Seeds for African Peasants

Peasants' needs and agricultural research – the case of Zimbabwe

by

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Contents

Boxes

Maps

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Summary

Chapter one seeks to place the present study in the context of *the peasant debate*. The peasant household is defined in relation to its role as a seed producing and consuming unit. The process of social differentiation and the development of peasant household production strategies are also discussed.

Chapter two discusses *commodification of peasant agriculture and its seeds*. It starts out with a general discussion of commodification of agricultural production in Africa, and moves on to narrow the focus to commodification of agricultural seeds in peasant societies. This process is discussed in relation to the on-going intensification of agricultural production. After discussing commodification of seed from the point of view of the peasant consumer, commodification of seeds is analysed from a seed production point of view: how the seed industry has by-passed the biological barriers for making seed a commodity, e.g. through hybridization. Finally, the conditions for seed production in peasant societies are discussed.

Chapter three, analyses *plant breeding and agricultural development*. The question of the ability of conventional scientific plant breeding to satisfy the seed requirements of peasant societies is discussed. This leads to a discussion of farming systems research as a method of identifying peasant seed requirements. The concept of indigenous plant breeding is thereafter discussed, and the factors influencing its efficiency compared with scientific plant breeding. Finally, the development of an integrated approach to plant breeding for peasant societies is called for.

Chapter four discusses *the agricultural sector in Zimbabwe*. It begins with a short historical review of the development of the racially-based agrarian structure. This is followed by an analysis of post-independence agricultural policy. Emphasis is on the new government's progressive policy to develop the infrastructure in the neglected communal areas, and the implementation of land reform. Thereafter, production conditions and marketing trends for the major crops in the communal areas are analysed. A discussion on food security and self-sufficiency, both nationally and on the rural household level concludes the chapter.

Chapter five is an introduction to Silobela communal area, describing briefly the administrative structures and agro-ecological environment of the study area.

Chapter six consists of an analysis of household economics. The economy and livelihood strategies of the individual household are analysed in the context of the village economy. The chapter begins by discussing the economic options available for peasant households in Silobela communal area.

The households in the sample are then stratified according to the annual household income. This social stratification is used to analyse the patterns of household income and expenditure, as well as other important economic indicators, e.g. access to assets, size of crop production and involvement in the market economy. The analysis continues with household composition and division of labour, and concludes with household livelihood strategies.

Chapter seven, *farming system analysis*, contains an analysis of the farming system of Silobela communal area. Principal elements of the farming system are described and analyzed, including energy flow from outfield to infield, land use, land tenure and household labour constraints. This analysis provides the framework for the remaining farming system analysis. By applying an energy flow concept, three components of the farming system emerge: out-field capacity, livestock production and in-field capacity. The analysis of the out-field capacity includes the grazing management of the communal pastures and strategies applied to cope with the shortage of fodder for livestock. Livestock production is analysed in respect to its two primary functions in the farming system: nutrient transfer capacity and its draught power capacity. The analysis of the in-field capacity includes cropping pattern, crop management and crop production strategies. The chapter ends by summarizing the research constraints in the farming system and then proposes appropriate technical solutions of these resource constraints and discusses the socio-political conditions for change.

Chapter eight, *the role of seeds in the farming system*, analyses peasant's access to improved and indigenous varieties of seed. It focuses on the efficiency and organization of different types of market sources, and then moves on to analyse the social differentiation of seed use for each of the major crops: maize, groundnut, sorghum and sunflower. Finally, the ways these seed varieties are adapted to the resource constraints and farm management conditions are examined, e.g. method and timing of tillage and weeding.

Chapter nine reviews agricultural research in Zimbabwe, analysing the *institutional framework for plant breeding*. The institutional and legal institutions within the seed industry that are important for understanding the role and function of plant breeding are described. An overview is presented of the level of plant breeding activities, indicating where they take place.

Chapter ten presents a *review of plant breeding programmes* for all major crops grown by communal farmers. The objectives and results from each of the commodity research programmes are discussed in relation to the requirements for the communal farming sector. Only government research programmes only are discussed.

Chapter eleven analyses the *re-orientation of plant breeding since independence*. There has been a shift in the political goals of government plant breeding, from serving only large-scale commercial farmers before independence to serving all farming sectors since then. The analysis examines the extent to which plant breeding efforts have changed methods and goals as a result of the national political changes over the last decade. Finally, *the seed requirements of peasant societies* are evaluated as well as the relationship between, on the one hand, peasant households' resource constraints and livelihood strategies, and on the other hand, their seed requirements. It is suggested that a seed catalogue is required, adapted to the range of sub-optimal resource conditions facing different social strata of peasants.

Chapter twelve discusses the *inadequacy of formal scientific plant breeding* and the extent to which plant breeding in Zimbabwe satisfies the seed requirements of peasants in the communal areas. In addition, it analyses the root causes for the present situation.

Finally, chapter thirteen, in relation to the objective of *sustainable poverty-oriented plant breeding*, calls for the establishment of a dialogue between scientific plant breeding and peasants. A two-string model for integrated plant breeding is proposed.

Introduction

Crisis in peasant production and the role of agricultural seed

African agriculture is in crisis. In spite of the great dependence on agriculture in Africa and more funds spent on agricultural research per capita than in Asia or Latin America (Haugerud and Collinson 1991), productivity has continued to grow slowly, while the population growth is the highest in the world.

Observers have pointed at four root causes of the crisis in African agricultural production: 1) the overall economic crisis has a negative affect on possibilities for increasing productivity; 2) the agricultural policies of African governments have not given appropriate incentives or support to stimulate growth in the agricultural sector, but have squeezed it through low producer prices and the monopoly of inefficient parastatals; 3) population growth and commercial expansion of agriculture have caused an environmental crisis, as farmers have been forced to abandon their environmentally sound resource management systems for the benefit of short-term productivity gains; and finally 4) agricultural research has failed to develop the technology required by peasant producers.

The focus of this study is to contribute to the understanding of the last of these four factors, by analyzing the role of agricultural seeds in peasant agriculture, determining their seed requirement and analyzing the ability of the supply systems to satisfy their requirements.

Agricultural seed technology is among the most important technologies for agricultural development. The genetic qualities of the seed determine the potential yield and thus the productivity of other agricultural inputs and farm management practices. Moreover, adoption of improved seeds can, independently of the use of other external inputs, increase productivity for the peasant. The relatively low cost of improved seeds, compared with other external inputs, makes the adoption of improved seeds one of the easiest and cheapest ways for peasants to increase their production.

In spite of the high potential of seed for improving productivity, the diffusion of 'green revolution' varieties has been limited in Africa, compared with the Asian experience. There have been success stories of rapid diffusion of improved varieties (where hybrid maize cultivation in Zimbabwe is a frequently quoted case), while the greatest part of agricultural production in Africa has not been assisted by formal scientific plant breeding.

This study has its point of departure in two misconceptions about technological development in Africa: 1) that the existence of scientific research institutions necessarily contributed to economic change, and 2) that technology was readily available and could be easily obtained through transfer arrangements (Juma 1989).

Conventional scientific plant breeding aims at increasing yield potential under optimal farm management conditions, and the improved varieties multiplied and distributed by organized seed production have proven to be appropriate for commercial farmers. This study will question whether the seed requirements for African peasants are the same as their commercial colleagues.

The study thus sets out to analyze the differences in production conditions between commercial farmers and peasants, as these are assumed to influence their production objectives and thus their seed requirements. Four factors are believed to differentiate peasants from commercial farmers: 1) the existence of imperfect markets for land, labour, capital and products; 2) the partial participation in the market; 3) resource constrained sub-optimal production conditions; and 4) an early stage in the processes of agricultural intensification and commodification. These differences are taken into account in determining peasant seed requirements.

The two systems of seed supply are also analysed with respect to their ability to satisfy the seed requirements of peasant societies. The majority of the seed supply in Africa today stems from indigenous plant breeding, which is undertaken by the farmers themselves and linked with community seed exchange systems. It has existed for centuries and is linked with traditions within the community and household. The land races are highly adapted to the specific local production objectives and sub-optimal resource conditions. The indigenous plant breeding system is increasingly being marginalized by supply of improved varieties which are able to increase yields when combined with use of inputs and good farm management.

Two processes are seen to change peasant seed use. The commodification of agriculture is increasing the demand for surplus production for marketing, while intensification of agricultural production is increasing the pressure on resources. The study analyzes the effect of these processes on the role of seed in peasant society.

Research objectives

The role of agricultural seed in peasant agricultural production is analysed by focusing on the relationship between plant breeding and peasant seed requirements. This analysis is closely linked with other studies, published elsewhere (Friis-Hansen 1991b; Cromwell, Friis-Hansen and Turner 1992; Friis-Hansen 1992), which analyse the organization of the seed industry in developing countries in general and in Zimbabwe in particular.

The study has four objectives:

- to understand the role of agricultural seed in the development of peasant agriculture
- to determine the seed requirement of peasant societies in Zimbabwe
- to review plant breeding in Zimbabwe since independence, with reference to the development of peasant agriculture
- to discuss the prospects for sustainable poverty-oriented plant breeding

Chapter 1
The Peasant Debate

Who are peasants?

Peasant is not an easy term to define, as peasant formations grow from historically specific combinations of structures and do not correspond to concepts of either political economy or conventional economics. Peasants are not just small-scale farmers or entrepreneurs, nor are they simple commodity or capitalist producers. With one foot in subsistence and the other in the market, peasant societies are only of marginal importance in the world economy, despite the fact that they are probably the largest group including approximately one-quarter of the world's population.

Because the term peasant has been developed through empirical generalization it is not possible *a priori* to specify the level of market integration; it can vary from minimum to nearly full integration. For this reason, some writers within the theoretical orientation of Marxist political economy (Ennew 1977) reject the peasant as an analytical concept but are unable to find another concept to cover the same group of farmers, as the term does not refer to a unique set of productive relations. They conclude that the term peasant should be replaced with a well-defined concept from the political economy: simple commodity producer. Henry Bernstein agrees with them in his earlier writings and argues in favour of the use of the concept of simple commodity producer: "Since one cannot distinguish any single peasantry, it is impossible to analyse peasants as a class" (Bernstein 1979).

Friedman very convincingly defends the use of the term peasant until a more elaborate theoretical framework is developed:

> ... simple commodity production identifies a class of combined labourers and property owners within a capitalist economy, and the circuits of reproduction of simple commodity production intersect with those of commodity, landowning, and banking capital, and with markets in labour power, in abstractly determined relations. Peasant households reproduction involves important communal and or class relations which limit the penetration of commodity relations into the productive process. (Friedman 1979:162)

A fundamental difference between peasants and simple commodity producers is that peasants operate within a system of imperfect markets for land, labour and capital. This does not imply that peasants are not engaged in commodity production. On the contrary, the existence of commodity production is a part of the definition of peasants, but it "does not exclusively or even principally define the relation of peasants to each other or to outsiders.

Peasant households have important communal relations, including local exchange of products and reciprocal sharing of labour" (Friedman 1979: 165).

Frank Ellis identifies four criteria which should be fulfilled for an analytically workable definition of peasants (Ellis 1988:4): 1) it should serve to distinguish peasants not just from non-farm social groups, but also from other kinds of farm production be it plantation, estate, capitalist farm or commercial family farm; 2) it should contain a sense of time as well as of change, in order to avoid mistakenly identifying peasants with stagnation and tradition; 3) it should encompass the household as a unit of analysis, the larger economy, and the interaction between them; and 4) it should possess relevance for economic analysis, in the sense of delineating economic conditions of peasant life which differ analytically from those of other social groups or farm enterprises.

With point of departure in these criteria, Ellis arrives at a definition:

> Peasants are farm households, with access to their means of livelihood in land, utilizing mainly family labour in farm production, always located in a larger economic system, but fundamentally characterized by partial engagement in markets which tend to function with a high degree of imperfection. (Ellis 1988:12)

This broad consensus definition does not obviate the inherent problem of capturing the diverse range of peasant relationships and experiences in a single construction (Isaacman 1990:2). Some critics have maintained that the term peasant is too vague and covers a range of different labour processes, including petty commodity producers, share croppers, subsistence producers only engaging in commodity production to satisfy the requirement for cash income, peasants forced to produce commodity production under state regulated labour and marketing systems, and finally, peasants operating in migrant economies.

This broad definition of peasants is well suited, however, to determine seed requirements and will therefore be used in this study (see categories c) and d) in box 1). There are four important factors differentiating peasants (using the above definition) from commercial farmers with regard to access to and requirements for seed. These factors are: 1) existence of imperfect markets for land, labour, capital and products; 2) partial participation in the market; 3) resource constrained sub-optimal production conditions; and 4) low level of development of the processes of agricultural intensification and commodification. These factors are discussed in detail in the following sections.

The process of social differentiation

Chayanov (in Harriss 1985) explained the process of differentiation among household producers as a result of the cyclical process of life from birth to death. This analysis was based on the generalization of demographic and

Box 1. Categories of seed users

a) Large-scale commercial farmers are primarily located in relatively high potential areas with well-established market infrastructure. The objective of production is to maximize marketable surpluses, and the purchase of improved seed from the formal sector is an important means of achieving this. Individual orders are large and the main requirement is for high-yielding seed. Although numerically the smallest group, it has historically exerted a strong influence through its buying power on the directions pursued by plant breeders and on the way commercial seed organizations, in particular, have developed. This was especially the case in much of pre-independence Africa, although this influence is now waning in many areas as a result of land reform and the greater participation of the public sector and non-market oriented organizations in the seed sector.

b) Small-scale commercial farmers are also oriented toward maximizing marketable surpluses, but due to the smaller scale of production, a more labour-intensive mode of production is usually used and individual seed requirements are smaller. These farmers are also a relatively attractive market for commercial seed organizations, although a more highly developed distribution system is usually required. In many countries, particularly in Asia, this group and its buying power, although small, is growing rapidly.

c) Small-scale semi-commercial farmers are in the process of changing from a pattern of production geared primarily to satisfying domestic consumption needs for food and other natural resource products, and are strongly influenced by social relations in many countries, but particularly in Africa, where it is estimated to include more than 60 million farmers (Mellor 1988). Many are located in areas of limited agricultural potential, remote from market infrastructure and have very limited cash resources. Increased use of improved seed has significant potential for increasing productivity for this group, but their ability to make use of formal sector seed organizations, both public sector and commercial, is constrained by the physical and economic environment in which they operate. The improved delivery of seed to this group thus presents a major challenge for the organized seed sector. It is on the seed needs of this group in particular that this study focuses.

d) Subsistence farmers—in most countries, few purely subsistence farmers remain since the level of market penetration integrates most are integrated into the commercial economy for at least some consumption goods and therefore for a proportion of production. Most save their own seed or rely on the informal sector in other ways, and there are particular difficulties associated with producing and distributing seeds for this group using formal sector organizations. Until their wider resource constraints are more directly addressed, and they are able to participate more fully in conventional markets, supplying them through public or commercial seed organizations is unlikely to be feasible—although there may be an important role for NGOs/PVOs and other local-level organizations to work together to alleviate these constraints.

economic processes of the individual household. The theory has been much criticized for not taking the peasant household's external relations into account. Lenin (in Harriss 1985) is the primary source for those writers arguing that the process of commodification eventually will result in the establishment of social differentiation. The argument is that the family production unit will disappear and give way to the formation of three classes: a small class of large-scale capitalist entrepreneurs; a large class of agricultural labourers with no or little land; a class of middle farmers who are self-sufficient household producers using primarily their own family labour.

