticultural section, and administration (Thou, 1979).

The service has no financial interest in the seed industry and is seen as impartial in enforcing the seed law. Based on the advanced state of procedures employed, the seed testing service was admitted to the Organization of Economic Cooperation and Development seed testing scheme in 1973 and is a member of the International Seed Testing Association, a world body which establishes standards and procedures for testing seed (Njeru, 1976). Such international links are vital for the Kenyan seed export industry.

Seed Potato Certification

Certification in Kenya starts with the registration of seed growers. Currently ADC is the sole certified seed grower but does not hold a legal monopoly on production. When registering, a prospective seed grower must supply the cropping history of the proposed field and the seed source. In addition to this information, the grower must attest to the absence of bacterial wilt and state the variety and hectares to be grown (Thou, 1979).

There are two field inspections in the certification process, usually six and nine weeks after planting. On the basis of the field inspections the crop is either approved, rejected or approved for own use. There are regulations about size grading, labeling and sealing, however these were not initially enforced (Thou, 1979). In the past, the lack of enforcement was due to logistical problems, but with the beginning of the ADC potato project, specially printed bags are routinely labeled and sealed by NSQCS (Siror, 1980).

Although there is no formal post harvest inspection, 100 tubers from each plot are selected and planted in post-control plots which are grown out at the Lanet station of NSQCS as a check on the previous year's inspection. NSQCS-Lanet also has capability for virus testing with ELISA techniques. This is done as an informal check for the information of the inspectors but could conceivably be incorporated into the formal certification procedure.

Changes in the Seed Potato Rules

The basis for the seed potato rules currently in effect originated in the Seed and Varieties Act of 1972. Rule modifications since then reflect the increasing experience of inspectors and seed growers and changing conditions of seed production. The seed rules have not yet been passed by parliament, and in this quasi-legal state they are, in effect, only regulations. This has worked to the advantage of the seed certification service. With quasi-legal status, modifications to the regulations are more easily suggested and adopted. For example, as ADC has gained experience with seed production, the seed project technical staff has observed that virus tolerances are too strict and that pest and disease tolerances should be specified for each class of seed. In cooperation with NSQCS, changes were implemented on a trial basis for one year. Some of the changes for equivalent grades of seed are noted in Table 3. Additional diseases have been added and tolerance levels for different diseases and pests have been adjusted both up and down to more realistically reflect current conditions.

Another fundamental change in the rules concerns eligibility for growing seed. When first formulated, the rules stated that any potato farmer in Kenya could be a seed grower. However, NPRS and NSQCS experienced several problems: very small fields and remote locations which make inspection logistically difficult and expensive. Also, a lack of commitment by growers to seed multiplication resulted in sales of seed as ware, frequent rejection of crops grown in marginal areas with high disease presence and incomplete inspection process due to inadequate handling and storage. As a result, the rules were modified in the early

1980's to restrict eligibility to growers with fields of a minimum of five hectares above 2,300 m with adequate handling and storage facilities and a general commitment to seed growing (Ngoroi, 1982).

56 large scale farms, most of which are located in the cool highland areas. Several of these farms in the Meru area were recruited into the seed multiplication scheme during this period (Karuntimi, 1978). Individual SFT farm managers, however had little experience with potatoes and production, and quality control

Table 3 Disease Tolerance Levels for Seed Certification 1976-1988

Disease or condition[1]	Basic 1976	Basic 1988 1st	Basic 1988 2nd	Certified 1976	Certified 1988 1st	Certified 1988 2nd
Black (*Erwinia* spp)	.2	.0	.0	1.0	.0	.0
Severe virus disease (leafroll, Y group, severe mosaic)	.2	.9	.5	.5	1.2	1.0
Mild Mosaic visible in field	.5	1.5	1.0	2.0	2.0	1.3
Nematodes (*Melodogyne* spp & *Ditylenchus* spp)	.1	.3	.2	1.0	.4	.3
Fusarium & Verticillium Wilt	-	.2	.2	-	.3	.3
Rhizoctonia (*Rhizoctonia solani*)	1.0	-	-	2.5	-	-
off-types	-	.3	.2	-	.4	.2
volunteers	.5	.3	.2	1.0	.4	.2

Sources: NSQCS, 1978, 1988

Note: [1] These tolerances are only a portion of the set of regulations governing seed certification. The complete regulations can be found in the sources.

Seed Multiplication

In 1976, the government requested two parastatal organizations -- the Agricultural Development Corporation (ADC) and the Settlement Fund Trustees (SFT) -- to multiply seed potatoes. ADC is a profit-seeking firm established by an act of parliament in 1965 with the government a significant, but minority, stockholder. The corporation was originally founded to manage the large estate farms purchased by the government from departing white farmers after independence, but now it is also charged with promotion and execution of schemes for agricultural and agro-industrial development. The majority of its income derives from the sale of maize and wheat seed and livestock operations. The maize and wheat seed are processed and marketed by the Kenya Seed Company, a subsidiary of ADC. ADC headquarters are in Nairobi and it owns fourteen farms scattered around the country, including several in favorable potato production areas near Molo in Nakuru District (ADC, nd). SFT, the other parastatal, manages more than

problems were chronic. By 1980 there were no SFT farms multiplying seed potatoes.

Reacting to the government request, in 1979 ADC requested assistance from the Dutch Minister of Foreign Aid to start a seed potato project in Molo District. The project objectives were to utilize ADC farms to produce certified seed potatoes by multiplying basic seed stock from NPRS-Tigoni and to make this seed easily available to farmers (Mendoza et al., 1986). The project ended in 1989.

Shifting responsibilities among institutions

There have been more than three decades of work in organized seed production by the Kenyan government. During this time there have been two distinct phases in institutional arrangements for the organized seed program. The first phase consisted of a concentration of activities in NPRS as a result of the development of the Tigoni station and staff capability during the special projects in the 1960's and 1970's.

During a brief period in the mid 1970's, nearly all the activities of certified seed production were the responsibility of NPRS (Table 4).

The second phase is marked by the dispersal of these responsibilities to other institutions. Today, among the seed program activities, basic seed production and clonal maintenance breeding are the only responsibilities of NPRS; all the other activities have been assumed by other institutions. This dispersal resulted from the combined effects of difficulties of NPRS in managing and executing some of its responsibilities and by special projects to build capacity to undertake these activities in the receiving institutions. For example, due to loss of staff, NPRS was unable to successfully mount the National Performance Trials for germplasm evaluation. The responsibility for the trials was shifted to the national seed certification service during a special project which built capacity in that agency. Fundamentally the shift mirrors the increasing development of the seed industry in the country, with potato seed production and distribution enjoying the benefits of capacity building achieved during the development of a modern seed sector for other crops.

Table 4 Changes of institutions responsible for seed potato related activities in Kenya

Activity	Year Assumed by NPRS	Year Passed on by NPRS	Present Agency
National Performance Trials	1976	1988	NSQCS
Germplasm Maintenance	1968	1988	NPQS
Basic Seed Production	1968	-	NPRS
Seed Certification	1972	1976	NSQCS
Certified Seed Production	1968	1978	ADC
Seed Promotion	1969	1978	ADC

Sources: Homann, 1979, NSQCS, 1982, Bos, 1986, Ministry of Agriculture. Various years

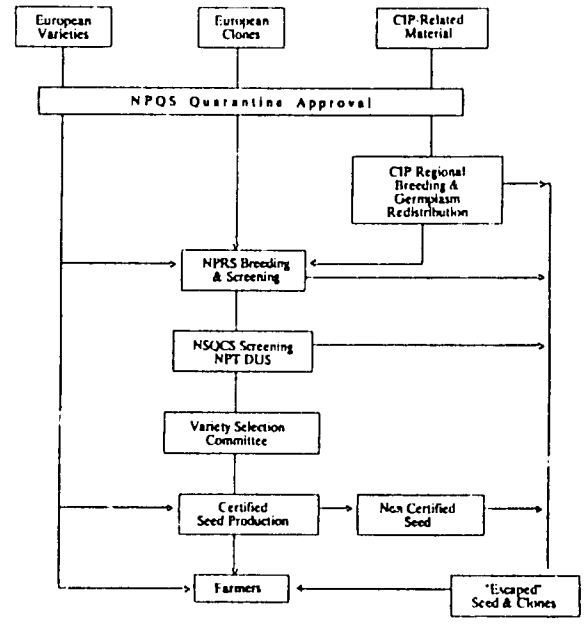
4. Breeding and Variety Distribution

The objective of formal seed programs is to produce seed of varieties with characteristics suitable to the needs of farmers, processors and consumers. Without appropriate varieties, any seed production program faces difficult challenges in gaining acceptance and diffusion of its seed. In Kenya, farmers cultivate a large number of varieties and tend to change varieties frequently. Attempts to meet the varied demands of consumers would naturally create problems for a formal program with limited resources inclined to manage only a few varieties. Establishing priorities for a limited set of varieties based on farmers preferences is one method for resolving these contradictory demands.

Breeding predates most other forms of organized scientific inquiry into potato improvement in Kenya. Nevertheless, while there has been a long tradition of potato breeding, screening of imported clonal material and introduction of European varieties have been the most important sources of germplasm. Figure 5 illustrates the important sources of potato germplasm entering Kenya and their flow through official and non-official channels towards farmers.

This chapter examines the history of breeding and variety introduction in Kenya and notes the current state of potato breeding. The distribution of varieties is discussed, followed by farmers' perceptions of varieties and how those perceptions are formed and modified. The contrast between farmer perceptions and those of scientists is highlighted, and the lack of correspondence between varieties in seed production and those popular with farmers is presented.

FIGURE 5. SOURCES AND FLOWS OF BREEDING AND SCREENING MATERIAL AT VARIOUS TIMES IN KENYA



Variety Introduction and Breeding

Since potatoes were introduced into Kenya in the late 19th century, numerous European varieties have been sent to the country over the years. Table 5 provides a list of selected introductions and official varieties. Since the 1960's special projects in collaboration with the English, German and Dutch governments have influenced the pattern of introductions.

Perhaps the most remarkable variety in this listing is Kerr's Pink. It is the longest established popular variety, first introduced in 1927 and reintroduced in 1930 and 1941 and still widely grown today (Robertson, 1976). The culinary quality of Kerr's Pink is highly appreciated and this has preserved its place in the market despite it being susceptable to late blight and alternately included and excluded from organized seed production.

Table 5 Officially Released or Important Introduced Potato Varieties: Kenya

Name	Introduction	Source	Release
Kerr's Pink	1927	UK	-[1]
Dutch Robjin (Golof)	1945	Holland	-
Roslin Eburu (B 53)	1953	UK	1953
Anett	1965	Germany	1972
Maritta	1965	Germany	-
Feldeslohn	1965	Germany	1972
Desirée	-	Holland	1972
Kenya Akiba	1968	UK	1969[2]
Kenya Baraka	1969	UK	1973
Rolsin Bvumbwe	1969	UK	1974
Roslin Gucha	1971	UK	1974
Roslin Tana	1971	UK	1974
Roslin Ruaka	1971	UK	1974
Roslin Karura	1971	UK	1974[2]
Roslin Athi	1971	UK	1974[2]
Cardinal	1985	Holland	nr[3]
Romano	1985	Holland	nr
Pimpernil	1985	Holland	nr
Kenya Chaguo	n/a	Kenya	1988[4]
Kenya Dhamana	1982	CIP	1988[4]

Sources: Ministry of Agriculture 1975, 1976; KARI, 1988, Todd, 1969, 1972, 1973, 1976; Robertson, 1976.
Notes: 1: '-' indicates date unknown. 2: Withdrawn 3: 'nr' indicates not officially released as a variety. 4: Kenya Chaguo is K59a/26/1 and Kenya Dhamana is CIP 800224.

Organized potato breeding and variety selection in Kenya started in 1943 with Mr. R.M. Natrass and continued under his direction until 1960 (Todd, 1969). The main focus of the program during this period was selection for late blight resistance using materials from breeding programs in Scotland, Northern Ireland and the Netherlands. The first successful introduction from this program was the variety Dutch Robijn in 1945. By the early 1950's it was widely distributed throughout the country due principally to its moderate field resistance to late blight and good consumer acceptance.

Roslin Eburu, also known as B53, a yet more successful variety, was introduced in 1953. This variety originated from the breeding program of Dr. William Black of the Pentlandfield Station in Scotland. Because it has some field resistance to late blight, this was the most popular potato variety in Kenya during the late 1950's (Todd, 1969). The Roslin series of varieties has been important in the history of the crop in Kenya. The name Roslin, which appears in the mailing address of the Pentlandfield station, is combined with the names of Kenyan rivers or other landmarks and was given to new varieties originating from the Pentlandfield-based breeding program of Dr. Black. Todd credits Roslin Eburu with perhaps having saved the potato in Kenya, providing resistance during periods of heavy blight pressure and declining area. In the 1970's the distribution and popularity of Roslin Eburu was gradually eroded by the informal diffusion of Kerr's Pink from Meru District to the areas south of Mt. Kenya which depend on Meru for seed (Todd, 1976).

In the 1960's bacterial wilt became a serious production problem. Using seed produced abroad, the selection program was expanded to include bacterial wilt resistance. Kenya Akiba was introduced at this time, but suffered from poor tuber appearance, irregular sprouting, long stolons, susceptibility to leaf roll and early blight and was later withdrawn (Robertson, 1976).

In 1965 and 1966, sixteen varieties were introduced from Germany (Homann, 1979). The most successful of these were Maritta, Anett and Feldeslohn. All three are still found in farmers' fields, and the latter two were still in seed production in the late 1980's.

In 1969, the beginning of the Kenya-ODA project brought renewed vigor to the breeding program that had lapsed after independence. Dr. Black became personally involved, sending many new candidates for introduction. The objective of the breeding program during the period of ODA cooperation (1969-1976) was to produce varieties with good resistance to late blight, resistance to bacterial wilt and drought tolerance (Todd, 1973). Fom an initial shipment of 95 clones, several selections were named and recognized as official varieties in 1974. These included Roslin Athi, Roslin Bvumbwe (introduced from Malawi in 1969), Roslin Gucha, Roslin Karura, Roslin Ruaka and Roslin Tana. By the next year reports noted that Roslin Athi was susceptable to late blight and Rolin Karura susceptable to leafroll virus. Observers felt that these two introductions were made prematurely (Ministry of Agriculture, 1975) and they were eventually withdrawn.

During the ODA and FAO breeding projects, Kenyan counterparts were on staff, but

in 1979 shortly after the close of these projects and the departure of expatriate staff, the last of the Kenyan counterparts resigned from the potato program. For a short period in 1980, a trained potato breeder was still in the program. Since the departure of the breeder, however, there has not been a qualified breeder in the program and most screening work has continued at only a minimal level.

The ADC potato project has been influential in the introduction of several new varieties during the 1980's --the first new group of variety introductions since the 1960's. Variety trials conducted by the ADC project were started in 1985. In 1988 there were 32 varieties in the trials, including many new European varieties (Bos, 1988). Another significant introduction of new varieties was the 1985 importation of 200 tons of the Cardinal and Romano varieties to overcome the emergency shortfall of seed due to drought experienced in the previous two seasons (Bos, 1986b).

In 1986, CIP stationed a potato breeder in Kenya to head the regional breeding program, which compliments the regional germplasm distribution center previously established in collaboration with NPQS. The objectives are to develop clones with high stable yield incorporating resistance to late blight, bacterial wilt and viruses. Improved adaptability to non-traditional growing areas and improved storability and culinary quality are also objectives. This program does crossing and screening of material received from CIP's central quarantine facilities in Lima, Peru. Material is screened through the advanced clone stage.

The advanced clonal material is described, and bulked for distribution when requested by potato programs in the east and southern Africa region. Continuing with an advanced clone to the point at which it becomes a named variety is normally part of a national performance testing program. Though the objective of the CIP regional breeding program is to serve the needs of all East and South African countries, clearly the breeding and the screening done at various sites by CIP in Kenya produces locally-adapted cultivars. One example of this is the clone CIP 800224 which was named as an offical variety in 1988.

Evaluation and Release of New Varieties

The administrative processes of evaluation and release of new varieties are conducted under the auspices of NSQCS. When NPRS presents a new clone or desires to import a variety released elsewhere, the breeders are required to submit performance data of that clone to the Specialist Variety Release Committee which reviews the data. The members of this committee are selected from the NPRS, ADC and NSQCS and other interested parties. The review process critically examines the agronomic characteristics of the proposed variety, contrasting it to competing varieties. If it proves to be satisfactory, the variety is included in the National Performance Trials (NPT) (Boinnet, 1985).

There are distinctness, uniformity and stability trials (DUS) in addition to the National Performance Trials. These trials are designed to assure the stability of varietal characteristics over several generations of multiplication and to assist in compiling the technical information for officially listing (indexing) the varietal characteristics. This is a responsibility of the varieties section of NSQCS which has produced a technical guide for varieties (NSQCS, 1982). With good results from the NPT and DUS trials the Committee forwards a recommendation for release to the National Variety Release Committee. The task of the Release Committee is to review the technical information and allow the release of the variety only if it will markedly contribute to increased production (Boinnet, 1985).

As specified in the Seeds and Plant Varieties Act of 1972, the NPT are conducted for a maximum of three years in several agroecological zones. Variety trials of potatoes, which were *de facto* performance trials, were conducted by the agronomy section of the potato unit as material became available near the end of the Kenya-ODA potato breeding project (Cheruiyot, 1976). Sites for the trials are deliberately chosen to be representative of conditions in favorable and marginal potato production areas.