According to Lenin's thesis, the middle farmers would finally be abolished as the process of differentiation progressed. The class of capitalist entrepreneurs would eventually be taken over by company capital. History has shown that this has in fact not taken place: family producers have survived throughout the world, both in developed and developing countries.

Although there has been an increase of company-owned farms, the survival of family production units in advanced capitalist economies such as Denmark has shown great resilience. This is historically so, because of the cultural and legal protection of family farm units. The small family units have in recent years been sustained by the success of a farmers' lobby to increase EEC price subsidies to provide a level of income comparable to that of urban dwellers. Moreover, for a variety of reasons such as the length of the production cycle, uneven distribution of labour demand, variability of climate and consequent high risk and difficulties of supervision, the interest of company capital in investing directly in agricultural production has been limited. The company capital of agribusiness has been invested in and indeed controls the levels of inputs, credit, marketing and processing. The entry of company capital into the actual production process has primarily been undertaken where vertical integration has increased profitability, such as in the wine and sugar industries.

Forces within the capitalist system itself work against the abolishment of the peasant household unit. Bernstein (1979) describes these forces as the "simple reproduction squeeze". Through two processes, the simple reproduction squeeze limits capital accumulation in peasant societies: 1) surplus appropriation takes place from the peasant society to the outside economy, i.e. capitalists, urban dwellers or the state bureaucracy, and has taken different historical forms, including taxation, pricing mechanisms and rents of various kinds; and 2) due to devalorization of peasant labour, peasant households have to work harder to sustain the same level of income when prices are squeezed. Moreover, unequal exchange is more possible for peasant than for simple commodity producers:

> Resistance to commodification implies lack of integration into markets for renewal of means of subsistence; income required from the sale of household products may therefore be lower than under commodification, and there exists a possibility for lowering prices without undermining reproduction. (Friedman 1979:173)

Other writers argue that because peasant producers are not separated from their means of production, they retain a degree of control over land and family labour. For this reason, they survive as an organizational form of production. Peasants may be more efficient users of capital than large-scale capitalist producers, and some have argued that one reason for the survival of peasant producers is that they are able to produce goods cheaper than capitalist producers (Djursfeldt 1982).

The Marxist peasant theories developed in the 1970s experienced a crisis during the 1980s, partly because of their failure to explain declining productivity and poverty. Several writers who contributed to peasant theory then have since changed position. As an example, Bernstein has shifted from viewing peasants as trapped in the crisis of reproduction to emphasizing the ambiguous class position of peasants as petty commodity producers (see Isaacman 1990).

Moreover, at least three sets of theoretical orientation have become more vocal in the peasant debate during the 1980s and criticized the deterministic and economically biased Marxist theories. These theoretical orientations focus on gender relations, relations between people and the environment, and interrelationships between materialism and culture. Neo-Marxist research concerned with sociology and culture have through 'everyday life' analysis "stressed that rural communities were capable of creating an alternative oppositional culture and were not necessarily victims of false conscience and ruling-class hegemony" (Isaacman 1990:12). Feminist scholars have challenged the household as the unit of analysis and argued that the debate has portrayed male reality only. It is also argued that the advance of the process of commodification is strongly linked with the intra-household organization of labour, with the control within the household of critical resources, and with the process of social reproduction.

Researchers concerned with ecology and sustainable agriculture have added a new element to the peasant theories by focusing on the complex ways in which peasants interact with their environment (Richards 1983). Some writers have moreover analysed the influence of critical environmental issues on the processes of commodification, social differentiation and gender relations (Mandala 1982). Recognizing that both cultural and gender relations are important issues, this study emphasizes the relationship between people and environment.

Peasant household production strategies

Economic household theories have made important contributions to understanding the economics of different peasant household production strategies. The household is the unit of analysis for these theories and they are concerned with the reaction of the household to changing market conditions. This section examines four major groups of household theories: profit maximizing, risk aversion, labour productivity maximizing, and utility maximizing.

1. The profit maximizing peasant

The theory of household profit maximization treats the household as a farm business, and predicts that all households act as an "economic man" whose main aim of production is to allocate resources in order to maximize profit.

Utility is a sole function of profit, and profit maximization coincides with utility maximization. Profit does not necessarily have to be in terms of money.

> What is required is for there to be adjustments of inputs or outputs which would give the household a higher net income whether measured in money or physical terms, and this applies equally to a near subsistence household as to a fully monetized one. (Ellis 1988:64)

The profit maximizing theory[1] is based on two basic assumption: on the one hand, that the resource and production conditions confronting the farmers in a sample are homogeneous; on the other hand, that the markets for land, labour, capital and input/output products are fully competitive.

These assumptions are rarely likely to pertain to African peasant societies. Many case studies have shown resource and production conditions in peasant societies to be highly heterogeneous. Land in African peasant societies is traditionally not subject to sale, and its allocation and use are guided by cultural, social and political relations. With the increased commercialization of agriculture, this has changed to some extent, and the use right to land and the assets on it are in some rural African societies today traded for cash payment. Sale of agricultural land in a purely commercial sense with title deeds is still rare in Africa. Labour is in many peasant societies not freely available for sale, and work is primarily carried out by family labour. There are clear divisions of labour within the household which further limit the competitive allocation of labour. Finally, the availability of capital in peasant societies is clearly limited and competitive capital markets are not developed. One obvious obstacle to the development of a competitive capital market is the fact that private deeds to land do not exist, and the peasants have no collateral for obtaining loans.

It is therefore clear that the assumptions of the profit maximization theories are not present in peasant societies. The peasant household economy is meanwhile being increasingly commercialized and the profit goal is becoming increasingly important. A recent analysis of the applicability of the profit maximization theory concludes:

> The proposition that peasant farmers are efficient in a pure neoclassic profit maximizing sense is neither proven as a general hypothesis, nor is it insightful of variation and its causes in the peasant economy... . Even if the nature of peasant economy inhibits the attainment of efficiency in its strict neoclassic sense, this does not mean that a strong element of economic calculation cannot exist in the context of the multiple goals and constraints of the farm household. (Ellis 1988:73)

2. *The risk aversive peasant*

Theories concerned with the element of uncertainty in peasant agricultural production focus on the trade-off between profit maximization and risk aversion. Risk may be defined as the frequency of occurrence of an event or

[1] A detailed description of the profit maximization theory can be found in Upton (1976).

series of events which the peasant subjectively expects. If droughts are expected in one out of four years, the risk of drought will have a probability of 0.25. Uncertainty refers to the general character of environment in which the peasant operates and to which various degrees of risk can be attached (Ellis 1988:83–84).

The uncertainty and risk confronting peasant societies can be grouped into three types: uncertainty about the natural environment, market fluctuations, and social instability. Uncertainty regarding the natural environment includes the impact on agricultural production of variations in climate and attacks from pests and diseases. This uncertainty is often considerably higher under tropical and subtropical conditions than under temperate conditions. Peasants have developed a wide range of production strategies aimed at reducing the risk of environmental uncertainty in production. Such production strategies include inter-cropping, staggered planting and use of drought tolerant early maturing varieties.

It is a common feature of agricultural production that market prices at the time of sale are unknown when production decisions are made. This problem is severe in peasant societies where the input and output markets are imperfect and market information is lacking. An example of peasants' risk-averting behaviour is to set aside more land for subsistence production than is warranted by the relative prices of cash and food crops. With regard to input markets, peasants may react to market uncertainty by avoiding total dependency on external inputs.

Social uncertainty includes the insecure control over resources within peasant society. Both the local and state institutions demanding regulatory control over allocation and use of resources have in most African countries undergone turbulent change, and peasant societies have often been caught up in conflicts between opposing authorities.

There are clear differences between risks in peasant societies and in industrialized societies with fully capitalized family farm units. On the one hand, the relative variation in output is significantly lower in industrialized agriculture in temperate climates than in peasant tropical or subtropical agriculture. On the other hand, capitalist farmers in industrialized countries are often covered by crop insurance, while crop failure may be a question of life or death for a peasant household.

3. *The labour productivity maximizing peasant*

Many writers stress the importance of labour productivity in peasant household production strategies. The theory of labour productivity maximization assumes that there is no labour market and that all work in agriculture is done with household labour. The trade-off is thus one between work and leisure. The theory is a variation of the profit maximization theory, in which leisure is pursued as a separate goal in the absence of a labour market.

The focus of this set of theories is the size and composition of the labour force within the household. In the 1920s, Chayanov developed a theory of rural development which has been highly influential, based on an analysis of how peasant households allocate their labour.

> The labour process is dominated by the relationship between work done and income received. Increased income brings diminishing marginal utility, and increased intensity or duration of labour bring increased marginal dis-utility. (Harriss 1982:209)

Chayanov argues that the peasant household, using its own labour force, would apply it to agricultural production according to its internal equilibrium. This equilibrium is determined by equating the household demands and needs with the drudgery involved in meeting them. Using a concept of consumer/producer ratio, Chayanov analyses the effect of changing household structure during the life cycle of a peasant household on production and income. This is done by differentiating between different types of households: newly established households with only husband and wife have a low consumer/producer ratio, while established families with many children have a relative higher consumer/producer ratio. Chayanov did not analyse the sexual division of labour within the household.

4. The utility maximizing peasant subject to production and labour constraints

The new household economics[1] have developed a theory in which profit maximization is only one aspect out of several. It aims at combining viable parts of previous theories and is based on a set of assumptions which are present in the peasant societies of southern Africa. These include an acknowledgement that agricultural production is not the only source of income and that different members of the households can participate in different labour markets. The assumptions also apply a more elaborate pricing structure, differentiating between farm-gate and retail prices.

> Non-market and market activities are included within the same framework by taking the household-economics view that commodities have two costs: a market cost and a time cost. Wants, such as the staple food, may be obtained using time-intensive or market input intensive techniques. Thus, food may be grown on the farm using time-intensive techniques or purchased in the market-place using market input-intensive technology. The choice of technique used in producing the consumption commodity depends upon the opportunity cost of time for the household member producing it, the efficiency of own production and the different market input costs. (Low 1986:44)

The utility maximization theories emphasize the relation between allocation of labour between agricultural and non-agricultural activities. The proportion of household labour force engaged in non-agricultural activities, such as migrant labour, is a function of, on the one hand, the money wage levels and, on the other hand, the consumer price of food.

[1] A prominent example of this type of household theory is that presented by Low (1986).

The explanation value of the utility maximizing household theories, along with the other household economic theories, is seriously limited. These can be summarized in three points:

1. The sphere of analysis is limited to the household, and the theories can therefore not say anything about the development of society as a whole.
2. The definition of economic efficiency in micro-economics assumes a perfect flexible and competitive market, and the very definition of peasant societies is that they are only partially involved in imperfect markets.
3. The theories treat the household unit as a single decision-making unit and do not take into account gender relations, division of labour etc.

Chapter 2
The Role of Seed in the Process of Commodification

Commodification of agricultural production

Africanists have emphasized the importance of the development of commodity production for the process of social differentiation. The process of commodification and the development of capitalism through linking rural household producers with capitalist production is a dominant process of change. Reproduction is a fundamental concept for understanding the relation between household production and social formation. Reproduction of agricultural households can take place in two different ways, through commodification or through reciprocal ties for renewal of the means of production and subsistence.

Bernstein (1979) defines commodification as a process of deepening commodity relations within the cycle of reproduction. The individual households become increasingly dependent on commodity relations for reproduction. The end result of commodification is simple commodity production, where the household units buy, sell and compete with each other on markets.

The fact that peasants operate under imperfect markets for land, labour and capital has important consequences for how the process of commodification affects peasant societies. As opposed to the simple commodity producer, peasants do not relate to product markets individually and competitively. This implies that if market prices become unfavourable, peasants have the possibility of either totally withdrawing from the market or choosing to continue to sell at the lower price.

In the discussion of why peasants have resisted the process of commodification, writers have pointed to explanations both within the peasant society and in its relation to the outside economy. Three arguments have been put forward with point of departure in the ability of peasant society to resist commodification:

1. The peasant household has retained a certain amount control over its means of production, notably land resources, enabling it to reproduce itself. Moreover, cultural and social norms within peasant societies are reciprocally rather than individually profit maximizing.
2. Communal user rights to land and the fragmentation process of inheritance counteract accumulation and concentration of wealth among a few potentially capitalist household producers.

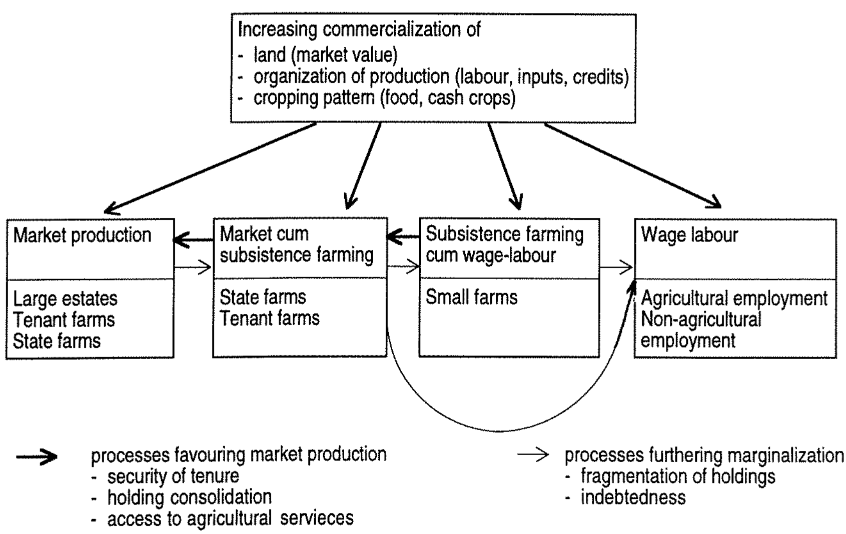
3. The peasant household has a capacity for 'self-exploitation' when it resists market pressures by continuing to produce despite falling product prices. The peasant household can sustain its level of income by intensifying its labour input.

In his thesis of the uncaptured peasant, Goran Hyden (1980) takes this argument one step further, and argues that African peasants "enjoy considerable autonomy with respect to outside institutions such as the market and the state".

Many writers have since criticized the notion that peasants are uncaptured by state or market forces, arguing that reduction in marketed production is rather a sign that they are unmotivated because of too low producer prices or because of gender relations (Staudt 1987). Others have challenged the data on which the theory is based (official marketed production in Tanzania), and documented that large volumes of crops have been marketed through unofficial canals such as the black market (Raikes 1988).

A number of empirical studies on Africa have shown that the effect of commodification has varied greatly. This is illustrated in figure 1. While some peasant households have become simple commodity producers, the reproduction of other households continues to depend on non-commodity relations. In some societies, commodification resulted in considerable social differentiation and divided the peasantry into accumulating and impoverished peasants.

Figure 1. *Peasants in the process of commodification*



Source: Adapted from Hinderink and Sterkenburg, 1987:21

In other societies, the expansion of commodity production did not have a similar impoverishing or polarizing effect, as peasants have been able to refrain from commodity production or have withdrawn from the market all together.