To conduct the testing, the Variety Section of NSQCS was started in 1976. In 1979, the first trials included potatoes, maize and sunflower. On the assumption that trials are the final step

in the breeding process, it was decided in 1982 that the breeding sections of the individual commodity stations could better implement the trials with NSQCS in a monitoring role. Upon the request of NPRS, NSQCS continued the trials on their behalf through the 1984 season (Oluoch & Githendu, 1984). Returning the trials to NSQCS was subsequently considered because individual stations often had difficulties conducting the trials due to funding or personnel problems. For example, NPRS lacked a qualified potato breeder and the potato trials were returned to NSQCS in 1988. Table 6 shows from 1979 to 1984 the consistency of the NPT program conducted by NSQCS and from 1985 to 1988 the lack of testing by NPRS.

Lack of a qualified breeder in NPRS has adverse effects in addition to the ability to conduct activities such as the NPT. One problem has been the absence of an advocate to push varieties through the screening and approval process. As a result there have been delays in the recommendations for release of new varieties. As example, the clones CIP 800224 (Kenya Dhamana) and K59a/26/1 (Kenya Chaguo) were provisionally released in 1980 (Ministry of Agriculture, 1980-82), entered in the NPT and after the legislated three years were recommended to the Variety Release Committee in 1982 (Oluoch & Githendu, 1984). However, they were not named until 1988 (KARI, 1988). Kenya Chaguo is the first official variety actually bred in Kenya.

Distribution of Potato Varieties

Many potato varieties are currently grown in Kenya. Many older varieties are still cultivated in limited amounts along with newer, official varieties. In addition, there are varieties of unknown origin not recognized as "official" by the government but cultivated by farmers nonetheless. Among these many varieties only a few are popular with farmers and are widely distributed. Field work for this study documented farmers claims to have planted at the moment of the survey, more than 50 varieties. However, only five of these were grown by more than six percent of total sample farmers. Seventy percent of all farmers interviewed grew more than one variety except in Meru where slightly more than half the farmers grow only Kerr's Pink.

Table 6 Numbers of Sites and Entries in the National Performance Trials for Potatoes, Kenya Long Rains 1979-88

Year	Sites	Number of Entries	Sites
1975	8	-[1]	-
1976	8	12	Tigoni, Katumani, Embu, Kibirichia, Molo, Nyyeri, Njabini, Kericho
1977	-	-	-
1978	-	-	-
1979	3	6	Tigoni, Lanet, Molo
1980	6	12	Tigoni, Lanet, Molo, Ol Joro Orok, Meru, Taita
1981	8	16	Tigoni, Lanet, Molo, Ol loro Orok, Kisii, Machakos, Sirikwa, Thika
1982	7	21	Tigoni, Lanet, Molo, Ol Joro Orok, Kisii, Machakos, Sirikwa
1983	7	22	Tigoni, Lanet, Molo, Ol Joro Orok, Kisii, Sotik, Endebess
1984	8	22	Tigoni, Lanet, Molo, Kisii, Sotik, Nyahururu, Machakos, Endebess
1985	0[2]		
1986	1	25	Tigoni
1987	0		
1988	-	-	-

Sources: Ministry of Agriculture, 1975, 1976; Oluoch & Githendu, 1984; Wambugu, 1987
Notes: 1. "-" indicates data not available 2. trials not conducted in 1985, 1987

There are distinct regional patterns in variety distribution. Though the areas are not strictly comparable, the study by Durr and Lorenzl (1980) and the field work for this study offer information on the distribution of varieties and changes during the decade. Most striking is the almost complete change of varieties made by farmers in the last twelve years (Table 7). In 1977, Kerr's Pink was the most popular variety in five of six potato production regions; today it is important only in Meru where it has remained the most popular variety for more than four decades. Several leading varieties in the past are

no longer as popular with farmers. These include Roslin Eburu and Maritta. Nyayo did not appear in the survey of 1977 and is the single most popular variety of the 1988 survey. The origin of Nyayo is unknown.

The proliferation of local names demonstrates the difficulty of assessing variety distribution. A complete listing of names from surveys in 1976-77 and 1988 are presented in appendix tables 1 and 2. Potatoes are not native to Kenya so all varieties come from imports or local breeding efforts, yet there is a large number of locally named varieties. This is also indicative of the intense interest in new varieties as a mechanism for replacing seed as discussed in the previous chapter.

Many of the locally named varieties could be duplicates. The nomenclature of officially recognized varieties and unrecognized lines can become confused, such as the local variety called "Desirée" (after the released variety of the same name) which is believed by some scientists to be an escaped clone from the National Potato Program. Because local Desirée is bitter during periods of insufficient rain, potato traders in some areas refuse to buy any tubers called by this name.

Table 7 Potato Varieties in farmers' fields, 1976/77 and 1988 (in percentages of sample)

	Molo		Ol Kalou		Kinangop		Kiambu		Nyeri/Mga		Meru	
Variety	76	88	76	88	76	88	76	88	76	88	76	88
Nyayo	-	60	-	92	-	-	-	88	-	75	-	6
Desiree	-	56	-	46	4	38	-	70	-	25	-	8
Mukori	-	30	-	38	-	12	-	48	-	-	-	-
R. Tana	-	5	-	54	-	100	-	24	-	15	2	6
K. Pink	11	-	59	15	81	-	85	30	57	25	100	92
Maritta	17	8	20	-	53	-	13	12	9	-	-	3
R. Eburu	10	3	47	-	51	13	37	-	19	5	-	-
Kinongo	1	18	32	15	27	-	3	-	-	5	-	-
Anett	1	5	12	-	8	13	-	-	-	-	4	-
D. Robjin	25	-	19	-	5	-	3	-	2	-	-	-
K. Baraka	-	13	1	-	-	-	1	6	-	-	2	3
K. Akiba	-	3	1	-	-	-	-	-	-	-	-	-

Sources: 1976/77 data from Durr & Lorenzl (1980, 66), 1988 data from field work for this study
Note: This table includes only the most frequently mentioned varieties, the complete list of varieties can be found appendix tables 1 and 2.

Perceptions of Variety Qualities

Farmers and scientists often have different criteria for judging the value of different varieties. Both scientists and farmers evaluate agronomic traits based on their understanding of potato production. In his final report before leaving, the last potato breeder stationed at NPRS stated the breeding program objectives to be the production of potato clones with the following qualities:

- high yielding
- good quality (eg. high dry matter content, good keeping and crisping quality, low sugar content, etc.)
- high levels of horizontal resistance to diseases (late blight, bacterial wilt, and viruses, especially potato leaf roll virus)
- resistant to insects and nematodes
- wide ecological adaption (Nyachae, 1980).

These objectives apparently are unchanged to the present day. The yield and pest and disease resistance objectives remain from the previous periods. The good quality objective is new and provides for screening material for its

processing quality in support of the NPRS food technology research program (Ministry of Agriculture 1978, 1980-82, 1983).

Farmers however tend to assign higher priorites to consumption and economic factors than do scientists. The potato farmers of Kenya also display this tendency. During field work for this study, an open-ended question asked farmers to characterize the good and bad traits of the varieties they were producing. Notable was the importance of non-agronomic characteristics (Table 8). Kenyan potato farmers grow the crop for home consumption and sale and since they are women and in charge of food preparation and marketing; they judge varieties by a broad spectrum of needs. In addition to the agronomic and genetic traits, cooking time, eating quality and marketability are important.

Table 8 Frequency of potato variety characteristics mentioned by farmers for all varieties[1]

Characteristic	Percent
Yield	23.5
Culinary qualities[2]	21.6
Degree of Late Blight resistance	18.7
Marketability	14.2
Tubers (size, number)	5.8
Earliness	3.2
Storability	2.2
Others[3]	10.8

Source: Own data
Notes: 1: 153 farmers provided 310 responses. 2: Culinary qualities includes cooking time and taste evaluations. 3: Others included: hollow heart, dormancy, moisture requirements and early tuberization.

There are many factors that impinge on the official decision to include or exclude a variety from a seed production program including legal matters, budget considerations and availability of source material. However, certainly one important criteria is the opinion of the relative merits of varieties held by seed program managers. Tables 9 and 10 illustrate the lack of correspondence between varieties in seed production and those preferred by farmers. The farmer preferences are those revealed by their planting decisions.

In 1976/77 the two varieties most preferred by farmers were in the seed production program, though the quantity of Kerr's Pink was not in proportion to its popularity. The other varieties in the seed program basically were of marginal interest to potato farmers. A decade later the correspondence had worsened slightly. Only the second, sixth and eighth most popular varieties among farmers were included in the seed program. Kerr's Pink, the all time favorite, had been dropped from production. When and why Kerr's Pink had been dropped was difficult to discern. There have been allusions that since the Meru zone can produce seed, the program should prioritize those varieties found in areas

Table 9 Varieties in Seed Production and varieties preferred by farmers 1976/77

Varieties in Seed Production	MT of seed	Popular Varieties with Farmers[1]	Percent of Farmers Planting
Roslin Eburu	48.1	Kerr's Pink	62
Kenya Baraka[2]	45.2	Roslin Eburu	29
Annet	27.4	Maritta	20
Desirée[2]	21.5	Kinongo	11
Kerr's Pink	18.6	Dutch Robjin	10
Roslin Gucha[2]	5.8	Ngorobu	4
Roslin Tana[2]	2.7	Annet	4

Sources: Ministry of Agriculture, 1976; Durr and Lorenzl, 1980
Notes: 1: Farmers preferred varieties are ranked in order of frequency in which they were encountered in farmers fields, 441 farmers in 6 areas were surveyed. 2: Kenya Baraka and Desirée were planted by 4 and Roslin Tana by 2 farmers. Roslin Gucha was not encountered in the survey.

that cannot produce their own seed. The presence of Romano reflects the multiplications of the stock of seed imported in 1985. Many farmers still would not have had a chance to obtain this variety. The case of Annet is different. To persist with a variety that has simply not become popular in an interval of 10 years is an indicator of the lack of comprehension of the seed producers of farmer preferences. Undoubtedly the variety performs well in those tests conducted by the program. Evidently, however, the variety does not do well in farmers' conditions.