Agricultural intensification and commodification of agricultural seeds

The literature on agricultural intensification is rather substantial but very varied, and a strict definition of what is meant by intensification is often absent. Common for the definitions is that they involve increased use of resources of either land, labour or capital through a change in technology. The adoption of innovations such as mechanization, irrigation, use of organic manure etc. is often regarded in the literature as agricultural intensification.

The so-called modernist theoretical approach views the absence of agricultural intensification in Africa as an important explanation of the low level of productivity. Modernist writers (Goody 1971) focus on the absence of the wheel and plough-based technology in large parts of African agriculture and compare it with the historical development of European agriculture in the early middle ages. In Europe, the plough was the pre-condition for expanding the cultivated area and increasing labour productivity. Historically, the plough also stimulated permanent settlement, which further intensified the land use pattern towards continuous cultivation.

This position has tended to view African agriculture as backwards and has prescribed solutions in terms of transfer from the industrialized countries of modern technology, such as tractor mechanization, use of chemical inputs and irrigation.

The agricultural system theory offers the possibility to analyse how peasant households utilize their resources through a combination of farm management practices. The natural environment affects the farming system and is intimately related to technologies employed by the farmers. System approaches seek to explain the inter-relationships within the farming system, including environmental, technological and demographic factors.

Allan (1965) discusses the concept of carrying capacity, by which he seeks to explain the inter-relationship between human population, environment and agricultural technology. This theoretical tradition is further developed by Ruthenberg (1980), who systematically describes a number of different agricultural systems of progressing intensity, each defined by a restricted set of technical factors and relationships. Agricultural systems theory views agricultural intensification as a series of stages of intensity of land use, ranging from shifting cultivation with forest fallow, over bush fallow, grass fallow to continuous cultivation and integration of livestock and crop production.

Within this context, Boserup developed a thesis about the evolution of the farming system, with point of departure in the interrelation between labour productivity and intensity of land use. In her early work, Boserup (1965) introduces the thesis that population growth (and density) is a key explanation behind the intensification of systems of cultivation, including changes in technology and social institutions. She argues that population growth, and corresponding increase in population density, result in intensification of the land use pattern. When fallow periods are reduced, soil fertility will eventually be degraded and labour productivity will fall. Boserup argues that this creates pressure on society to adopt new technologies which, after an initial period of additional labour input, will increase productivity. Boserup's thesis is thus that the increased pressure on resources triggers a mechanism which facilitates the adoption of new technologies and leads to agricultural intensification.

Such an analysis, which limits itself to environmental, technological and demographic processes, is insufficient to understand the dynamics of agricultural development. There is a need to include economic, social and cultural, as well as environmental and technical factors and relationships in the definition of farming systems. This includes the economics of agriculture and other production activities and the manner in which these are affected by markets and by the interrelation between the rural and urban economy.

Boserup unquestionably contributed to the debate by stressing the importance of marginal labour productivity for the behaviour of the peasants. But her theory is fundamentally evolutionist, and builds on the notion that farming systems develop in progressive stages. Such an approach has shown to be too simple, as peasants may move both forward and backwards from such stages, depending on external factors such as market forces and state intervention.

The involvement of African peasant households in market economy has gradually increased over time. During the colonial era, the introduction of a hut-tax and measures such as forced cultivation of export crops forced the peasantry into migrant labour or sale of surplus production. By and large, the process of commodification of peasant production was limited to the sphere of circulation.

By the time of independence, the demand for household consumer goods such as clothing, salt, sugar, kerosene and charcoal etc., had gradually increased the minimum income required by peasant households. Over the last decades, the commercialization of peasant societies has continued, and the minimum household income required to socially reproduce the household has increased. Provision of social services provided not only better education, health facilities and clean water, but likewise increased the demand on income to pay for school uniforms, dispensary fees, medicine etc.

The demand for household income for social reproduction created pressure to increase the total household production and marketing. Increase of agricultural production can take place either through expanding the cultivated area or through intensification of agricultural production. Simultaneously with this drive to generate household income through an increase in marketed production, population growth increased pressure on land and other natural resources.

These two processes contradict each other, since population pressure limits the possibility of expanding the cultivated area. Increasing pressure on arable land of high quality led to intensification of land use and expansion of cultivation into marginal areas. The combined pressure on resources from population growth and increase in household requirements for cash income has been termed pressure of production on resources (Blaikie and Brookfield 1987). This pressure, where all other factors are equal, has resulted in a decrease in labour productivity. To an increasing extent, peasant households have thus not been able to reproduce their own means of production.

The pressure of production on resources has historically initiated the development and adoption of new productivity—enhancing technological innovations within the farming system. There exist many case-studies describing this process and showing that agricultural intensification is achieved by peasants applying new methods of allocating available natural resources. Considerably less attention has been given to describing the processes through which such innovations are developed. To a large extent, innovations are developed by individual farmers who have the material and intellectual surplus to experiment.

Intensification of the farming system may require an effective forum for decision making, involving such decisions as changes in land use rights, organization of grazing schemes or avoidance of environmental degradation. The ability to make and implement such decisions today is not very great in many rural areas of Africa, as there is a leadership vacuum. The power of the traditional leaders has generally been significantly reduced or abolished, while local government representatives' ability to arrive at the required decisions and to implement them is highly questionable.

Extension services and agricultural research in post independence Africa have strongly emphasized increased use of external inputs as a means of increasing agricultural production. Very little effort has been devoted to assisting peasant communities to develop their own resources and build upon the already existing farming system.

To summarize, there are strong forces within the peasant communities to increase commodity production through intensifying the farming system. The institutional capacity within the peasant community to do this has been weakened, and natural resources have become increasingly more scarce. Meanwhile, state and private companies have emphasized the adoption of external inputs, notably fertilizer, pesticides and improved seeds, as a means of intensifying agricultural production.

As a response to the pressure of production on resources, peasant producers have increasingly become dependent on the purchase of seasonal external inputs for regenerating the desired productivity level. The increased use of and dependence on external inputs have increased the level of household income required for reproduction. The process of commodification has thus expanded from being limited to the sphere of circulation to include the peasants' means of production.

The commodification of the peasants' means of production includes five distinct processes:

1. Mass selection of local varieties is replaced by use of annually purchased improved varieties.
2. Regeneration of soil fertility through fallow rotation and application of organic manure is gradually being supplemented or replaced by use of mineral fertilizer.
3. Local technologies such as inter-cropping, crop-rotation and use of ant-hills or local roots to fight crop diseases and vermin are replaced by use of pesticides.
4. Weeding by hand and use of burning and shifting cultivation to limit the growth of weeds are replaced by use of herbicides.
5. Agricultural hand tools made by the blacksmith inside the peasant community are replaced by industrially manufactured, mechanized tools.

There is a clear difference between commodification of agricultural seed and the four other processes which replace land and labour with capital.

Peasants can, and indeed many do, obtain their seed requirements from their own saved seed. The seed industry must produce a product which is clearly superior in quality to retained seed, and the market for improved seed is thus very sensitive to quality and price. The genetic quality of seed determines the upper limit of yields, and therefore of the productivity of other agricultural inputs and cultural practices within the farming system. Quality refers to both increased yield and yield stability.

Improved seed can contribute substantially to productivity, independent of other purchased inputs, and this can be of particular benefit in resource-constrained peasant environments. The opposite, that improved seed yields less than indigenous seeds under sub-optimal farm management conditions, can also be true. Yields and therefore the overall profitability of a particular improved variety may or may not be factor neutral, depending, for example, on use of complementary inputs and labour or depending on how well the variety is adapted to the physical and socio-economic conditions under which it is grown. The characteristics required of improved seed are thus more location-specific than those required of other seasonal inputs.

There are finally great inter-seasonal variations in the variety-specific demand for improved seeds. Depending on weather conditions, the seasonal demand for improved seeds will vary; timeliness of access to seeds is critical in satisfying demand.

Organized seed production and peasant seed requirements

This section discusses organized seed production and the extent to which it meets the requirements of peasant societies. It begins by analysing biological barriers for commodification of seed and proceeds by describing the structure and organization of organized seed production. Finally, it discusses organized seed production's limitations in meeting the equity demand of securing adequate and appropriate seed for peasant societies and indicates possible options for cooperation between organized seed production and informal peasant seed diffusion mechanisms.

Biological barriers for commodification of seed

It is important to keep in mind that seeds are living organisms, able to reproduce themselves. This is described concisely by Kloppenburg, in his analysis of the political economy of plant biotechnology in United States:

> A seed is itself used up (or rather, transformed) as the embryo it contains matures into a plant. But the end result of that process is the many fold replacement of the original seed. The seed thus possesses a dual character that links both ends of the process of crop production: It is both means of production and, as grain, the product. (Kloppenburg 1988:11)

The commercial value for the seed industry of an improved crop variety, as a commodity, is directly linked to the size, buying power and density of the demand. Because of the dual character of seed as both grain and product, the peasants reproduce the necessary part of their means of production by simply cultivating the crop and selecting seeds for the coming season from the harvest. After purchasing an improved crop variety, the peasant may, with a reasonable level of farm management, subsequently propagate the seed for a number of years without any significant loss of yield potential or characteristics.

> There is little incentive for capital to engage in plant breeding for the purpose of developing superior crop varieties, because the objective in which that research is valorized—the seed—is unstable as a commodity-form. The natural characteristics of the seed constitute a biological barrier to its commodification. (Kloppenburg 1988:11)

The seed industry in industrial countries has overcome the biological barriers of commodification of seed, as a result of a number of both technical and social developments. The establishment of 'intellectual property rights' has greatly facilitated the economic viability of the seed industry. Three technical developments have been of particular importance for commodification of seeds:

1. emphasis on hybrids as opposed to non-hybrids;
2. emphasis on vertical resistance to pathogens as opposed to horizontal resistance; and
3. emphasis on varieties with yield stability over wide areas as opposed to breeding for specific local agro-ecological conditions and sub-optimal management conditions.

These developments are discussed further in chapter 3.

The structure of organized seed production[1]

Organized seed production consists of a framework of institutions linked together by their involvement in or influence on multiplication, processing and distribution of commodity seed (see figure 2). The links between institutions are many and diverse and include not only those directly involved in multiplication, processing, distribution and quality control of seed, but a range of linked institutions at national and sectoral levels that, while not integral components of the seed sector itself, exert an important influence on performance.

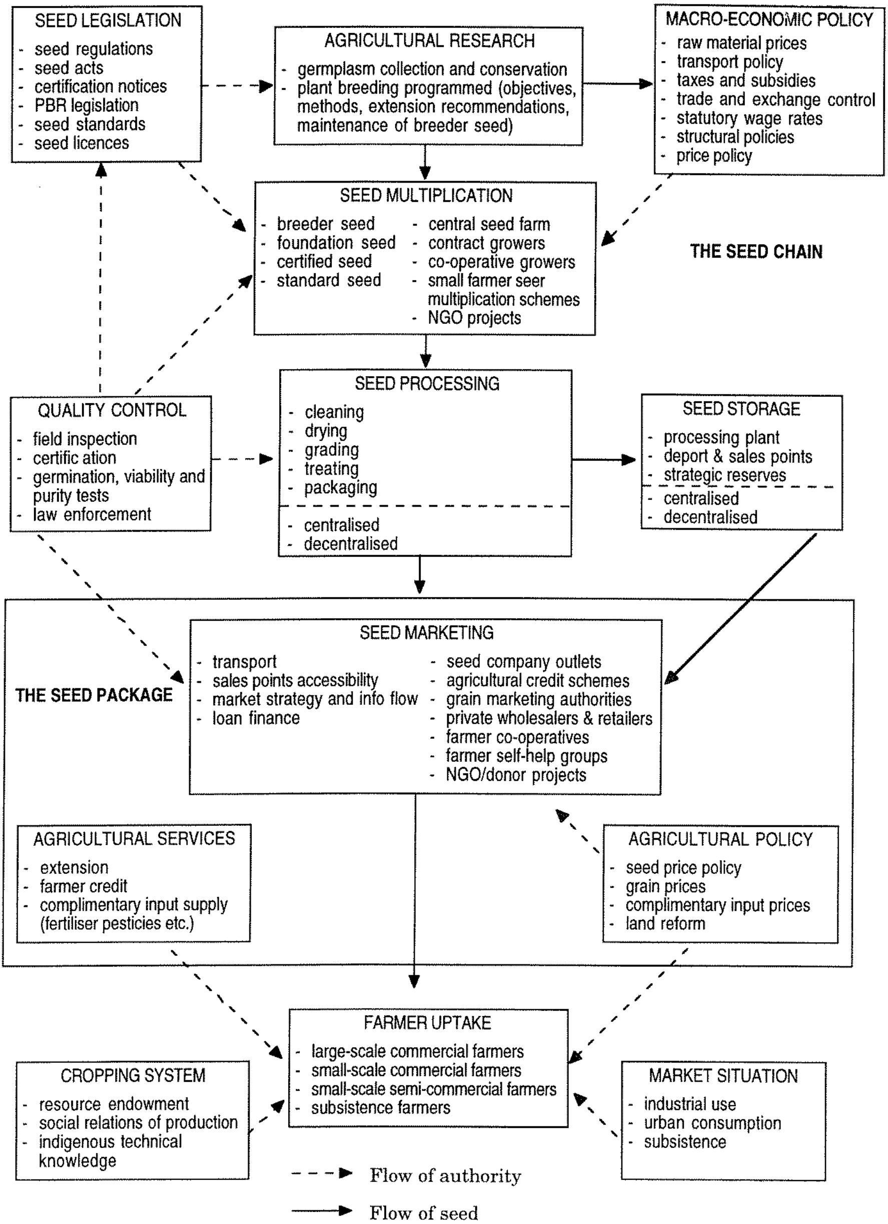
Two characteristics can be distinguished from figure 2. First, seed production is a *longitudinal* process in which the seed undergoes a number of stages from germplasm manipulation, over seed multiplication, processing, storage and marketing, to eventual purchase by farmers. This process is in figure 2 called the seed chain; organized seed production as a whole is only as successful as its weakest link (Muliokela and Kalingile undated). Second, organized seed production can be viewed *latitudinally* and the farming system considered as an integrated whole. Successful seed delivery and adoption by the peasant depends on the appropriateness and efficiency of what is termed in figure 2 the seed package. The success of any one component of the seed sector is thus strongly influenced by the performance of the other components and by the strength of linkages between them. These linkages are a significant distinguishing feature of the seed sector and all decisions made at each stage of seed sector development have to take adequate account of them.

Organization of the seed industry

The operational objectives of organized seed production organizations are primarily determined by the nature of the interest group controlling them. Box 2 is an attempt to classify the different organized seed production organizations into four groups. It should be noted that there is considerable overlapping between the objectives and structures of different organizations. These four forms of organized seed production organizations have different comparative advantages in performing different activities within the seed chain and supplying different types of seed to the various categories of seed users in different contexts. Furthermore, within one seed sector, different types of organizations are often responsible for different stages in the chain and package.

[1]This and the following section build directly on Cromwell, Friis-Hansen and Turner (1992), in which a more comprehensive analysis can be found.

Figure 2. *Structural framework of organised seed production*



Source: Cromwell, Friis-Hansen and Turner 1992.

Box 2. Forms of ownership and organization of organized seed production

1. *Public sector organizations*: ministries or parastatal enterprises, such as the Seed Multiplication Unit of the Gambian Ministry of Agriculture, the Ethiopian and Tanzanian Seed Corporations, for which commercial viability is not usually the primary operational objective although cost-recovery may be important. The public ownership of these organizations dictates, firstly, a bureaucratic decision-making structure and, secondly, the setting of production targets geared towards meeting national development objectives rather than responding to market incentives. Thus, public sector seed organizations include all categories of seed users, and particularly those less able to participate in commercial seed markets, within their operational mandate. This requires them to be involved in the production, processing and distribution of a wide range of seeds which can include, depending on prevailing farming systems, seeds that are relatively low in value and/or high in cost.

2. *Private sector commercial organizations*: both multi-national corporations, such as Panaar in Zimbabwe and Cargill in Pakistan, and indigenous small- and medium-scale seed enterprises, for which profitability is an important objective. The operational objectives of this type of seed organization dictate a market-oriented decision-making structure which gears production to providing those types of seed for which there is an effective commercial demand and which are profitable to produce. Thus, the involvement of commercial organizations in the seed sector is, in the absence of other incentives, much more sporadic and targeted to specific market segments and types of seeds, and structured on a strictly profit-making basis.

3) *Farmers' organizations:* a broad range of indigenous organizations, including local cooperatives, community organizations and church groups, involved in the seed sector for primarily developmental rather than commercial reasons. These are often supported by foreign and local NGOs/PVOs, such as Action Aid in Gambia and Zimbabwe Seeds Action Network. These organizations represent an intermediate form between the bureaucratic and the purely commercial and have usually developed to fill a gap in the market not served by either of them. In particular, farmers' organizations often operate at a local level which enables them to meet the needs of seed users poorly served by other types of organization because of their location, lack of resources etc. In some cases, seed users themselves control these organizations; in others, umbrella organizations provide the necessary resources. But in all cases, participatory decision-making structures geared expressly to meeting the seed needs of the target group are an important feature.

4) *Informal sector activities:* These include all the methods, such as retaining seed on-farm from previous harvests, farmer-to-farmer seed exchange based on barter, social obligation etc. by which farmers obtain seed other than from formal sector seed organizations. Although these are not formally organized, they account for the majority of seed sector activity in most developing countries and can involve well-established and elaborate mechanisms for the diffusion of seed over relatively wide areas. For technical reasons, it is not possible to maintain all types of seed successfully at farm level and the seed that is produced and distributed in this way is usually of lower quality than that which the formal sector can provide. But for seed users badly served by formal sector organizations, informal sector activities are the natural source of supply and therefore must be included in any analysis of seed sector performance.

Source: Cromwell, Friis-Hansen and Turner (1992:6).

Inadequacy of organized seed production to meet requirements of peasant society

Seed industries in the developing countries are commonly expected to perform two quite different economic functions simultaneously:

> ... an equity function of delivering the types and quantities of seed required by different categories of users in a timely manner to appropriate locations at an acceptable price; and an efficiency function of fully recovering the fixed and variable costs of seed production and delivery. (Cromwell, Friis-Hansen and Turner 1992:1)

A recent review of seed industries in 35 developing countries (Cromwell, Friis-Hansen and Turner 1992) concluded that for the small-farmer seed market it is often impossible to fulfil both these functions simultaneously. Private seed companies are commonly found to be reasonably efficient, but they are seldom engaged in operations which are not profitable, e.g. multiplication of improved varieties of open-pollinated subsistence crops or delivery to marginal areas with low density of demand. Equity goals are often embodied in publicly owned seed industries, but because of bad performance with respect to the efficiency function, these organizations have often not fulfilled their equity goals despite substantial subsidies. This is also the case for African parastatal seed companies.

The demand for improved agricultural seed is high in African peasant societies today, but the effective demand for improved varieties is not likely to be massive, even if it is linked to an information campaign conducted by the extension service. Peasant societies are commercialized to only a limited extent; their buying power is subsequently low; and a large proportion are scattered in areas with a low standard of infrastructure and long distances to urban and industrial centres. Moreover, the effective demand of an improved variety of open-pollinated, self-pollinated or vegetatively propagated crops is likely to decline over a limited number of years after its release, as peasants through mass selection become self-sufficient with the variety in question.

From the discussion above, it is clear that a range of improved varieties exist which today are not multiplied and distributed to peasant societies, despite an obvious need for them. It can also be concluded that the reason for this is that it is not profitable to produce certain types of seeds (varieties which are easily retained by the user) and certain types of crops (crops of marginal economic importance) for certain groups of users (peasants living in marginal areas with low effective seed demand).

There is thus no doubt that the governments in the developing countries, donor agencies and NGOs will continue to have a role to play, also to secure production and distribution of those types of improved seeds which are not supported by market mechanisms. Such support can either be direct involvement in seed production or indirect involvement by providing controls and incentives for the private seed industry for activities which are otherwise not profitable.

> Where the organization of the seed sector has been re-examined, particularly in the last decade in the context of structural adjustment programmes seeking to restore macro-economic equilibrium, the most common option considered has been the transfer of the existing centralized institutional structures from the public or parastatal to the private sector; there has been relatively little attention to the possibility of reforming the institutional structure itself in favour of a more decentralized system using existing community-level mechanisms. (Cromwell 1990:9)

A major conclusion of the recent seed sector review (Cromwell, Friis-Hansen and Turner 1992) is that the formal organized seed production is highly centralized with high costs and low efficiency in reaching the small-farmer seed market. A more decentralized, location-specific and sensitive approach to seed production and distribution, which to a greater extent involves local, small-scale organizations, could reduce costs and increase efficiency (see box 3).

Box 3. Characteristics of informal small-farmer seed diffusion mechanisms

Five key characteristics distinguish informal small-farmer seed diffusion mechanisms from those of organized seed production:

1. They are *traditional*, not necessarily static over time in the way they operate, but well-established and often elaborate structures, based on and developing out of the traditional channels of information and exchange existing within the community.

2. They are *informal* or semi-structured in their organization, changing between locations and over time, and not subject to the same rigidities of ownership and control as formal sector organizations.

3. They operate mainly, although not exclusively, at the individual *community level*, among households within one community, although lines of supply may extend over a relatively wide geographical area.

4. A wide variety of *exchange mechanisms* are used to transfer seed between individuals and households, including cash sales, barter and transfers based on social obligations.

5. The individual quantities of seed thus exchanged are often very small compared to the amounts formal sector organizations typically deal in.

Source: Cromwell (1990).

Chapter 3
Plant Breeding and Agricultural Development

Scientific plant breeding and its relevance for peasants

This chapter analyses how scientific plant breeding has been carried out in Africa and its relevance for peasants. It starts with a discussion of concepts of technological development in Africa, and goes on to analyse the adequacy of scientific plant breeding in Africa with respect to peasant seed requirements. A reference is made to the difference between the plant breeding requirements of Asia and Africa. Finally, the biases in scientific plant breeding which are influenced by seed industry interests are discussed.

Conceptions about technological development in Africa

Dr. Juma, director of the African Technology Centre in Nairobi, emphasizes two major misconceptions about technological development in Africa: 1) that the existence of scientific research institutions necessarily contributed to economic change, and 2) that technology was readily available and could be easily obtained through transfer arrangements (Juma 1989).

Juma concludes that most scientific institutes in Africa have played an insignificant role in relation to the technological requirements. Moreover, in cases where institutes have identified and tackled problems, the innovations have seldom articulated themselves through society. There is a long list of development projects which failed partly because of unreflected transfer of technology, and such projects have tended to create technical dependency while increasing foreign debts.

Yet, International Agricultural Research Centres (IARCs) have spent more funds in Africa (per capita, per hectare and per ton of food) than anywhere else, and with less results. A major limitation to the relevance of work conducted at National Agricultural Research Institutes (NARIs) and IARCs in Africa is the strong bias in their orientation towards western agricultural education (Collinson 1988).

> University agricultural curricula are still centred on large fields, machines, straight lines and intensive management. Relevance is also jeopardized by a single-discipline focus, narrow peer group evaluation, unquestioning adherence to inherited breeding strategies, and inadequate exposure of plant breeding to small farmers' circumstances. (Haugerud and Collinson 1991:3)

This development paradigm is based on the assumption that the introduction of improved 'modern' agricultural technology, in terms of mechanization and use of biochemicals, into peasant farming systems will result in increased productivity.

More recently, observers[1] have concluded that the right technological solutions to local problems do not exist 'on the shelf' in Africa, but have to be developed through genuine research which takes the requirements of user groups seriously. Instead of aiming at increasing productivity *per se*, agricultural research and development policies should aim at satisfying the agro-ecological, socio-economic and culture-specific goals of a diversity of peasant communities. Attention has been drawn towards the need for careful attention to the design of improved technologies (Low 1986), i.e. technologies designed to reduce the risks facing peasant societies.

Inadequacy of scientific plant breeding in Africa

It is appropriate to begin this discussion with a quotation from the introduction to Michael Lipton and Richard Longhurst's recent book, *New seeds and poor people*:

> We have, as economists, felt compelled to invade several areas of natural science that were quite unfamiliar to us. In some parts of this book, we are reporting our learning processes. We think this may help other economists and social scientists, because the structures of natural sciences around plant breeding partly shape, partly interact with, its effects on poverty and development. (Lipton with Longhurst 1990:x)

Two underlying assumptions support the establishment of a dialogue between scientists and peasants: 1) the technology required by resource-poor peasants is not readily available 'on the shelf' from science,[2] and 2) peasants are plant breeders in their own right,[3] and scientific plant breeding can draw on work embedded in the indigenous landraces.

> At virtually all agricultural research centres in the early 1970s (and at many today), biological scientists generally assumed that they understood the problems of crop production and the ideal solution for developing countries. In their view, economists and other social scientists had a secondary role (if any) to play in the R&D process. It was to facilitate the transfer of improved technology by helping determine optimal input levels and by training farmers and convincing them to follow recommendations. (Horton 1991:222)

While some cooperation between social science and agricultural science has emerged in the international and national agricultural research stations in

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[1]A review of this literature, with special reference to Africa, can be found in Low (1986). Two general literature reviews concerned with agricultural technology generation are by Ali and Byerlee (1989) and Ghatak and Ingersent (1984).

[2]This has been shown to be true in a large number of cases in Africa, and is a conclusion in a recent review of technology in Africa (Juma 1989:208).

[3]An increasing body of literature has documented this (see e.g. Richards 1985; Chambers and Jiggins 1986).

Box 4. Limitations of scientific plant breeding under low-external-input agriculture

Hardon and de Boef (1993) list four factors which limit scientific plant breeding in its ability to address the diversity of crops and environments under low-external-input agriculture:

Institutional constraints include limited capacity to address the multitude of different crops, environments and cropping systems involved.

Technical constraints include a poor understanding of the genetics of tolerances and adaptations to environmentally induced complex biotic and abiotic stress factors, and difficulty in handling these factors under experimental conditions.

As a consequence of the *economic cost* of plant breeding programmes, single varieties should have wide usage, which limits investments in minor crops.

Conceptual problems relate to the fact that the whole complex of technology development within the public and private sectors is largely product-oriented and fails to consider adequately the context in which new technologies must perform.

Africa, the statement above is still true for most institutes. In Zimbabwe, where farming systems research has been undertaken since 1984, social science impact is limited to adjustments of package recommendations, and has had no noticeable influence on fundamental plant breeding objectives.

The most widely known social science literature on plant breeding is concerned with the impact of the so-called green revolution, the successful diffusion of improved wheat and rice varieties in Asia and Latin America in the 1960s and 1970s. Improved varieties of wheat and rice resulted in doubling the yields between 1958 and 1978 after centuries of slow growth. Table 1 reveals that the diffusion of improved varieties of wheat and rice have come a long way, comprising 52% of all wheat areas and 54% of all rice areas in the developing countries. Yet, the increase in food production has not resulted in an improvement in human nutrition or alleviation of poverty. Most of the productivity gain has been passed on to the urban consumers in the form of lower prices for food (which has marginalized areas where no improved varieties are used). Moreover, the gains in terms of increased employment because of improved varieties have been eroded by labour-displacing innovations such as herbicides, mechanization etc. More recent analyses have found that the improved varieties of the green revolution have been beneficial for both small and large farming units, and thus some of the conclusions of early studies have been modified. The absence of social development can to a large extent be attributed to socio-political factors unconnected with the technology itself. Poor and hungry people do not need technology which increases food production, but better entitlement to food through access to land, employment income or remittances to improve their standard of living (Sen 1981, 1986). Lipton (1989) has recently summarized the discussions on the impact of the green revolution in Asia as follows: "Greening yes, revolution no".

Table 1. *Areas of wheat and rice in the developing countries,·mid-1980s*

	Wheat area, 1982-83			Rice area, 1982-82			Wheat and Rice area 1982-83			Maize area, 1983-86[f]		
Region	Total mn. ha	MVs	%MVs	Total mn. ha	MVs	%MVs	Total mn. ha	MVs	%MVs	Total mn. ha	MVs	%MVs
Asia (non-communist)[a]	32.1	25.4	79.2	81.1	36.4	44.9	113.2	61.8	54.6	44.1	15.7	35.5
Asia (communist)[b]	29.1	8.9	30.6	41.2	33.4	81.0	70.3	42.3	60.2[c]	27.0	19.2	71.1
Near East[d]	24.8	7.6	30.6	1.2	0.1	8.4	26.0	7.7	29.6	5.1	2.4	46.4
Africa[e]	1.0	0.5	50.6	4.3	0.2	4.7	5.3	0.7	13.3	29.0	14.9	51.3
Latin America	10.7	8.3	77.6	7.6	2.5	32.9	18.3	10.8	59.0	50.5	27.3	54.0
All LDCs	*97.7*	*50.7*	*51.9*	*135.4*	*72.6*	*53.6*	*233.1*	*123.3*	*52.9*	*178.0*	*79.4*	*44.6*

Source: Lipton with Longhurst 1990

Notes: MV = modern varieties

[a]Excludes Taiwan and West Asia.

[b]Excludes North Korea. Incomplete estimate for short varieties in China.

[c]Corrected from 58.0.

[d]North Africa, West Asia and Afghanistan.

[e]Excluding the Republic of South Africa and North Africa; including Sudan.

[f]1985–86 area in MVs as proportion of 1983-85 average area harvested.

Wheat and rice MVs are almost all semi-dwarf (a few intermediate height) and derive, respectively, from CIMMYT and IRRI or CIAT, or from national developments of these or similar progeny. Maize MVs are commercially purchased—either hybrids or else open-pollinated varieties released later than mid-1976.

The green revolution varieties were bred to be highly responsive to the application of external inputs such as fertilizer, pesticides, water (irrigation) and additional labour. A central reason why the impact of such improved varieties has been huge in Asia, while generally less relevant in an African context, is that the conditions for production are fundamentally different in the two continents. Asia at the time of the green revolution could be characterized as having land shortage and labour surplus. In Africa, the situation is different in that large areas of the continent have land surplus, while labour availability is commonly scarce. Moreover, employment opportunities in the non-agricultural sector in Africa have clearly been more favourable than those available in the agricultural sector.

Another important reason is that areas which have adopted highly responsive varieties in Asia are relatively homogeneous, and are to a large extent based on irrigation. The absence of irrigation on any larger scale in Africa means that improved varieties must adapt to a diversity of environments and farming systems.