The discrepancy between seed program preferences and farmers' actual choice of varieties indicates that farmers' priorities are not clearly understood or known by scientists or are simply disregarded.

Table 10 Varieties in Seed Production and varieties preferred by farmers 1988

Varieties in Seed Production	MT of seed	Popular Varieties with Farmers[1]	Percent of Farmers Planting
Roslin Eburu[2]	275.9	Nyayo	53
Anett[2]	253.6	Desireé	42
Romano[2]	170.6	Mukori	25
Pimpernil[2]	166.0	Kerr's Pink	21
Dutch Robjin	152.0	Roslin Tana	21
Feldeslohn[2]	81.8	Dutch Robjin	6
Desireé	52.6	Kinongo	6
Kenya Baraka	15.2	Kenya Baraka	5
		Maritta	5

Sources: Bos, 1988; Own Study
Notes: 1: Farmers preferred varieties are ranked in order of frequency in which they were encountered in farmers fields, 153 farmers in 20 areas were sampled. 2: Percent of farmers planting Roslin Eburu, Anett, Romano, Pimpernil and Feldeslohn was 1%.

5. Initial Multiplications

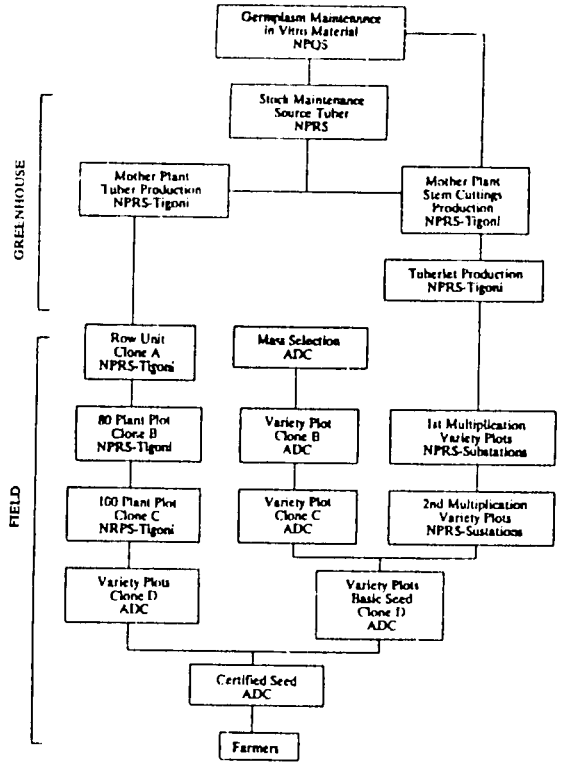
Included in the phase of intital multiplications are three steps: (1) maintenance of the varieties, (2) production of pre-basic seed and (3) production of basic seed. This chapter reviews the development and implementation of germplasm maintence, pre-basic and basic seed production techniques utilized by NPRS and ADC. The presence or absence of bilateral projects with technical assistance has strongly influenced the choice of technique. NPRS started seed production using clonal multiplication techniques. Rapid multiplication was used for germplasm maintence. Recently, rapid multiplication has been revived for use in seed production. During a period of especially irregular supply from NPRS, ADC initated basic seed production using mass selection. The reasons for and impact of NPRS selection of techniques are examined. The role and impact of the bilateral projects are also discussed.

Background and Definitions

The objectives of germplasm maintenance (referred to as maintence breeding in Kenya) are to preserve disease-free stocks of the existing varieties, assure their varietal purity and bulk these varieties for delivery to breeders, researchers and basic seed producers. Germplasm maintence techniques used in Kenya have been clonal and in vitro. Clonal techniques of maintence consist of keeping tubers disease-free by sequential planting in pots in greenhouses. In vitro techniques consist of maintaining disease-tested cuttings in glass containers. Both techniques rely on comprehensive disease testing to maintain health quality.

There have been various methods utilized in Kenya for the initial multiplications of seed. These include mass selection and clonal and rapid multiplication from mother plants (Figure 6). The terminology referring to these processes varies from country to country. The process starts with some sort of source tuber or plantlet drawn from germplasm maintence. This material is variably called breeder, foundation or elite seed. This is multipled one or more times in the greenhouse or field to produce stock or pre-basic seed. Pre-basic seed is typically multiplied in the field to produce basic seed.

FIGURE 6. BASIC SEED PRODUCTION TECHNIQUES IN KENYA



Clonal versus Rapid Multiplication

Clonal multiplication of potatoes is slow. In greenhouses, under optimal conditions and management, the multipication rate may reach ten units harvested for one unit planted (10:1). More typically in open fields, under less optimal conditions and management, the multiplication rate can average 4:1 as is the case in Kenya (Njorge, 1986). For example, if starting with 100 kg of planting material after a single multiplication in the greenhouse and three in the fields there will be potentially 64 tons of seed. With each multiplication the seed becomes increasingly infected with diseases, reducing its quality as planting material.

These are compelling reasons for the interest in rapid multiplication techniques Rapid multiplication reduces the number of field-based generations necessary to reach a given quantity of seed by improving the efficiency of the first multiplication of seed from its source material. By a variety of mechanisms, the multiplication rate of the first generation can be increased from 10:1 to potentially over 100:1. Thus, from the example above, the result after four generations would be 640 tons of seed. There is a deservedly high premium on maintaining the seed healthy since disqualifying one ton of production from certificaton in the first field multiplication results in 64 tons lost three multiplications later.

The Kenya-GTZ Seed Potato Project

As noted in Chapter 3, government involvement in basic seed production began in 1957 as an activity of the seed certification scheme. Seed stock were supplied to seed growers as an extension of the screening activities of the breeding program. A lack of trained inspectors and viable inspection standards created a lack of confidence in the program and it gradually declined in importance (Todd, 1969). The government revived the seed program as a cooperative project with GTZ from 1968 to 1975.

The original objective of the GTZ project was broadly stated as the development of "a viable seed potato industry in Kenya". Designed to compliment the research-oriented projects of ODA and FAO, the project concentrated on aspects of seed production and supporting research. Over time the project objectives were gradually focused on "germplasm maintenance and basic seed production, storage of seed and ware potatoes, extension of substations and the establishment of a test laboratory for the identification and elimination of potato virus diseases" (Homann, 1979). To achieve these objectives, the project provided many of the facilities and much of the equipment during this developmental phase of the Tigoni station.

In the early stages of the project, seed was mass selected and propagated from healthy-looking plants, and also was clonally multiplied from virus-tested mother plants. Mass selection consisted of visually selecting up to 1000 clones from healthy-looking plants which were then multipied one or more times. Clonal multiplication entailed multiplication from mother plants grown from high quality, virus-tested tubers. Mass selection was employed as a rapid start up to quickly get seed material available after which the technique was phased out. Interestingly, mass selection was utilized 15 years later by ADC for the similar need of rapid start up of seed production.

Germplasm maintenance

Germplasm maintenance at NPRS was initially based on clonal selections but now also relies on in vitro material. The source materials for clonally-derived mother plants are taken from eye cuttings, stem cuttings or healthy plants from the field. The healthy plants are multiplied into the desired quantities via a series of field multiplications.

In 1977 the GTZ project installed greenhouses and a virus testing laboratory. The eye-cutting test was among the testing proceedures implemented. This test is a cleaning procedure in which individual eyes are excised from selected mother tubers, then grown and tested for disease via indicator plants or laboratory-based virus tests. The procedures made possible by the project's facilities and the use of vigorous roguing -- removal of off-type or diseased plants -- produced material capable of meeting certification standards (Homann, 1979). After the termination of the project in 1979, these facilities fell into disuse, and by 1983 most varieties in the germplasm maintenance and seed production program were infected with virus and sent to NPQS for cleaning (Ministry of Agriculture, 1983).

This prompted a major change in the germplasm maintenance program to use of in vitro-derived mother plants. The low altitude and associated warmer temperatures at the Tigoni station allow the development of large aphid populations. The presence of these virus vectors makes it difficult to maintain mother plants free of disease, the key requisite in any germplasm maintenance program. In vitro-derived mother plants are selected from the stocks maintained by NPQS. The in vitro material is propogated and then removed from the test tube and grown in pots. By ensuring a much more controlled environment, this method

is more sanitary and more easily facilitates maintenance of the mother plant material in healthy condition.