Standardization cum diversification in scientific plant breeding

Introduction of farming systems research into African research programmes over the last decade has mainly been the result of initiatives from donor organizations, which have also financed most of these new programmes. It is likely that many of these plant breeding programmes, which aim to develop varieties which are adapted to specific local conditions, will not have commercial interest for the seed industry.

The seed industry continues to develop its own varieties and to influence government plant breeding programmes. The three main bases of the seed industry are discussed in the following: 1) emphasis on hybridization; 2) emphasis on vertical resistance to pathogens; 3) emphasis on yield stability over wide areas.

1. Emphasis on hybridization

Because of the progeny of hybrid seed, it cannot economically be saved and replanted, as it is genetically unstable and the saved seed will be of highly variable quality. Hybrid seed has therefore use value and exchange value for the peasant only as grain, not as seed.

Discovery of hybridization was of importance for the involvement of private seed industries. Because of hybrid vigour, these seeds could potentially out-yield the conventional cross-pollinated or open-pollinated varieties. The yield potential combined with farmers' need to buy seeds annually, secured a market for the industry. Since the individual seed company could protect the parent inbred lines of its commercial hybrid seed from competitors, the industry had a strong incentive to invest research efforts in development of hybrid varieties as opposed to non-hybrids.

For a number of technical reasons,[1] hybrids have only been possible for cross-pollinated crops, such as maize, sorghum, millet, sunflower, faba beans and pigeon peas. Hybridization in Africa has especially been important for maize, for which the national seed companies have followed the same trend as western countries and concentrated research and multiplication efforts on hybridization rather than on open-pollinated seed.

Hybrid seed may be an appropriate type of seed, even for resource-poor African peasants, if a number of conditions are satisfied:

1. The national seed industry should able to ensure a stable sufficient supply of hybrid seeds to the farmers. It is a major problem that many African national seed industries suffer from limited capacity due to inefficient management and shortages of spare parts etc. Peasants have thus experienced an erratic supply of hybrid seeds, and unlucky peasants have to rely on second generation hybrids or local landraces. This can be difficult if dependency on hybrids has been established.

[1]Because of the natural mechanisms of self-pollinated crops, it is complicated and expensive to manipulate these crops on a field scale to produce hybrids. The notable exception to this is rice, for which hybrid varieties have been available in China for over twenty years, although they have not spread to other rice-producing countries. See Cromwell, Friis-Hansen and Turner (1992:15).

2. The seed industry should be able to supply hybrid seed before the optimal planting time. There are typically only two to three months from the time of harvesting the hybrid seed to the optimal time of planting. This implies that the national seed companies have to be efficient in processing and distributing the seed to farmers. As this is seldom the case in Africa, many peasants experience crop losses due to late delivery of hybrid seeds.
3. Hybrid seeds need to be sold at a competitive price, for maize typically double the grain price. Because of the high degree of centralization of national seed industries in Africa, and the exorbitant and ever increasing transport prices, hybrid seeds are often an unnecessarily expensive type of seed for peasant communities.
4. Hybrid seeds are only an appropriate option for Africa if they are offered in competition with non-hybrid improved varieties and well established landraces. The plant breeding and seed industries have strongly emphasized hybridization, often at the expense of developing improved open-pollinated varieties, and the only alternative to hybrids has thus been the existing local landraces. As discussed in the next section, the availability and quality of local landraces varies greatly, both geographically and between crops.

2. Emphasis on vertical resistance to pathogens

Different forms of resistance are bred into the seed against attacks from pathogens such as insects, virus, bacteria and fungus.[1] There exist two qualitatively different forms of resistance to pathogens: vertical resistance and horizontal resistance. Vertical resistance can be defined as resistance that is "monogenetic, pathotype-specific and liable to fail in the face of the evolution of new pathotypes". Horizontal resistance can be defined as "resistance that is pathotype-non-specific and generally polygenic as to genetic control" (Simmonds 1991:190).

Scientific plant breeding and the seed industry have been strongly biased towards developing vertical resistance into improved varieties. There are obvious economic incentives for the seed industry to engage in the development of vertical resistance into their improved varieties. On the one hand, vertical resistance provides total immunity against specific pathogens and thus ensures maximum productivity. But on the other hand, vertical resistance only lasts for a certain period of time, after which it has to be replaced by another vertical resistance thus creating a continuous demand for *commodities* of new improved varieties with new vertical resistances.

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[1]The technical information in this section is largely based on an excellent recent article entitled "Genetics of Horizontal Resistance to Diseases of Crops" by N.W. Simmonds, printed in *Biological Review*.

> The great attraction always was (and is) that an effective vertical resistance gene coffers immunity, that is, total resistance or a state of no disease. In general, this state can only be achieved and sustained by relentlessly efficient breeding programmes devoted to introducing new vertical resistance genes into new cultivars at least a little faster than the pathogen can generate new pathotypes... . Biffen noted in 1903 that immunity to a prevalent wheat yellow-rust pathotype was determined by a single recessive gene, in fact a vertical resistance gene that later failed. Since that time, and especially in relation to the airborne fungal pathogens of inbreed cereals, hundreds of other vertical resistance genes have been used and failed. (Simmonds 1991:191)

The bias towards vertical resistance has gone hand in hand with the use of agrochemicals (insecticides, herbicides and fungicides), with which the industry has offered commercial farmers an unprecedented level of control over nature. It is recognized beyond doubt that the use of agrochemicals (and especially the metallic ones) is in the long run socially and environmentally detrimental. It is not only scientific plant breeding and seed industries which have been strongly biased towards vertical resistance, also scientists have focused on vertical resistance while disregarding horizontal resistance.

> The literature is, historically, heavily biased towards vertical resistance because of its general simplicity, its many and spectacular failures, concentration of the rust of inbred cereals and sheer plant pathological habits. In the limit, this bias has led to the implicit view that horizontal resistance is somehow not real resistance and that only a vertical resistance immunity (however transient) is true resistance. (Simmonds 1991:192)

This bias has its roots in the evolution of biological science, as explained by Simmonds (1991:190):

> The emergence to general attention, in the early years of this century, of Mendelian genetics was, it would generally be agreed, a key event in the history of science. Along with Darwinian ideas and statistics (which seriously penetrated biology only in the 1920s) the outcome was neo-Darwinian evolutionary theory... . Plant breeding was penetrated by biometrical ideas only lately (little before the 1950s) but plant breeders, usually with large families to look after, were perfectly accustomed to seeing Mendelian segregation.

In contrast to vertical resistance, horizontal resistance is not based on Mendelian segregation.

> Critical evidence of horizontal resistance is always genetic in nature and depends upon the demonstration of non-Mendelian, continuous distributions of response that are amenable to biometrical proof of heritable components of variability. (Simmonds 1991:195)

3. Emphasis on yield stability over wide areas

As is discussed further below, the seed requirements of peasants in Africa vary greatly according to the specific agro-ecological environment, farming system and social, cultural and economic preferences of the peasant households. As it is not economically viable for the seed industry to produce the wide range of seed required by different groups of peasants and commercial farmers, it has developed methods of plant breeding designed to enhance the size of the market of improved varieties.

Plant breeding has focused on the development of varieties with a high level of yield stability under different agro-ecological conditions. Instead of developing varieties which are adapted to specific agro-ecological environments, cross-country yield stability is a major selection criteria for choosing between varieties when tested in multi-location advanced variety trials.

It is likely that the interaction between variety and environment is high in Africa, where the diversity of agro-environments is considerably higher than in Asia. In Asia, the green revolution had succeeded in terms of increasing yields because of the large homogeneous areas under irrigation. In an African context, however, selection for yield stability over wide areas are most certainly resulting in lower average yields than would be achieved if selection were made for local agro-ecological environments.

From Farming Systems Research to Farmers' Participatory Research

This section discusses the recent conceptual development of agricultural research. Farming systems research was developed as a critique of the inadequacy of conventional agricultural research in developing countries, and in Africa in particular, to produce results which were appropriate for resource-poor peasants. Farming systems research includes a broad spectrum of activities concerned with interdisciplinary programmes of on-farm trials, socio-economic surveys and methods of communication between farmers and scientists. Farming systems research includes the following features and aims:

1. an empirically based, applied problem-solving approach to agricultural research;
2. a holistic 'systems' approach, in which problems identified for a particular crop are diagnosed in relation to production of other crops, household consumer preferences, access to credit and external inputs, off-farm income etc.;
3. aims, rather than at developing generally adaptable solutions, at solutions tailored to relatively homogeneous groups of farmers within specific agro-ecological zones;
4. an inter-disciplinary method involving both natural and social scientists;
5. a dynamic research approach in which the research priorities and extension messages are intended to be continuously reviewed in the light of the generation of new knowledge about farmers' behaviour and priorities;
6. a participatory off-station research approach, including socio-economic and technical surveys and on-farm trials, which aims at ensuring links to basic research.

During the late 1970s and early 1980s, a number of farming systems research manuals were developed by the international agricultural research institutes and donors involved in agricultural research (Merrill-Sands 1986). These cover a wide range of approaches from commodity oriented research to research covering the whole farming system. One prominent approach developed by CYMMIT is *on-farm research with a farming system perspective*, which aims to generate technology to increase resource productivity for an identified group of farmers, based on a concept of farming systems perspective and using on-farm research methods (Byerlee et al. 1982). Many of these manuals for farming systems research are based on schematic step procedures which allow the researcher to start at different levels of knowledge about the farming system and socio-economy of the target group of farmers. Such a schematic approach is shown in figure 3.

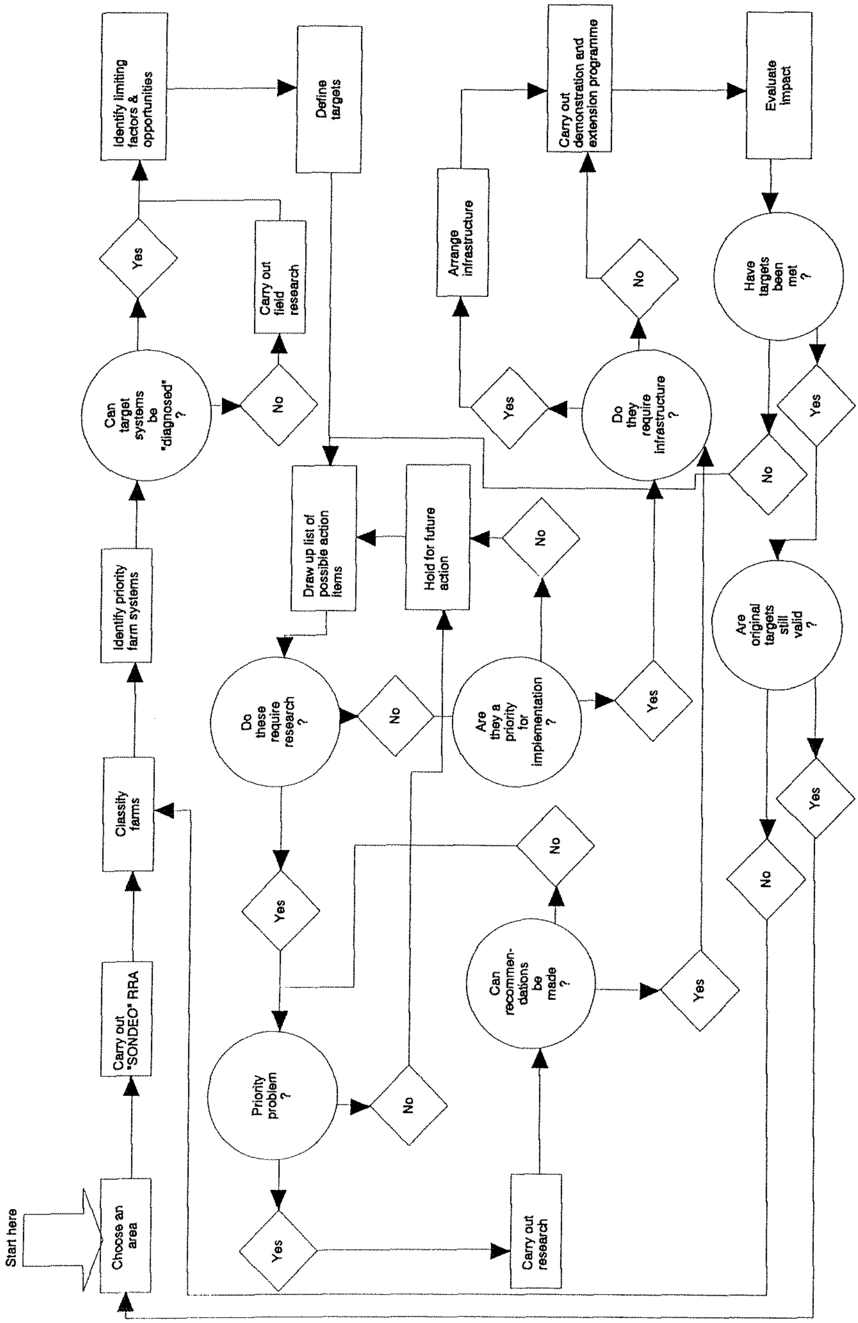
The farming systems research cycle can be reduced to five major stages (Maxwell 1983):

1. Classification of relatively homogeneous groups of farmers with regard to socio-economic characteristics, resource constraints and agro-environment. The classification has implications for setting the priorities of the research programme, design and location of trials and economic recommendation domains.
2. Through diagnostics, production constraints and technical options for the target group of farmers are identified.
3. If technical solutions exist 'on the shelf', recommendations draw on these; if not, technology has to be developed through on-farm and/or on-station trials.
4. Implementation of the technical solution is often included in the mandate of farming systems research, either through diffusion of technologies or through generating advice to be used by extension service.
5. As farming systems research is participatory in nature, evaluation of achievements plays an important role in most farming systems research manuals. According to these manuals, evaluations should result in reappraisals which can initiate a new cycle of farming systems research.

A crucial question in the implementation of such a farming systems research cycle is the extent to which it is able to capture the processes of change in peasant societies. A clear pitfall of such a schematic approach is that it can reduce reality to a static picture, in which socio-economic as well as technical constraints are placed in their respective boxes. The use of *farmers' participatory research* instead of formal household surveys as field work methodology can further limit the in-depth understanding of on-going processes of change.

The interdisciplinary nature of the farming systems research teams have given rise to a range of problems:

Figure 3. *Steps in a farming systems research cycle*



> Agronomists are not familiar with economists arguing the case for using one set of fertilizer levels rather than another. Economists, on the other hand, are generally not used to being told what survey information is needed in order to influence a technology planning decision. Social scientists are otherwise taught to be critical evaluators, standing in the side lines, but rarely trained to share the responsibility for what technology is generated and disseminated. (Biggs 1985:7)

Communication, flow of information and reactions to information, among the members of the farming systems research team and between the farming systems research team and conventional commodity research programmes is crucial for success. Integration of farming systems research into the national agricultural research institutions in Africa has experienced serious problems in this regard. Information flow from young economists working in newly established, donor-funded farming systems research units has had little impact on old established, commodity-oriented research programmes. Although the farming systems research unit in theory should be important for determining the priorities of the agricultural research programmes, reality is very different.

A number of institutional factors limit the efficiency of farming systems research in Africa. Farming systems research units have frequently been administratively placed under departments other than the one conducting the agricultural research. This has complicated communication and the decision-making process. Moreover, scientists have little incentive to participate in farming systems research under the present institutional system.