Multiplication Techniques at NPRS

Clonal Multiplication

The clonal multiplication scheme installed during the Kenya-GTZ project is based in the field using the row and plot unit technique (Figure 6). The first generation (named "A" in the NPRS scheme) consists of the tubers produced in pots in the greenhouse from an individual mother plant. Clone A is planted in a single row (the row unit). If any one plant tests positive for disease the entire row is removed. The second and third generations (clones B & C) continue to be separated to distinguish the original mother plant source and are planted in plot units where roguing is done during certification inspections. In the final Clone D stage all the tubers of a single variety are mixed and grown (Munene, 1982).

Rapid Multiplication

At NPRS-Tigoni the Kenya-GTZ project provided facilities for and staff trained in rapid multiplication techniques. Rapid multiplication was first introduced at the Thika station in 1969. Though the Kenya-GTZ project viewed rapid multiplication techniques as useful only in a germplasm maintenance program (Ballestrem & Holler, 1977), rapid multiplication had also been used in seed production (Todd, 1973). After the termination of the project the rapid multiplication facilities and virus testing laboratory in Tigoni fell into disuse.

Beginning in the mid 1980's ADC representatives began voicing concerns about the quantity and quality of seed they were receiving from NPRS (Bos, 1986, KARI, 1986). Suggested alternatives to improve the situation were discussed and as a result CIP was requested by KARI to assist in improving basic seed production at NPRS (Njorge, 1986; KARI, 1987).

Thus from 1988 to 1991, a small Kenya-Italian-CIP project was implemented to reinstate a rapid multiplication scheme for seed production (Carli, 1989). The project provided for technical assistance and the rehabilitation of the tissue culture laboratory, the glasshouses and the soil sterilization unit and electrification of the facilities. The project also reinstituted virus testing for viruses X, Y, S and Leaf Roll by ELISA tests and Spindle Tuber Viroid with NASH tests. In 1988 four varieties --Anett, Romano, B53 and Kenya Baraka-- were selected to start production. By 1991 Kerr's Pink, Desirée and Kenya Dhamana had been added to the NPRS seed stock management program. The production aspects of the project were supported by an adaptive research program that emphasized efficiency in rapid multiplication techniques utilizing the varieties needed for seed production.

The NPRS rapid multiplication scheme consists of raising mother plants in pots, taking cuttings from these plants for rooting, then transplanting the rooted cuttings to greenhouse beds to produce tuberlets -- the small-sized tubers produced under the high plant density conditions (Figure 6). The advantage of this tissue culture-based scheme is the high multiplication rate made possible by taking multiple cuttings and producing tuberlets as a first generation, thus reducing the number of generations needed to produce a given quantity of seed. At present there is about 200m^2 of greenhouse space available for tuberlet production. With current varieties this means 20-30,000 tuberlets per growing season.

Basic Seed Production

The original NPRS basic seed production scheme planned for multiplication to be done in Tigoni and the three sub-stations, Njambini, Marindas, and Marimba. Among Tigoni and the sub-stations, the area which can be devoted to seed production is 8.4 ha in each of the two growing seasons and is distributed as shown in Table 11. However, in the current scheme the tuberlets produced in Tigoni -- called Prebasic Seed 1 -- are planted in the field only in the substations at Marindas and Marimba where they are multiplied two or three times to basic seed. Production problems at Tigoni and Njambini caused their elimination from field multiplication of seed leaving a total of 4.8 ha available for basic seed production.

Table 11 Seed production capacity at NPRS stations (ha)

Station	Long rains	Short rains
Tigoni	2.4	2.4
Njabini	1.2	1.2
Marimba	1.6	1.6
Marindas	3.2	3.2
Total	8.4	8.4

In Tigoni warmer weather associated with the low altitude (2,100 m) allows high levels of aphid infestation causing virus infection. Infestations from potato tuber moth are also a problem. Disease-related production problems are regularly reported in the Annual Reports (Ministry of Agriculture, 1983, 1984). Various research projects related to viruses during the Kenya-ODA project confirmed the virus pressure that causes the rapid degeneration of field-produced potatoes in Tigoni. Logistical problems were also anticipated (Todd, 1972). The field area available in Tigoni is limiting. Quarantine seed production requires an adequately long rotation period between potato crops, effectively restricting the area available for potato during any given cycle. Further, research plots do not combine well seed production plots, bringing the possiblity of disease and staff not trained to appreciate the field quarantine requirements into close contact with the seed plots.

In Njambini, at 2,590 m, frost is a recurrent problem, especially during the short rains. During 1988, the status of the sub-station as a seed producer was revoked due to an outbreak of bacterial wilt in the station. Difficulty in maintaining proper isolation resulted in infestation of the station's fields.

The 2,800 meter altitude and the location within the pasture station make Marindas the best site for seed production among the NPRS stations. The long rotation of pasture between potato crops and the isolation from other potato fields assist in maintaining health standards.

Early in the 1980's, Marindas was projected to become the center of basic seed production and, with the installation of irrigation equipment, the area devoted to potato production could be increased to 16 ha with the capacity to produce 320 tons of seed (Njoroge, 1980). The irrigation equipment has not been purchased (KARI, 1988).

The Marimba sub-station traditionally not been a reliable producer of seed and was inactive for most of the 1980's. The problems of Marimba are more related to coordination and logistics than physical conditions or disease. Initiated at the invitation of the Meru District Agricultural Officer (DAO), the station has not been able to consistently get supplies, staff or equipment from the office of the DAO as was originally agreed (Homann, 1979; Njoroge, 1980). In late 1991 the sub-station was again included in the basic seed production scheme to satisify the demand for Kerr's Pink from the Meru area.

Trends in NPRS seed production

Seed production activities by NPRS are poorly reported, in some years only hectares harvested are recorded, other years give only production from Tigoni, and other years do not provide variety totals. In 1977 the seed program was producing on twelve hectares and in 1978, 136 tons of seed were produced on fourteen hectares for a seed yield of 10 t/ha. Total seed production reached a peak in 1976 at 169 tons (Ministry of Agriculture, 1976, 1978).

After the close of the GTZ project in 1979, production dropped dramatically. The trend of seed production in the 1980's can be established based on the more consistent recordkeeping provided by the ADC project (Table 12). By 1981, ADC was the sole recipient of seed from NPRS. Production has been highly variable. The variation is due in part to severe drought during the 1983 and 1984 crop years and frost in Njambini. The Tigoni station repeatedly experienced problems with disease control. As example, 62% of total seed area in Tigoni was rejected for certification due to virus infection in 1985 (Bos, 1986b).

In addition to problems caused by external factors there are several internal reasons given by NPRS for the failure to provide adequate seed supplies. In 1980, the lack of an irrigation system and glasshouses at Mirandas and poor funding for the seed program were identified as constraining problems (Njoroge, 1980).

Table 12 Seed produced by NPRS, 1976-88

Year	Tons
1976	169.0
1977 [1]	–
1978	136.0
1979	95.0
1980	–
1981	12.8
1982	16.1
1983	3.2
1984	3.8
1985	25.0
1986	12.8
1987	11.8
1988	21.4
1989	

Source: Bos, 1986 letter, KARI 1988
Notes: [1] 1977 & 1980 data missing.

In 1987, many of these same problems were evident at the four stations in addition to the deterioration of the buildings and equipment inherited from the days of the special projects. Problems include the breakdown of the irrigation system, lack of vehicles to transport inputs, frequent breakdown of the tractors which delays land preparation, breakdown of the cold store and finally lack of enough funds for the seed program (Njoroge, 1986; KARI, 1987). As example, it was noted in the 1978 Annual Report that land preparation was not completed in time at the Marindas and Marimba sub-stations due to a shortage of tractors. During visits to the Njambini and Marindas sub-stations in 1988 the same problem was mentioned again. The ability of NPRS to react to and solve problems is apparently extremely limited.

Basic Seed Production by ADC

On numerous occasions ADC potato project managers have noted problems caused by the irregular supply of basic seed provided to them by NPRS (KARI, 1986, 1987, 1988, Mendoza, et al., 1986). In response, ADC proposed in 1986 to begin their own pre-basic seed production program based on mass selection as a temporary measure to protect against production shortfalls from NPRS and provide a reliable supply of seed (Bos, 1986b). This program lasted until 1989 when NPRS began more reliable deliveries of basic seed.

NPRS and the research system in Kenya

As demonstrated above, the performance of NPRS in meeting its obligations as a reliable basic seed producer have been questionable. It is useful to view these problems from the a broader perspective of the research system. Relative to its neighbors, Kenya has a well-developed system of commodity-oriented research stations and supporting facilities. However, in Kenya as in many other countries the agricultural research institutions are under budgetary pressure. In the government-commissioned study of the Kenyan agricultural research system by ISNAR, weaknesses were identified in: (1) the balance between personnel and operating costs, (2) adequacy for the scale and scope of operations, (3) allocation of resources with reference to the relevance of research in meeting program goals, (4) adequacy of support for individual scientists to engage in productive research, and (5) stability of funding for research programs and stations (ISNAR, 1985). Though directed at the overall system, most of these concerns also apply to the National Potato Research Program and its stations. Since basic seed production is an activity of the research station, the health of the research system directly affects the seed system.

Budget

During the Kenya-GTZ project expenditures on seed production consumed the majority of the Tigoni station budget (Homann, 1979). Despite the shedding of various seed related activities, seed production still consumes over half of the NPRS operations budget (Njoroge, personal communication). The ISNAR report notes that operating capital support for Ministry research stations is "extremely poor and too variable for ... research productivity." From 1979 to 1984 the budget for recurrent expenses at NPRS-Tigoni fell every year, the only station in the country to experience an uninterrupted decline (ISNAR,

1985). The decline in budget occurred just as the last of the special projects ended. Without funds for maintenance, the state of the physical plant and capital items such as vehicles, tractors and irrigation pumps gradually declined.

Staff

During the same period the number of researchers (Agricultural or Technical Officer grades) grew by one to eighteen. However total salaried staff at the station grew from 69 to 89 (Ministry of Agriculture, 1978, 1984). While the researchers have less money for planning and executing research, there is more support staff. More and more of the declining budget goes to salaries. In this environment there is a rapid turnover of scientific staff: ISNAR estimates that the average length of employment in the research division of the Ministry is 2.5 years for Kenyan personnel and 3.5 years for expatriates. As example, during the last four years of the GTZ project, four different Kenyan staff counterparts worked with the GTZ seed production advisor (Homann, 1979). Kenyan agroindustrial concerns traditionally absorb many government agricultural scientists and technicians. This high turnover rate has serious implications for donor agencies and institutions such as CIP concerning the length and type of training programs and the amount of training investment in individuals.

Impact of the Kenya-GTZ project

The impact of the GTZ project has been unfortunately minimal. The physical structures and equipment provided by project funds have not been maintained or replaced. Most of the staff that were trained have departed. The ability to manage the technologies introduced during the project were apparently lost. In 1987, the refrigerated potato stores built by the GTZ project were not functional due to equipment breakdown. The virus laboratory was largely non-functional and not used for seed quality control. Much of the germplasm collection was lost and what remained was badly infected with a variety of diseases such that NPQS was requested to assist in reestablishing the collection.

The benefits of rapid multiplication are well known and rapid multiplication techniques had been evaluated and established by the GTZ project. However the remaining NPRS staff continued with field based clonal multiplication. One result of this was the high rate of rejection of seed due to virus infection. Restablishing rapid multiplication as the basis for basic seed production was one of the goals of the Kenya-Italian-CIP project. Except for the closure of the Njambini substation, the substations remain in essentially the same condition as they were at the close of the GTZ project. Its restablishment was one of the objectives of the CIP coordinated effort. Interestingly, NPRS administration has continued the clonal multiplication system in parallel with the new rapid multiplication system. Whether the rapid multiplication scheme at NPRS can survive without external technical assistance remains to be seen.

6. Building Seed Supplies

In this chapter the model selected in Kenya for building seed supplies is presented. Past experience with other models is discussed and problems with the current model are analyzed. Kenya has opted for a model driven by commercial considerations, the appropriateness of this model is examined.

The concept of certified seed as employed in Europe and North America seems an anomaly in a country such as Kenya where most potato producers are peasant farmers in disconnected production zones pooly served by input or output markets. The high cost of that seed and the difficulties in obtaining it would seem to preclude wide use. However, the philosophy behind a certified seed scheme in a setting such as Kenya can be and is extended to the concept of somehow gradually improving the quality of a source of seed that may eventually be available to a large number of farmers. The scale of that effort depends on the rate of health degeneration of the quality seed and the possibilities for its diffusion.

Producing, certifying and distributing certified seed in Kenya is the responsibility of ADC and NSQCS. After the pre-basic step, certified seed production consists of field-based clonal multiplication and the accompanying quality control measures. Thus, expanding seed supplies to volumes needed to meet a reasonable percentage of the seed requirements requires a considerable number of hectares. There are several strategies to address this problem. The strategy pursued in Kenya is a tightly controlled process where production and certification are highly centralized. This is accomplished by using the parastatal corporate farms of ADC. For potatoes this requires a considerable investment in land and storage. Investment in or coordination with a seed distribution network is also required. The benefit of this investment is an assured supply of seed produced under strict control. This chapter examines in some detail the organization of the ADC work as it represents an especially comprehensive effort at certified seed production and distribution. Many certified seed programs are significantly deficient in one or more of the areas addressed by the ADC effort.

Another option to build seed supplies is to sell or distribute small quantities of seed to a large number of growers relying on the farmers' multiplication and distribution via existing informal seed flows. While the large number of seed multipliers eliminates the possbilility of certification or further testing, it is also the least costly option. This option is not considered under the current seed law. Even the establishment of an informal seed scheme without certification would have problems. Except in the Meru area, there are no well established seed flows. That combined with the extreme local nature of farmer seed distribution, would limit the effectiveness of informal distribution of quality seed.

A third strategy and one widely used in North America and Europe is to contract seed growers to produce the seed crop. On one extreme, the contractural arrangements may provide for government supply of inputs, supervision of production, and purchase and distribution of the resulting seed. On the other extreme there may be a passive scheme that simply sells seed to the multipliers and relies on their voluntary compliance for production and distribution.

In Kenya the contracting option has been tried on various ocassions since the first attempts at certified seed production in the late 1950's. Direct contracting with individual farmers has proved impractical due to administrative problems in enforcing the seed law, steady provision of seed to the growers, the expense of certification visits and difficulty in insuring the distribution of seed. This experience led the government to request different agencies with government farms to participate in seed multiplication. Kenya Seed Company, the Settlement Fund Trustees (SFT) farms and ADC were the entities involved.

SFT farms were recruited into seed production in 1976. The effort began with sites on two farms and two years later the number had risen to ten. The seed potato production was done in cooperation with NSQCS so as to meet certification requirements. However, SFT

farm managers (who run their farms independently) did not have experience with potato growing and numerous agronomic and phytosanitary problems were experienced (Karuntimi, 1978). These problems, combined with an inadequate plan for distribution of the harvest, adversely affected the viability of the plan and gradually the SFT program was abandoned.

Prior to ADC involvement, Kenya Seed Company (KSC), the major seed-producing company in the country, considered potato seed production. In 1976 on the basis of a feasibility study, KSC decided against potato seed multiplication and distribution (Halcrow et al, 1978). In the proposed KSC scheme, multiplication would have taken place on ADC farms and KSC would have provided the storage, management and distribution services, but the differences between regular botanical seed such as maize or wheat and seed potatoes plus the market risk involved dissuaded KSC from assuming this responsibility.

The ADC Seed Potato Project

In February, 1979, with assistance from NSQCS, ADC developed a proposal for a potato project to comply with the government's request to develop a certified seed potato production program. The scheme developed was very similar to the one proposed in the KSC study. The project developers recognized the problems of having seed producers scattered throughout the country and formulated a project with the following objectives:

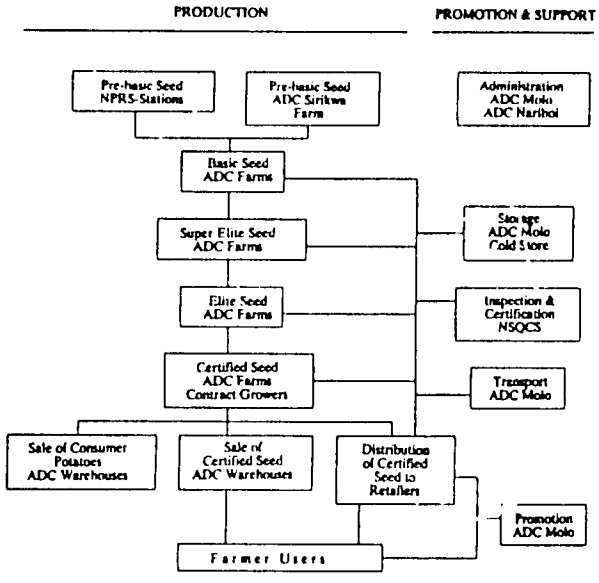
1. to produce high quality seed potatoes on the ADC Molo farms;
2. to expand seed potato production to meet domestic demand and, if excess capacity existed, for export;
3. to establish adequate storage facilities on the Molo farms;
4. to establish a proper seed distribution system in cooperation with Kenya Seed Company or Kenya Grain Growers Cooperative Union;
5. to train ADC staff in seed production, storage and marketing;
6. to extend this training to local potato farmers and
7. to cooperate with the Ministry of Agriculture in all matters related to basic seed, new varieties and seed potato production.