> Traditional evaluation procedures for researchers dictate the production of a number of articles published in referred journals. The numbers of meetings and popular publications are criteria for extension personnel. Neither meetings nor publications is the primary objective of the farming systems research/evaluation approach. (Hildebrand 1982:906)

This general statement is supported by a review of farming systems research in Eastern Africa, which argues that a main reason for the low activity level of farming systems research is that this form of research offers little merit for the careers of local researchers (Collinson 1982). In fact, farming systems research has been funded to a large extent by donor organizations, and to some extent also carried out by expatriate staff.

The theoretical development of farming systems research since the mid-eighties has been very limited, and since then the emphasis has been on empirical work. A considerable number of farming systems research studies have been undertaken. Meanwhile, there has been increasing recognition of what has been termed *indigenous technological knowledge*. An impressive number of studies have emerged that stress the fact that peasants have a wealth of knowledge about their farming systems. It is today a recognized fact that indigenous technological knowledge is not traditional, but that peasants are constantly experimenting and are highly skilled at adapting technologies to their micro-environment. It is yet to be shown how this knowledge can be used by the formal agricultural research system. Some writers have recently suggested that the recognition of indigenous technological knowledge should lead to a re-orientation of agricultural research (Richards 1985; Chambers and Jiggins 1986). The argument is that many failures in technological development have been caused by researchers' inadequate understanding of the peasants' situation. This also applies, to some extent, to farming systems research, which has essentially remained a 'top-down' approach, despite the participation of peasants in the research process.

Peasants have detailed knowledge about their environment and have over time developed refined production strategies which adapt their household objectives to the resources available. While acknowledging the importance of formal agricultural research for understanding the dynamics and rationale of existing farming systems, some researchers question the extent to which formal agricultural research can make use of indigenous technological knowledge.

> Observations will generally be more valuable than their explanations, and the criteria they apply for selecting new technologies more exacting than their experimental methods. (Tripp 1989:7)

When analysing the possible role of indigenous technological knowledge for the formal agricultural research system, one can distinguish between three different stages in the research process: diagnostics, experimentation and evaluation.

Farming systems research applies a number of informal survey methods for the purpose of utilizing indigenous technological knowledge during the diagnostic phase. This approach aims at establishing a continuous dialogue between farmers and scientists, rather than attempting to arrive at a specific solution to the problem at hand.

Informal survey methods have been developed and refined during the 1980s under the umbrella of farmers' participatory research. During the evolution of these methods, the emphasis has changed from rapidity to participation in the process by the farmers, and the name has changed from 'farmers' participatory research' to 'participatory research appraisal' (Freudenberger and Gueye 1990). These methods include group meetings, participatory observations, development of problem lists, ranking exercise and drawing of various types of diagrams and thematic maps with the active participation of farmers.

Farming systems research has proved to be more hesitant in involving farmers in the design, implementation and evaluation of experiments. To the extent that experiments have been conducted on-farm, their design and management have tended to be carried out by scientists, allowing for little influence by farmers.

The aim of on-farm trials is ideally to test innovations under actual farm conditions. The design of on-farm trials can be more or less managed by the scientist. To be comparable with on-station trials, non-experimental variables such as date of planting, seeding rate, or choice of intercrop are often determined by the scientist. Even if the scientists make efforts to duplicate the farmers' management practices, such predetermined decisions

> ...eliminate the possibility of the experiments being managed with the judgement that farmers usually apply, conditioning their weeding practices, for instance, to the amount of weed growth. (Tripp 1989:13)

When farmers conduct their own experiments, they adjust the design on the basis of sequential decisions made as the season progresses. Faults in the design of on-farm trials have often resulted in useless results. Work needs to be done with regard to defining the limits of flexibility for experimental design, and reaching agreement with the cooperating farmers about responsibilities during the experiments.

Evaluation of experimental results of farming systems research has usually been done by scientists, excluding farmers' opinions. The reason for this is the conviction that farmers' evaluations will vary between households, depending on their specific situation, and that their judgements are not sufficiently exact. But the final evaluation of a given innovation lies with the farmers, when they decide whether or not to adopt it; therefore, a dialogue should exist between farmers and scientists, also in the evaluation phase.

Indigenous plant breeding

As farming system studies have become more widely applied in communities throughout the developing countries, indigenous knowledge has become increasingly acceptable among academics. Richards concludes, in a recent literature review (Richards 1989:19–25), that the existence of peasant experiments, innovations and adaptive practices is now commonly accepted. The majority of examples of peasant experiments discussed in the literature are concerned with peasants as plant breeders.

This section discusses the basic methods and objectives of indigenous plant breeding, the factors limiting its efficiency, and compares the positive and negative factors of indigenous and scientific plant breeding.

Basic methods and objectives of indigenous plant breeding

Mass selection is the basic method used in indigenous plant breeding. The peasant selects seeds from his own fields, either before or after harvest. The selection is based on direct assessment of either whole plants or the economic part of it, according to the breeding objective of the peasant. The peasant thus selects on the basis of phenotypic characteristics (characters which are easy to observe) and not the genotypic characteristics used by scientific plant breeding. Observed variation is caused by the combined influence of environment and genetics. Mass selection as a method of plant breeding is only efficient in breeding for characteristics with high inheritability, which is a measure of the contribution of genetic variation to the total variation (Berg et al. 1991:16).

Indigenous plant breeding has not managed to breed varieties which are highly responsive to external inputs and which meet the demand for increased productivity. The strength of indigenous plant breeding is its ability to adapt varieties to the specific cultural, economic and social requirements of peasant societies and farming systems. Plant breeding objectives of indigenous plant breeding can be divided into four groups: adaptation to specific local agro-ecological environments; adaptation to specific household preferences; adaptation to resource-constrained farm management conditions; development of horizontal resistance to pathogens.

A primary objective of indigenous plant breeding is to adapt landraces to specific micro-level agro-ecological niches. These niches may be both natural and man-made. Through enhancing the agro-ecological micro environment, peasants throughout the world have increased agricultural productivity. A common example is inter-cropping, which enables the peasant to harvest several crops from one field while minimizing the risk of failure of the entire crop.

Adaptation of landraces to household preferences through indigenous plant breeding includes such characteristics as: ability to be stored in the household without chemical treatment; palatability in relation to local recipes or cultural ceremonies; suitability for specific methods of processing and for specific end uses, such as locally brewed opaque beer.

The third group of objectives of indigenous plant breeding is adaptation of landraces to farm management practices such as fallow rotation, methods of tillage, planting, weeding and harvest. These include characteristics such as time of maturity and ability to compete with weeds.

Horizontal resistance to pathogens is generally high in varieties developed through indigenous plant breeding, because of the high intra-varietal variation commonly found in landraces. Simmonds (1991:223) stresses six important features of horizontal resistance:

1. Horizontal resistance is polygenetically determined and its expression always has an error/noise component.
2. It only rarely reaches immunity or a state of no disease. In fact, it can vary from very susceptible to varying degrees of resistance (but not immunity).
3. It is pathotype non-specific.
4. It is durable because of low interaction with pathogens. It is the consistent interactions of vertical resistance which lead to adapted pathotypes and subsequent failure of resistance.
5. It consists of a number of components describing a state of less disease, without any indication as to the mechanism for bringing this state about. These components include resistance to infection, delay of infection, reduced growth of pathogen (after infection) and reduced reproductive capacity of the pathogen.

6. To a varying degree, it is developed in all crops against diverse pathogens including insects, fungi, bacteria and virus. Horizontal resistance is highly effective in suppressing great numbers of potentially damaging diseases at economically trivial levels, even though its very presence often goes unrecognized.

To summarize the advantages of horizontal resistance: It provides the peasant who cannot afford chemical control with a robust, cheap and reliable resistance to pathogens. Moreover, it reduces the risk of crop failure generated by failed vertical resistance.

Factors influencing the efficiency of indigenous plant breeding

Indigenous plant breeding selects and recombines wanted landraces from the intra-crop bio-diversity within a given geographical area. The availability of diversity to choose from, and the nature of this diversity, varies greatly between different geographical areas, depending on two distinctly different processes.

First, bio-diversity is not equally distributed in the world. During the 1920s, the Russian biologist Vavilov developed the concept of 'centre of origin' and constructed a map over the centres of origin for the world's major crops. Each centre of origin is characterized by the existence of wild relatives of the crops and long traditions for domesticating them. Moreover, there is a continuous gene flow from the wild relatives to the landraces through introgressive hybridization.[1]

There are thus major differences in the bio-diversity available for indigenous plant breeding of maize in Mexico, which is the centre of origin of maize, and Zimbabwe, where maize has only been grown for little more than one century.

Secondly, there are differences in the nature of the intra-crop diversity. In areas where the introduction of improved varieties have had a major impact, this have led to a widespread process of genetic erosion of the indigenous landraces. This process has not only led to the extinction of a wealth of genetic diversity maintained through indigenous plant breeding, but moreover has greatly limited the future options for indigenous plant breeding in the areas, since the diversity from which to select has diminished.

The green revolution has furthermore resulted in introgressive hybridization from improved varieties to landraces. In Tanzania, this is described as a qualitatively different type of genetic erosion, as characteristics of hybrid maize are unintendedly transferred to local landraces.[2] Gene transfer from

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[1] Introgressive hybridization means transfer of genes between two distinct taxonomic species through inter-specific crossings and recrossings between hybrids and the parental species (Berg et al. 1991:6).

[2] Friis-Hansen (1987): The study shows that cross-pollination from long-season maize to local short-season landraces has tended to increase the time of maturity of the local landraces. The local landraces of maize are bred for short season through indigenous plant breeding to

improved varieties can also increase genetic diversity available for indigenous plant breeding. Paul Richards describes how rice cultivators in Sierra Leone purposely cross improved varieties with local landraces in order to combine the advantages of each.[1]

There are finally major differences in the efficiency of indigenous plant breeding, depending on whether a crop is self-pollinated, cross-pollinated or vegetatively propagated. Self-pollinated crops are easy for indigenous plant breeding to handle, because they naturally exist as a pure line and are genetically homozygous. If variability does occur, it can normally be eliminated in the process of rouging. No isolation is required for self-pollinated crops, other than the physical barrier sufficient to avoid any confusion between landraces at the time of planting and harvesting. While rice plays a major role in West Africa, self-pollinated crops have traditionally played a minor role in East and Southern Africa.

Cross-pollinated crops are more difficult for indigenous plant breeding to manage, as they are highly prone to contamination from foreign pollen. The possible distance of cross-pollination varies among the cross-pollinated crops, from a few hundred metres for maize and up to two kilometres for sunflower. In Tanzania, some peasants are reported to have a clear knowledge of isolation in time or space.[2] Cross-pollinated crops are also highly variable as a result of their genetic composition. The genetic variability within an open-pollinated landrace is often high and not easily maintained over time by indigenous plant breeding, because it tends to become more variable with successive multiplication. Because genetic variability is already high in landraces, unintended contamination by foreign pollen is not easily detected. The height of a crop such as maize makes rouging a more difficult task than does a self-pollinated crop such as rice.

Indigenous plant breeding is easy for vegetatively propagated crops. While indigenous plant breeding of Irish potato in Latin America is well documented, little research is done on indigenous plant breeding of African vegetative propagated crops such as sweet potato and cassava. A major problem for indigenous plant breeding of vegetatively propagated crops is the rapid build-up of pathogens (virus, fungus and bacteria) if no new diversity is introduced in a given area for a period of time.[3]

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provide food security for peasants in areas with low and uncertain rainfall regimes. The increased length of time to maturity because of unintended cross-pollination from long-season hybrids results in crop losses, because part of the fields with local (genetically eroded) landraces fail to mature because of insufficient rain.

[1]Personal communication 1991. A comparison between field work conducted in 1983 and 1990 by Paul Richards will be published in a forthcoming book.

[2]Friis-Hansen (1987). Tanzanian peasants isolate in time by ensuring that pollination is not synchronized for varieties planted close to each other. Isolation in space is also known, but less easily practised, as villagization and intensification of land use have made it virtually impossible to ensure sufficient distance between maize fields.

[3]Personal communication with Dr. Ian Robertson, Department of Crop Science, University of Zimbabwe.

Box 5. Complementary objectives of indigenous and scientific plant breeding

Two independent systems of crop improvement continue to exist in most developing countries, each with their own exclusive linkages for the management of plant genetic resources. These are characterized by Hardon and de Boef (1993) as:

> ...a formal institutional system involving international agricultural research centres (IARCs) and other regional and commodity-oriented centres, national research systems and private industry, linked to farmers through extension services and marketing in a linear model of technology development and transfer. The emphasis is on maximizing yields and use of external inputs with the main objective of solving macroeconomic and national needs for more food.
>
> ...an informal system at the farm level using and developing crop diversity through local landraces and seed production and distribution at the community level. The major emphasis is on yield stability, risk avoidance and low external input farming.

There is an urgent need to explore the comparative advantages of these two systems in order to provide better options for plant breeding and conservation of plant genetic resources. Hardon and de Boef point out three areas where more research is required to provide better support and improved management of plant genetic resources, and crop improvement at the local level, while maintaining the inherent characteristics of these systems:

Selection criteria. Only scant data are available which compare the performance of improved varieties with that of local landraces on farmers' fields, under farmers' management and utilizing farmers' evaluations. Hence, the factors which result in farmers preferring local landraces over improved varieties are not very well understood. There is also a need to better understand how farmers select material for the following year's crop, their selection criteria and the effectiveness of this selection. Finally, the methods which farmers use for field testing, data recording, and the conscious utilization of techniques such as introgression and hybridization need to be researched and documented.

Local specificity. The literature often suggests that specific local adaptation of landraces is important, particularly in more marginal environments in low-external-input agriculture. In locations where specific climatic factors prevail over long periods of time, local adaptation may be a logical consequence of local selection. However, where factors such as the onset of rain and differences in field size vary between years, local selection may well favour a degree of broad adaptability. Emphasis on yield security rather than maximum yield could also favour broad adaptability rather than local specificity, especially when desired secondary characteristics prove to be less environmentally sensitive.

Abiotic and biotic stress factors. It is generally assumed that genetic diversity within landraces and between crops in cropping systems provides a form of natural protection against both biotic and abiotic stresses. Local knowledge systems of maintenance of crop diversity, seed production and storage need to be investigated, assessed and compared with modern plant breeding methods.

Comparison between indigenous and scientific plant breeding

Indigenous plant breeding and scientific plant breeding are two different methods of research which

> ...should be acknowledged as what they are, two qualitatively different approaches which have evolved under different circumstances, each with its merits and clear limits.... The formal research with crops usually involves field trials according to some kind of randomized and replicated experimental design. If soils and other environmental factors are uniform, the methodology is a powerful way of detecting even small differences between treatments. The indigenous researchers do not know any such methodology. Their experiments are informal and results are usually recorded as qualitative assessments rather than quantitative measurements as in formal research. (Berg et al. 1991:11)

The problem of the experimental design of scientific plant breeding in Africa is that it is done in a farm management environment that is very different from that of resource-constrained peasants. The assumption that the various farm management factors can be studied in isolation results in the development of varieties which make high demands on the user in terms of farm management, if the full potential of a variety is to be achieved. Experiments in indigenous plant breeding, however, are conducted in the actual resource-constrained environment of the peasant, where he or she makes sequential farm management decisions as the season evolves. The peasant thus draws his or her conclusions on the basis of an overall qualitative assessment of the performance of the tested variety.

Chapter 4
Agriculture in Zimbabwe

History of the agrarian structure

Southern Rhodesia, as envisaged by the British colonial power, was to become a mining-based economy similar to that of South Africa. To force the local population of Ndebele and Shona tribes into the money economy as wage labourers or as producers of market food crops for the mines, a hut tax was imposed during the 1890s. Until this introduction of taxation, commodity production had only taken place to a very limited extent.

By the end of World War I, the colonial administration had realized that mining potential was limited and opened the country instead for white settlers to whom large farms were sold cheaply. Roughly speaking, half of the total potential agricultural land was allocated to white settlers, and the African population occupying it was resettled on the so-called native reserves. Not surprisingly, the vast majority of land of high agricultural potential with sufficient and stable rainfall was allocated to white settlers, while lower altitude, semi-arid and predominantly sandy areas were allocated to the reserves. By the end of 1930s, the whole of Southern Rhodesia was demarcated into four land classes: European areas, native reserves, state land and national parks.

During the following forty years, until independence in 1980, the colonial administration and later the Unilateral Declaration of Independence regime, carried out a policy which combined subsidies to the settler farmers with racially discriminatory measures as protection against competition from the native reserves. The policy had four major components:

- continued alienation of land occupied by the African population
- infrastructural development which served the European areas only
- orientation of agricultural research, extension and input supply systems towards the settler farming sector only
- discriminatory pricing policy towards crops cultivated on the native reserves (later called Tribal Trust Lands and after independence renamed communal areas)

Agricultural production units in the European areas, or large-scale commercial sector as it was renamed after independence, became profitable during the 1960s and 1970s only after decades of state subsidies and racially discriminatory practices. The demarcation of land confined the African population to overcrowded communal areas and secured a plentiful supply of cheap migrant labour. Moreover, labour was available during the periods when it was needed by the large-scale commercial farms and was not a burden on the profitability of the farms during off-season. Minimum salaries paid to migrant workers could be kept very low, as part of requirements of reproduction were met within the non-capitalist economy.

The migrant economy, cemented by the racist 'anti-land-reform', became over time increasingly important for the reproduction of the African peasantry. The population growth in the communal areas, and the resulting intensification of the land-use pattern, diminished the possibilities of survival with the use of existing technology. The reproduction of the peasant household was thus accomplished through a combination of subsistence agriculture and cash income from migrant labour. Agricultural production was undertaken primarily by female members of the household together with children, while migrant work was limited to men.

Post-independence agricultural policy

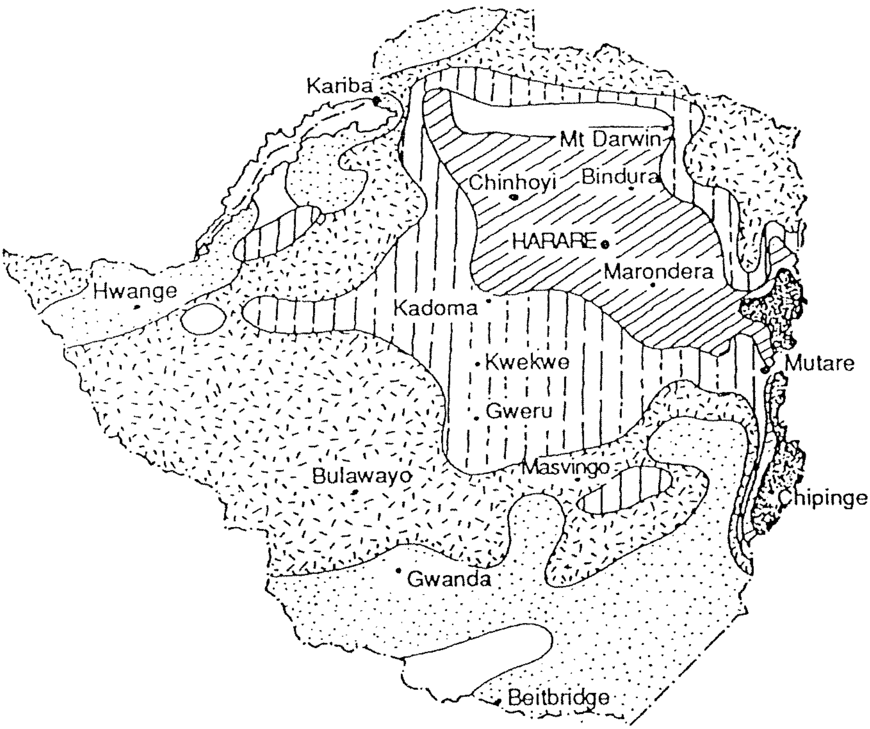
The policies important for the agricultural sector, including the moderate land reform, extension of agricultural services to the communal areas and attempts to reorganize the administrative structures within the communal areas, are discussed briefly in the following (see maps 1 and 2).

Land reform

After independence, the distribution of land between the sectors was extremely unequal, with some 6,200 large-scale commercial farmers controlling some 47% of the arable land, while approximately 700,000 households in communal areas were settled on about half of the land. The share of land owned by large-scale commercial farmers has today been reduced to 34% of total arable land cultivated by some 4,200 farmers. The pressure on land in the communal areas has increased as the population there has increased to an estimated one million families. A new sector of 52,000 resettlement farmers occupying 10% of the arable land has been created by the land reform.

This picture becomes even more striking when the quality of the land is taken into consideration. The proportion of high-potential land (Natural Regions (NR) I & II) controlled by the large-scale commercial farmers has been reduced from some two-thirds to 59% over the last decade. Meanwhile, some 90% of the communal areas and 80% of the resettlement areas are located in the areas of insecure rainfall (NR III, IV & V).

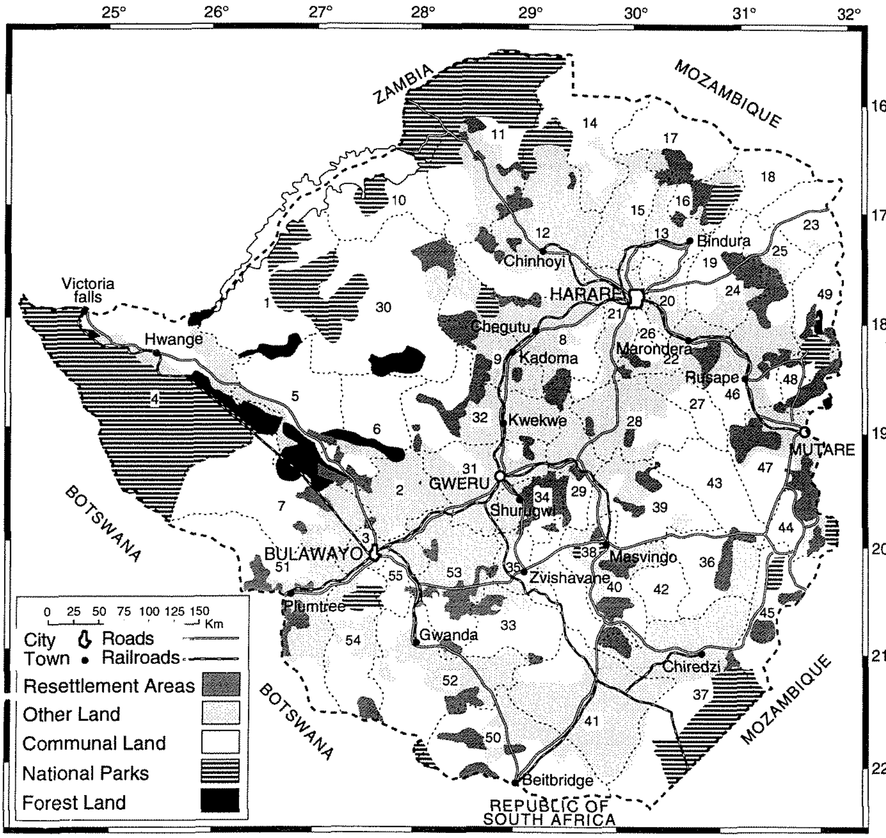
Map 1. *Zimbabwe's natural regions*



LEGEND

I	1.5% of the country's area. Very high rainfall (over 1000 mm). Low temperatures.	Specialized and diversified farming incl. forestry, tea, coffee, deciduous fruit, potatoes. Intensive beef and dairying.
II	19% of the country's area. High rainfall (700-1000 mm). Warm summer, cool winter.	Intensive farming of maize, tobacco, cotton, wheat, horticulture. Intensive beef and dairying.
III	17,5% of the country's area. Moderate rainfall (550-700 mm). Higher temperatures, dry spells.	Semi-intensive farming. Drought-resistant cotton, soya, sorghum. Beef rearing and breeding.
IV	33% of the country's area. Low rainfall (450-600 mm), seasonal droughts.	Semi-intensive farming. Drought-resistant crops under irrigation. Semi-intensive livestock.
V	29&% of the country's area. Very low rainfall (less than 500 mm). Very hot.	Extensive farming. Irrigation of lowveld sugar, citrus, cotton, wheat. Extensive cattle ranching.

Map 2. *Zimbabwe land classifications*



DISTRICTS

Matabele North
1 Binga
2 Bubi
3 Bulawayo
4 Hwange
5 Lupane
6 Nkayi
7 Nyamandhlovu

Mashonaland Central
13 Bindura
14 Guruve
15 Mazowe
16 Mukumbura
17 Muzarabani
18 Rushinga
19 Shamva

Midlands
28 Chikomba
29 Chirumanzu
30 Gokwe
31 Gweru
32 Kwekwe
33 Mberengwa
34 Shurugwi
35 Zvishavane

Manicaland
43 Buhera
44 Chimanimani
45 Chipinge
46 Makoni
47 Mutare
48 Mutasa
49 Nyanga

Mashonaland West
8 Chegutu
9 Kadoma
10 Kariba
11 Hurungwe
12 Makonde

Mashonaland East
20 Goromonzi
21 Harare
22 Marondera
23 Mudzi
24 Murehwa
25 Mutoko
26 Seke
27 Wedza

Masvingo
36 Bikita
37 Chiredzi
38 Chivi
39 Gutu
40 Masvingo
41 Mwenezi
42 Zaka

Matabeleland South
50 Beitbridge
51 Bulilimamangwe
52 Gwanda
53 Insiza
54 Matobo
55 Umzingwane

Table 2. *Land distribution by sector and natural region*

Sector	NR I	NR II	NR III	1990 NR IV	NR V	Total	1980 Total
LSCF	200	3690	2410	2410	2490	11220	15500
CS	140	1270	2820	7340	4780	16350	16400
SSCF	10	240	530	500	100	1380	1400
RS	30	590	1240	810	620	3260	NA
State farms	10	10	160	60	260	500	NA
Other	310	60	130	3640	2190	6360	4370
Total	700	5860	7290	14780	10440	39070	37670

Source: CSO, ARDA and DERUDE.
Note: LSCF: Large-scale commercial farms; CS: Communal sector; SSCF: Small-scale commercial farms; RS: Resettlement sector.

Combined, only about one-fifth of the small-scale farmers (CS, RS and SSCF) live in the higher rainfall areas (NR I & II). Another fifth live in the medium-potential areas (NR III) with sufficient rainfall for crop production but subject to occasional mid-season dry spells. Some 42% of the small-scale farmers live in NR IV, receiving 450–650 mm of annual rainfall and frequently subject to dry spells and drought. Finally, almost one-fifth of the small-scale farmers live in areas categorized as inappropriate for crop production (NR V), but nevertheless seek to grow crops for subsistence.

Background for resettlement

The liberation war was fought over the issue of land, and land distribution has since remained in the centre of the political debate. There is little disagreement over the fact that the inherited distribution of land in Zimbabwe is extremely unfair, and there is a good understanding of the historical reasons why. The political question today is rather concerned with the pace of redistribution, how far rectification can and should go and which form resettlement should take.

The legal guidelines for state acquisition of land for redistribution during the last decade were laid down in the Lancaster House Agreement that led to Zimbabwe's independence. This agreement contained a provision, not susceptible to amendment or repeal for a period of ten years, which protects the LSCF sector against land confiscation. The Lancaster House Agreement provides for compulsory state acquisition of land which is under-utilized for the purpose of resettlement, but farmers can require payment in convertible currency. Under-utilization is defined as failure to put the land substantially to appropriate agricultural use for a continuous period of three years, taking into account the extent of the development of the area. This provision has proved to be of little practical use, as it has been difficult to judge whether a particular area is under-utilized with such a broad definition.

The selection criteria for settlers was aimed at recruiting those most in need. The potential settler should be poor, in effect landless and have no formal employment. Even though some 60% of settlers have come from communal areas, a large proportion are ex-combatants and unemployed from towns with little practical farming experience. Also master farmers were given priority in the selection criteria, but as one of the conditions to become resettled is to give up all claims to land in the communal areas, only few in this category have been resettled.

The settlers are granted three permits, a permit to reside, a permit to cultivate and a permit to hold a given limited number of livestock. The form of tenure is highly insecure; the duration of the permits is uncertain; and the Ministry of Land, Agriculture and Rural Resettlement (MLARR) holds broad powers to terminate the permits with few rights of compensation for investments made by the farmer. Moreover, the question of who will inherit the land is not settled.

Models of resettlement

Three different models are used for resettlements. In model A settlements, each family is allocated 5 ha arable land and common grazing land to herd enough livestock to sustain its draught requirement. Each model A settlement is supposed to be serviced with schools, clinics, water supply and feeder roads to the market. The accelerated model A scheme emerging in 1982 is a model A scheme initiated without the necessary service structure. As shown in table 3, model A includes most of the settlers.

Model B schemes are cooperatives using the facilities of former commercial farms. The size of the model B schemes varies from 30 to 100 members who share all property, resources, equipment and livestock. All work is carried out collectively, and management and marketing are controlled by a cooperative committee. As shown in the table, the cooperatives occupy some 4.6% of the areas and less that 2% of the settled population.

Model C is a settlement scheme similar to that of model A but with links to a commercially run farm. The core estates are mostly ARDA farms but can be a model B cooperative. Less than 2% of the settlers are included in this model.

The pace of implementing the land resettlement scheme in terms of number of persons settled was strongest in the early stages of the programme. From 1981 to 1984, between 8,000 and 14,000 families were resettled annually. Since then, the level has been a few thousand settlers annually with the exception of 1988/89 when model B was boosted after many members had left the cooperatives the year before. Table 3 shows the rate of resettlement since independence.

Note that model A and C show number of families, while model B shows number of cooperative members. For some families settled in model B schemes, the husband, wife and grown children may be members of the cooperative.