The proposal was submitted for funding to the Dutch Minister of Foreign Aid. After approval a two-year project began in 1979. It was subsequently extended until 1989. During this period, technical aid provided by the Dutch included a seed potato advisor stationed in Molo; fellowships for ADC staff in seed potato training courses; construction of a potato cold storage; potato harvesting, handling and transport equipment; emergency seed imports in 1985 and a marketing advisor stationed in Nairobi (Kilele, 1985). At termination in 1989, the project left in place (1) a seed potato production program, (2) a cold storage for seed potatoes, (3) a marketing/ promotion unit, (4) a transport and maintenance unit, and (5) an administrative unit. From 1981 to 1987 a consumer potato production and marketing program was also implemented.

In Molo, the ADC Potato Complex consists of the administrative unit, the potato cold store, a transport unit and the Molo warehouse. The potato project provides management, supervisory and accounting services to the other units and receives a management fee for its services. The complex as a whole is considered by ADC as a service unit which provides handling, grading, transport and storage services to seed potato producers. The only current seed potato producers are the ADC farms and a few contract growers.

The majority of seed enters the ADC multiplication scheme as pre-basic seed from NPRS. If there are shortfalls from NPRS such as during 1984-88, clonal selections performed on the ADC Sirikwa farm may also be a source of pre-basic seed (Figure 7). This seed is then multiplied and stored for four or five cycles until there is sufficient bulk for distribution as certified seed. During grading, consumer potatoes are collected at the Molo warehouse and are sold there or distributed to other ADC warehouses for sale.

FIGURE 7. ADC CERTIFIED SEED POTATO SCHEME



Administration

The potato seed unit is directed by a senior manager who is assisted by section heads of production, storage, promotion and accounting. All are located in Molo. The senior manager is directly responsible to the Managing Director of ADC in Nairobi. The unit can call on various general support divisions of ADC such as Planning or Marketing. Primary among management responsibilities are planning and preparation of detailed work schedules, evaluation of work, compilation of data and reporting on progress, monitoring of costs to update service charges, staff training and motivation and cooperation with other institutions (Bos, 1986a).

The seed unit has its own budget and is considered a separate entity within the corporation. Each section of the unit must account for expenses. Charges for services are based on handling a 50 kg bag and set to cover costs and a small additional retail margin. Only after the fifth cycle do seed sales generate cash. In the previous cycles, value is added to the seed only by internal transfer of funds among ADC units. In any single crop year only about 50% of the hectareage produces seed for sale (Goldson, 1987).

Seed Potato Production

Seed potato production involves the cooperation of the four ADC farms at Nyota, Keldo, Tall Trees and Sirikwa, and the cold store at Molo which houses the administration and the transport units. The four farms are all in highland areas around Molo. Each farm is a separate administrative unit and has its own manager and set of accounts. Each is required to show a profit on its activities. Seed production is planned jointly with the farm managers, the potato seed unit and the Planning Division in Nairobi. Seed production is subjected to evaluations on performance criteria including total yields, percent of seed sized tubers, percent of damage during harvest and qualifying for certification. An external review team considered the health quality of the seed being produced as good as well as the handling of the seed during harvest, grading and storgage (Mendoza et al, 1986).

Contract seed growers

The decision to incorporate contract growers (outgrowers in ADC nomenclature) into the potato project was based on the objective to create a "...strong foundation of skilled seed potato growers essential for a growing new seed potato industry "(Siror, 1980). This activity was coupled with the extension objective of the original project proposal. The use of contract growers simultaneously provided extra production and served as a core of contact farmers for extension.

However, production by contract growers never matched that of the ADC farms in quality or quantity. An examination of 1985 production by the ADC Planning Department found that contract seed growers produced an average of 125 50kg bags per hectare as compared to an ADC farm average of 426. In addition, the percentage of table potatoes and rejects relative to seed-sized tubers was higher. The report concluded that there is no justification for seed contract growers when there is a shortage of basic seed and production is more efficient on ADC farms (Goldson, 1987).

Storage

Centralized large-scale storage of the potatoes produced by the seed unit was one of the primary considerations determining the project design. Originally, simple insulated stores were planned for construction on the ADC farms. Research had shown that these would be sufficient to hold seed in good condition for 3-4 months (Homann & Zetteimeyer, 1979). This would be sufficient to supply the three production seasons per year of the farms. Stores with a cumulative capacity of 950 tons (18,500 bags) were constructed on three of the farms and are currently utilized for curing and short term storage (Bos, 1986).

To bridge the imbalance between production seasons on the ADC farms and periods of strong farmer demand, the project found it necessary to construct a cold store. Completed in 1985, the cold store enables the project to hold seed for extended periods, creating additional flexibility in planning production and sales. In 1988 the cold store had seventeen rooms of refrigerated storage with a capacity of 2,250 tons of seed (45,000 bags). However, given the seasonal cycles of entering and removing stock, the effective capacity during 12 months is 3,300 tons of seed.

Seed entering the cold store has been graded and bagged, each bag being identified with a tag noting the basic data on the seed. Seed for further ADC multiplication is stored in chitting crates to maintain maximum seed quality.

Marketing and Promotion

One fundamental aspect of a marketing strategy is to have the seed available when farmers demand it. Adequate plans for distribution therefore are an important component of production planning. Cold storage helps partially resolve timing decisions but the physiological ageing of seed tubers continues to affect supply timing. ADC has incorporated knowledge of planting seasons and the corresponding periods of seed demand to plan their seed production within the limits allowed by the production seasons on the ADC farms.

In the project proposal, the initial plans for sales and promotion included the use of various sales locations in potato production regions including ADC warehouses and branches of the Kenya Grain Growers Cooperative Union (KGGCU). ADC was to provide only minimal promotional activities and to rely on the Provincial and District Agricultural Crops Officers of the Ministry Extension Service to promote certified seed. The original sales locations continue to the present. KGGCU and ADC warehouses are the most important sales outlets. District cooperatives, District Agricultural Officers, contract seed growers account for the remainder of external sales. Reported sales figures also include internal sales to the ADC farms from the the Molo Unit.

Until 1987, sales management and promotion by the potato project was very elementary. A potato brochure (ADC, 1987) was prepared and distributed to selling points prior to delivery of seed and advertisements were placed in local papers. The principal activity of the ADC sales manager was to remain in contact with retail outlets which requested seed prior to announced seed delivery dates. At non-ADC outlets, seed is sold on a commission basis, providing sales agents with an incentive for promoting the seed. All unsold seed is returned to ADC. All the movement of the seed between the farms, cold store, warehouse and retail outlets is via the transport unit of ADC.

Commenting on the seed distribution scheme, the external review team noted a very low farmer awareness of certified seed (Mendoza et al, 1986). This was again confirmed during field work for this study. Information diffusion is the responsibility of the extension service which clearly has problems in reaching the majority of farmers with information about the existence or advantages of using certified seed potatoes.

ADC management had long noted the sometimes indifferent and inappropriate way that sales outlets handled and promoted their stock of ADC seed which resulted in large returns of unsold or spoiled seed. Thus in 1987, a series of promotional and information gathering trips was conducted by ADC staff. The objective of these trips was to assess the knowledge of and interest in certified seed potatoes among governmental agricultural officers, sales agents, large farmers who might serve as seed multipliers, and other governmental or non-governmental institutions with interests in the Kenyan seed potato

situation (Bos et al, 1987). An additional field survey team contacted farmers to assess their variety preferences, production problems and interest in certified seed (Kapkirwok, 1988a).

The results of these marketing surveys confirmed the willingness of government agricultural officers to cooperate with ADC and the interest of many possible retail outlets in improving the handling and promotion of seed -- further indications for ADC not to rely on the extension service for promotion of certified seed. The farmer survey confirmed that the variety Kerr's Pink is an obvious omission from the varieties produced by ADC. Most farmers did not know of the existence of certified seed and among those who did, remoteness of sales pickup points was considered a problem. It also became apparent that seasonal delivery dates needed adjustment. Thus despite ADC-Nairobi management reluctance to become involved in seed promotion, a technical sales position was created in 1987.

The ADC technical sales representative, in cooperation with provincial and district crops officers of the Ministry of Agriculture, developed a four point strategy for the promotion of certified seed. The first point calls for raising farmer awareness about certified seed via a series of demonstration plots in farmers' fields, field days, and displays at agricultural fairs. Other activities include the development of articles for farmer magazines and a series of radio programs in Kikuyu, KiSwahili and English. The second objective is to demonstrate the benefits of quality seed via demonstration trials and field days while the third objective is promotion of better husbandry practices through field days, technical pamphlets and seminars for ministry staff. The final goal is to make seed more accessible through the recruiting of more sales agents, better utilization of KGGCU stockists, and direct sales to farmers via Ministry staff (Kapkirwok, 1988c).

Demonstration Trials

In addition to the role of farmer awareness and education, the demonstration plots and associated field days are an important feedback link to the potato project. Lacking an on-farm research program with trials in diverse parts of the country, NPRS is unable to provide information about the performance of varieties or quality of seed. Thus the demonstration trials are the only regular source of this sort of information. Although ADC stages trials to educate farmers, the trials also provide useful information to potato researchers in Kenya.

In 1988, trials in twelve sites in different districts were planned for the long rains season and eleven in the short rains season. Field days during planting, full bloom, and harvesting of the trials were conducted. The plots consist of six varieties, four from ADC planted with certified seed and two local varieties planted with farmers' seed. The trial results thus reflect the contributions of both seed quality and variety.

Due to the distortions of extrapolating trial plot results to hectares, the relative results are of more interest than the absolute values. The trials reported in Table 13 show generally favorable results, with the certified seed plots producing a 72% yield improvement over the local seed. The exception to this were the trials in Muranga. The trials were in a lower altitude coffee zone typical of production in the district. Because of the lower altitude the farmers rely on seed from Meru of the variety Kerr's Pink. Whether due to comparative seed health or variety/location effects, the superior performance of Kerr's Pink is persuasive evidence of the desirability to include that variety among those offered by ADC.

Table 13 ADC Long Rains Potato Demonstration Trials[1]

District	Muranga	Narok	Nyadarua	Nandi	Average
Average marketable yield (mt/ha)					
Local varieties	50.0	15.5[2]	36.5	27.5	32.5
Cert varieties	46.7	70.5	57.0	49.7	56.0
Average net revenue[3] ('000Ksh)					
Local varieties	29.0	-1.7	7.5	1.3	9.0
Cert varieties	26.3	20.3	17.1	10.2	18.5
Return to investment[4]					
Local varieties					193%
Cert varieties					94%

Source: Kapkirwok, 1988
Notes: 1. There were 12 trials in four districts. 2. Low yields were due to germination failure. 3. Net revenue is total revenue less variable costs. All values are at farmgate prices. 4. Return to investment on variable costs is net revenue divided by variable costs.

Seed Prices

In 1987, the ADC Planning Department analyzed the profitability of the potato seed project using data from the 1985/86 crop year. The report examined various factors affecting the efficiency of seed production and storage and concluded that the project was performing at a financial breakeven point for the various units involved. The analysis did conclude there were several possibilities for increasing the profitability of the operation: increased yields, increased percentage of seed in the overall crop and reduction of production and post-harvest losses (Goldson, 1987).

A factor frequently mentioned by Kenyan observers concerned with seed potatoes is the high price of certified seed. Sales prices are set by ADC based on estimates of seed production costs. Given the results of the demonstration trials above, it appears that the concerns over high prices are misplaced.

Certified seed appears to be a good investment for the potato farmer. For the economic calculations in the demonstration trials, local and certified seed were assigned equal costs. The average return to investment to variable costs for the certified seed plots was more than double that for local seed. This figure can be interpreted as the joint contribution of certified seed and variety to increased net revenues.

There are few potato production cost studies in Kenya. Durr and Lorenzl in 1976/77 surveyed farmers in six regions and found seed to represent 21% of variable costs on average, ranging from a low of 12% in Kinangop to 30% in Nyeri and Muranga. Thus the doubling of net returns would cover a significant increase in seed costs. However, the criticism that certified seed represents a burdensome cash expense has justification. Cash expenditures for production averaged 34% of total costs and in only three of the sites did farmers report purchasing seed. Thus a seed purchase would siginificantly increase cash expenditures of the potato farmer and cash availability may be limited.

Certified Seed Production and Distribution in Kenya

Distribution

Potato seed distribution is often problematic. Potato seed is a perishable, bulky product that has a limited period in which it is in optimal condition for planting. However, promotion and distribution have received neither the attention nor the external assistance to the degree enjoyed by other secto

ODA and GTZ projects there were provisions for development of seed marketing. However as production considerations were prioritized, the marketing objectives were not met (Homann, 1979, Todd, 1976).

Aside from timing production, the history of seed potato marketing in Kenya has largely been one of neglect. Though frequently mentioned, little has been written about the subject. Most frequently, promotion of certified seed was seen as a job for the extension service. There has been little doucmented followup from the Kenya research community of extension service distribution or promotion planning. Before the ADC project, distribution was assumed to be resolved by making seed available in a limited number of selling points such as the NPRS seed farms or in direct sales to farmers.

Several alternatives to building seed supplies within a broadly defined certified seed system were presented above. The current Kenya model emphasizes a high degree of control of the certification process by producing seed under the direction of ADC. However, ADC professes to have goals of producing only 1% of total seed requirements. Given this, the second alternative of injecting small amounts of seed into key points of the informal seed system, should be considered in combination with the ADC model.

The revised ADC marketing strategy is the first comprehensive plan to actually be implemented in the country. However, as is correct for ADC, the strategy is a commercial one and focuses on distribution through agricultural supply outlets. There are a significant number of potato farmers that do not frequent these outlets, especially those from remote production areas. This is reason to consider complementary marketing efforts designed for the particular needs of this sector

of the market. The fundamental elements of the ADC marketing plan are valid for implementing the second alternative: increasing farmer awareness and demonstrating the benefits of quality seed, improving production efficiency and increasing seed availability. Given the demonstrated weakness of the extension service in this area, a special project executed by a non-governmental agency is probably the best option for progressing with a quality seed diffusion plan.

Production

Certified seed production historically has vacilated in Kenya. Robertson (1976) noted that there was less certified seed production in 1975 than in 1971. This is a decline during the combined GTZ and ODA projects that had objectives in increasing certified seed production. None of this can be analized directly however as data and reporting are incomplete.

Even the ADC data on seed production, as noted in internal analysis, is unfortunately incomplete in coverage and inconsistent among reports (Goldson, 1987). However some data series do exist. ADC began seed potato production in 1979 on 65 hectares. Encouraged by the demand for seed and their capacity to produce it, project managers rapidly expanded the planted area until a disasterous sales year in 1981 when 20,000 bags of seed remained unsold (Table 14). Farmers reacted to very low market prices for potatoes by reducing plantings. Consequently the demand for expensive purchased inputs such as seed potatoes also fell. Since 1983 the area planted by the project has stabilized around 115 ha/year. This reflects conservative planning designed to avoid repeating the earlier overproduction and the stated goal of reaching 1% of seed requirements.

Table 14 ADC Seed Production

Year	Total Area (ha)	Total Prodn (mt)	Total Yield (t/ha)	Cert Seed Prodn	Yield (t/ha)	Seed as % of prod
1980	49.4	795	16.1	590	11.9	74.21
1981	124.3	2,747	22.1	1,644	13.2	59.8
1982	121.0	1,889	15.6	711	5.9	37.6
1983	172.1	2,000	11.6	1,235	7.2	60.5
1984	133.2	1,800	13.5	776	5.8	43.1
1985	118.6	2,495	21.0	1,440	12.1	57.7
1986	124.8	2,800	22.4	1,680	13.4	50.4
1987	110.0	2,229	20.3	1,169	10.6	52.5
1988	104.9			1,470		
1989				1,430		
1990				1,270		

Sources: Goldson, 1987, Bos, 1988

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APPENDIX TABLES

Appendix Table 1 Potato Varieties Named by Potato Growers in 1976/77 (Frequency of Responses in %)

Variety	Percentage	Variety	Percentage
Kerr's Pink	62.2	Tako	<1
B 53	28.6	Tanganyika	<1
Maritta	20.0	99	<1
Kinongo	11.3	Pimpernel	<1
Dutch Robjin	10.2	Kenya Baraka	<1
Ngorobu	4.5	Kenya Akiba	<1
Ngabati	4.3	Mkurino	<1
Annet	4.3	Roslyn Tana	<1
K.9	3.8	Gaturn	<1
C 53	2.9	Gatuwa	<1
K 49	2.9	Arka	<1
Susanna	1.9	B 52	<1
G.	1.8	Mwezi Mojs	<1
C.	1.6	Njai	<1
Thiba	1.6	Kenya 1	<1
C.52	1.1	K	<1
B 59	1.1	B	<1
Desireé	<1		

Source: Durr and Lorenzl 1980
Note: Number of farmers is 441

Appendix Table 2 Percentage of sample farmers growing given varieties: 1988

Variety	Percentage	Variety	Percentage
Nyayo	53	Anett	1
Desiree[1]	42	B	1
Mukori	25	Gituru	1
Roslin Tana	21	Feldeslohn	1
Kerr's Pink (Meru)	21	C	1
Golof	6	Kigeni	1
Kinongo	6	Romano	1
Ngure	6	Roslin Ruaka	1
Kenya Baraka	5	Purple	1
Maritta	5	Njae	1
Kihoro	5	Suzanna	1
America	3	Cardinal	1
Roslin Bvumbwe	3	Kathama	1
Njine	3	Kinare-Mwene	1
Roslin Gucha	3	Kibururu	1
Arka	2	Karoa-Iguru	1
Roslin Eburu (B53)	1	Muturu	1
Kiraya	1	Faraja	1
Kenya Akiba	1	Kiamucove	1
9	1	Michiri	1
Original	1	Rugano	<1
Gituma	1	Njine Giathireko	<1
Mukorino	1	Meru Mix	<1
Amin	1	Blue	<1
Pimpernel	1	Baranja	<1

Source: McArthur Crissman, 1989
Note: Number of farmers is 154, Desiree includes local and official