Table 3. *Rate of resettlement since independence*

	Model A	Accel. A	Model B	Model C	Total	Annual
1980/81	1,881	–	90	–	1,971	1,971
1981/82	10,199	60	560	–	10,819	8,848
1982/83	21,740	420	2,678	160	24,819	14,000
1983/84	27,277	974	3,879	827	32,957	8,138
1984/85	30,214	1,017	4,558	827	36,616	3,659
1985/86	34,696	1,017	4,792	827	41,332	4,716
1987/88	37,816	1,417	2,842	507	42,582	1,250
1988/89	40,666	1,115	6,116	827	48,724	6,142
1989/90*	42,948	1,042	6,594	827	51,411	2,687
Households	83.5%	2.0%	12.8%	1.7%	100%	
Population	94.4%	2.1%	1.9%	1.5%	100%	
Area	89.5%	5.4%	4.6%	0.5%	100%	

Source: DERUDE 1990.
* July 1989

Future resettlements

The target originally set for resettlements was 162,000 families. By 1990, approximately 52,000 families had been resettled, 110,000 short of the original goal.

In its draft for National Land Policy, October 1989, MLARR maintains the target of resettling 110,000 more families on 6 million ha of the remaining commercial farm land. This would leave about 5 million ha in the LSCS as commercial strategic crop areas.

The plan's target is 15,000 families resettled per year, which would mean that the goal of 110,000 could be reached around 1997. The plan assumes that the average cost of resettling one family is about Z$5,000 (1989 prices). Of this, about 50% is for land acquisition, the rest for schools, clinics and other infrastructure.

The projections in the plan represent a considerable increase compared with the number of resettlements which have taken place during the second half of the 1980s. During the last five years, an average of about 3,700 families have been resettled per year.

The proposed land policy is presently being discussed in Zimbabwe.

Provision of credit

While credit facilities for farmers in the communal and resettlement areas are theoretically available from all the commercial firms or institutions in the country, in practice, these facilities are almost exclusively obtainable from the Agricultural Finance Corporation (AFC). The commercial lending institutes and the commercial trading firms are reluctant to invest in this sector, mainly because of lack of any security by the borrower and the absence of any tangible track record. Certainly in the early stages, some funds have been made available in some areas through various aid agencies and NGOs, but these have been mainly grants and usually of an establishment nature. Redd Baran has probably been the most active in this field.

The AFC is a government parastatal established through an act of parliament in 1971 which amalgamated the Land and Agricultural Bank, the Agricultural Assistance Board and some smaller quasi-government financial bodies. The AFC initially only operated in the commercial farming areas of the country, but in 1978 the act was amended to enable increased operations in the small-scale commercial areas and the Small Farm Credit Scheme (SFCS) was initiated to take over credit functions from the African Loan and Development Trust and the Agricultural Loan Fund. In 1979, the act was further amended to accommodate peasant farmers in the communal areas, and in the first year of operation in this sector, prior to independence, some 4,500 communal farmers obtained short-term loans for cropping expenses for the first time. In 1982, the government directed the AFC to extend credit facilities to farmers in the newly established resettlement areas, and the Resettlement Credit Scheme (RCS) was initiated. Credit facilities under this scheme were only available to farmers from the second year of settlement (the first year was financed by a government grant to individual farmers).

AFC credit facilities under the RCS are similar to those available to communal farmers under the SFCS and are mainly confined to short-term (seasonal) loans for crop expenses. These are made up of crop packs, drawn up according to Agritex recommendations for the various crops in various agro-ecological zones throughout the country. A cash amount is not usually made available, although there are exceptions when heavy demand is obvious for reaping expenses and when model B loans are involved. Medium-term loans (2–5 years) are available for capital items, such as draught power, equipment, fencing, water supply etc., but before such loans are approved, the borrowers' agricultural activities must be assessed to be adequate to enable repayment.

Loans under the RCS were initially granted by government directive to individuals with the AFC having no right of refusal, but from about 1986, the AFC has exercised some discretion in its grants. It was initially envisaged that loans would only be granted under the RCS for 3 years of operation (i.e. the second, third and fourth years of settlement), and that loans thereafter would fall under the SFCS, but in practice this has not happened—clients coming into the AFC fold under RCS have remained under RCS.

Loans are available under RCS to both individuals under models A and C and to cooperatives under model B—the latter for one loan, with individuals within the cooperatives being liable for repayment both individually and collectively.

Post-independence trends in peasant agricultural production, productivity and marketing

This section analyses the agricultural performance of the communal and resettlement sectors. Two crops within the small farmer sector, namely maize and cotton, have shown remarkable progress since independence in terms of production and marketed output. The area cultivated with maize has increased from about one-third of the total area during the pre-independence period to approximately half of the cultivated area during the 1980s. Cotton cultivated as a cash crop has expanded rapidly and the area has more than tripled over the eight-year period. As a result of these trends, the share marketed by the small-scale agricultural sector increased from some 15% in 1978 to 35% in 1988.

Over the same period, the area occupied by finger and bulrush millet declined; part of this area may have been allocated to maize. Most of the millet was substituted by the equally drought-tolerant sorghum.

Production of maize in the small farm sector was stagnant during most of the 1970s, except for years of drought (especially the 1972/73 drought). The area cultivated with maize varied only little over the same period and productivity remained stable at a low level of productivity (600–900 kg/ha).

Only two years after the end of the liberation struggle, the small farm maize production had more than doubled. This spectacular increase had largely been accomplished through a 100% expansion of the area cultivated with maize over this period (1979–1981), and is thus not significantly associated with yield improvements. The expansion of maize cultivation did not substitute other crops, but was instead related to a total expansion of the cultivated area by 25% (Rohrback 1989).

Most area expansion between 1979 and 1981 was closely linked with the transition from war to peace. Many new families settled and others returned to their land, since the restrictions against settlement were abandoned. Also areas formally designated for grazing were increasingly put under plough.

Maize production declined to its pre-independence level during the 1982–84 drought, and the 1985 harvest surprised many observers by being two-thirds higher than the 1981 record production level. This production increase can be explained as an overall improvement of yields. The average productivity level in the small farm sector had almost doubled in 1985 compared with the pre-independence level, and reached an average of 1400 kg/ha.

The small farm sector only accounted for a few percent of the marketed maize during the pre-independence period. Opening the market for small farmers resulted in a ten-fold increase in their maize sales in 1981. The marketed volume doubled again from 1981 to 1985, when the small farmers contributed more than half of the country's maize supply and over one-third of the official purchases (Rohrback 1989).

An analysis of desegregated data suggests that the increase in marketed production within the communal areas is very unequally distributed geographically. Certain areas (e.g. Mashonaland) have a much higher rate of commercialization. Table 4 compares the sales of 18 of the better communal areas with those of all 170 communal areas. It shows that the 18 communal areas (some 10%) accounted for well above half of the total maize deliveries to the Grain Marketing Board. During the period of drought, the marketed share from these communal areas was even higher, reaching 84% in the driest year (1983/84). Even though some areas in Mashonaland were selling surplus production during the drought years, the majority of the rural areas relied on food relief or purchase of food using non-agricultural income (remittance from migrant labourers etc.).

Table 4. *Disaggregated data on maize sales to Grain Marketing Board in communal areas, 1980–85 (metric tons)*

Communal areas	1980–81	1981–82	1982–83	1983–84	1984–85
All	66,565	290,488	317,884	137,243	335,130
18 best	37,744	160,998	221,631	115,946	279,000
18 best (%)	57%	55%	70%	85%	83%

Source: Grain Marketing Board Registry. Elaborated from Nick Amin 1988:35.

All the 18 best communal areas are situated in relatively favourable locations. The very unequal distribution among the communal areas of marketed surplus production can be explained primarily by the climatic conditions. Moreover, the climatically less favourable areas (NR IV and V) are also marginal in terms of infrastructure, marketing channels, extension, credit and accessibility of suitable improved varieties and appropriate sustainable technological innovations.

Recent case studies indicate, furthermore, that a significant social differentiation of production between households exists. The most commercialized farms tend to be those which are above average in size, own an above average number of cattle and are situated in a better area in terms of rainfall.

The post-independence growth in small-scale maize production has now ended and evidence suggests that the easy gains from expanding technology and market support through extension service have been achieved. The improvement of productivity through adoption of hybrid seed and fertilizer was primarily achieved in the high rainfall areas, although it has spread with some success to the more marginal areas. There are several reasons for the transformation of semi-arid areas into maize-growing areas: maize is less demanding than small grains in terms of labour; maize is easier to process and less susceptible to bird damage; and most important, maize has proven to yield better than sorghum and millet in most years. The extension service faces a tremendous challenge in the semi-arid areas, but has unfortunately few technological options to offer.

The number of registered cotton growers in Zimbabwe increased from some 800 large-scale commercial cotton growers before independence to

150,000 growers in 1986 and 200,000 growers in 1989. Cotton production from communal and resettlement areas increased from 37,000 tons in 1980 to 176,000 tons in 1989. The area with cotton increased between 1980 and 1989 almost ten times, while yield per ha over the same period increased only about 20%. The main cause of the increase in cotton output has thus been area expansion. Cotton production is roughly shared, with 45% to commercial farmers, 45% to communal and resettlement farmers and 10% to Agricultural and Rural Development Authority (ARDA) and small-scale commercial farmers (SSCF).

Food security

Zimbabwe has experienced large surplus production of maize since independence. With large volumes in storage, Zimbabwe is today nationally self-sufficient in grain. This achievement is mainly a result of the success of commercializing the small farm sector and increasing its marketed output. The level of maize purchased by Zimbabwe Grain Marketing Board has, with the exception of the drought years 1983 and 1984, been more than twice the level of the pre-independence years. During all years except 1984, Zimbabwe has been able to export considerable volumes of maize to neighbouring countries.

From the point of view of social science, food security can be classified in relation to who is affected. Food shortage on the household level is not always related to the production level or physical availability of food in the area.

> People die of starvation, or go hungry, not because there is no food in their country, but because they cannot afford it and have no other means of access... . Aggregate effective demand (demand with money to back it) is insufficient to draw it there from richer areas (or to prevent its outflow to such areas)... . To assure the food supply of poor people in Africa, as elsewhere, is both a matter of increased aggregate food supply and one of providing the means for them to produce their own food or earn the incomes with which to purchase it. (Raikes 1988)

Food security can be defined as access by all members of society to enough food throughout the year to lead an active and healthy life. *Access to food* can in the Zimbabwean context be defined as the ability of a household to acquire sufficient food for what is considered to be its needs, through subsistence production, purchase from the market or food transfers.

Even though Zimbabwe has had a large surplus food production for most years, maize production has fluctuated considerably from year to year, predominantly because of variation in weather conditions during the growing season. Also geographically, there are large variations in the food production level, basically correlated with the boundaries of the natural regions. Zimbabwe experienced a new drought during the 1986/87 season, which severely affected part of the country, while other parts experienced surplus production. Table 5 shows a break-down by province of people in need of food.

Table 5. *People registered to be in need of food (31 December 1987)*

Province	Number of people
Manicaland	617,159
Mashonaland Central	123,374
Mashonaland East	258,525
Mashonaland West	165,280
Masvingo	306,228
Matebeleland North	164,991
Matebeleland South	188,780
Midlands	478,326
Total, Zimbabwe	2,302,666

Source: Ministry of Labour, Manpower Planning and Social Welfare.
Elaborated from Takavarasha 1988:5.

The Zimbabwe government has implemented a number of emergency drought relief programmes, including food handouts, water supply schemes, seed supply, cattle rescue operations and a public food for work programme. More than Z$800 million were spent on internal drought relief from 1980–85. In 1982/83, the government bought 46,343 tons of maize for drought relief, which increased to 223,900 tons in 1983/84 (Takavarasha 1988). The food relief programme has effectively prevented major catastrophes of starvation in the rural areas, but at the same time its extent is a clear indication that household food security in many communal areas is highly vulnerable.

Chapter 5
Introduction to Silobela Communal Area

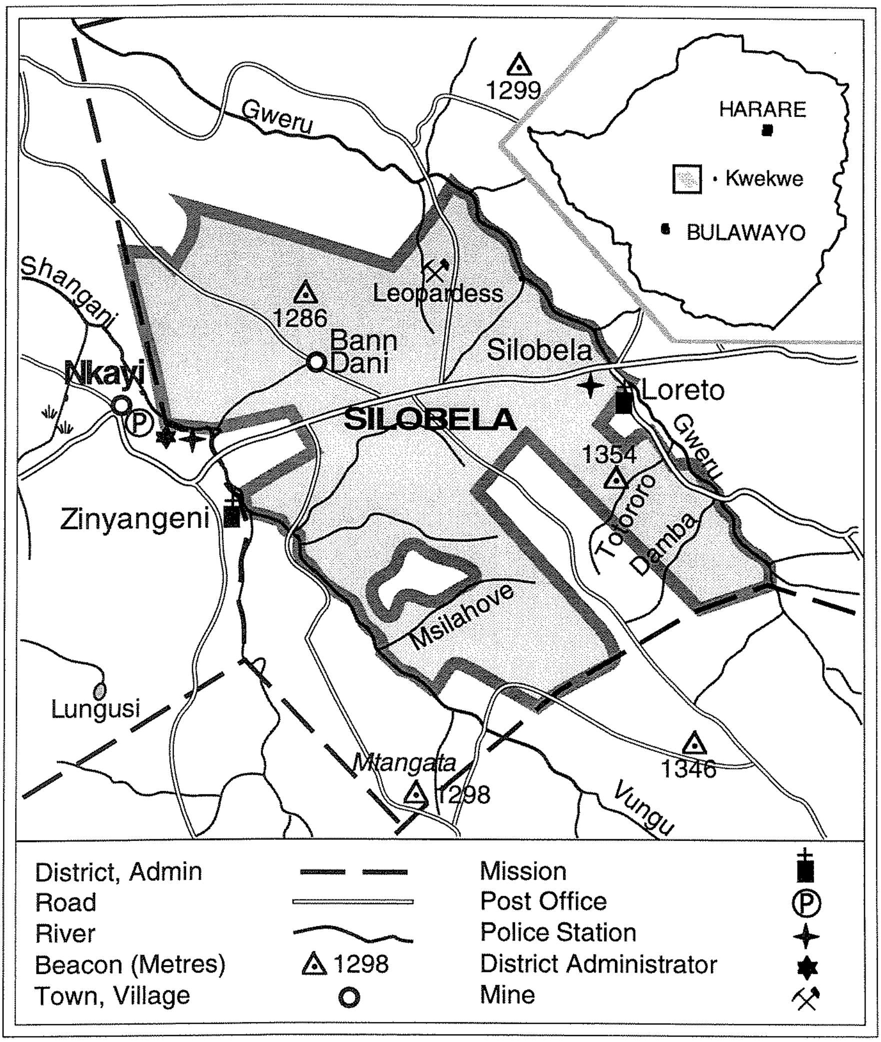
The study area

Silobela communal area is located in Kwekwe District, 80 km west of Kwekwe Town (see maps 3 and 4). It is bounded on the east by Gweru river, and to the west by the Vungu and Shagani rivers. To the south, Silobela communal area borders Lower Gweru communal area and to the north, Nkai communal area. According to statistical information collected from Agritex (1989), its total area is 102,659 ha of which 39,824 ha is arable land, 48,404 ha grazing pastures, 207 ha occupied by rural service centres, schools and dips and 434 ha by human settlement. The same source estimates the total resident population to be approximately 42,772 persons.

The majority of the population today living in Silobela communal area was forced to resettle there during the 1940s. The areas from which they were moved generally had a considerably higher potential production than Silobela communal area, primarily because of higher and more reliable rainfall and more fertile soils. The peasant households in the enumeration area were moved from Hogo District, located between Gweru and Changani, because their land was confiscated in order to be allocated to large-scale commercial farms.

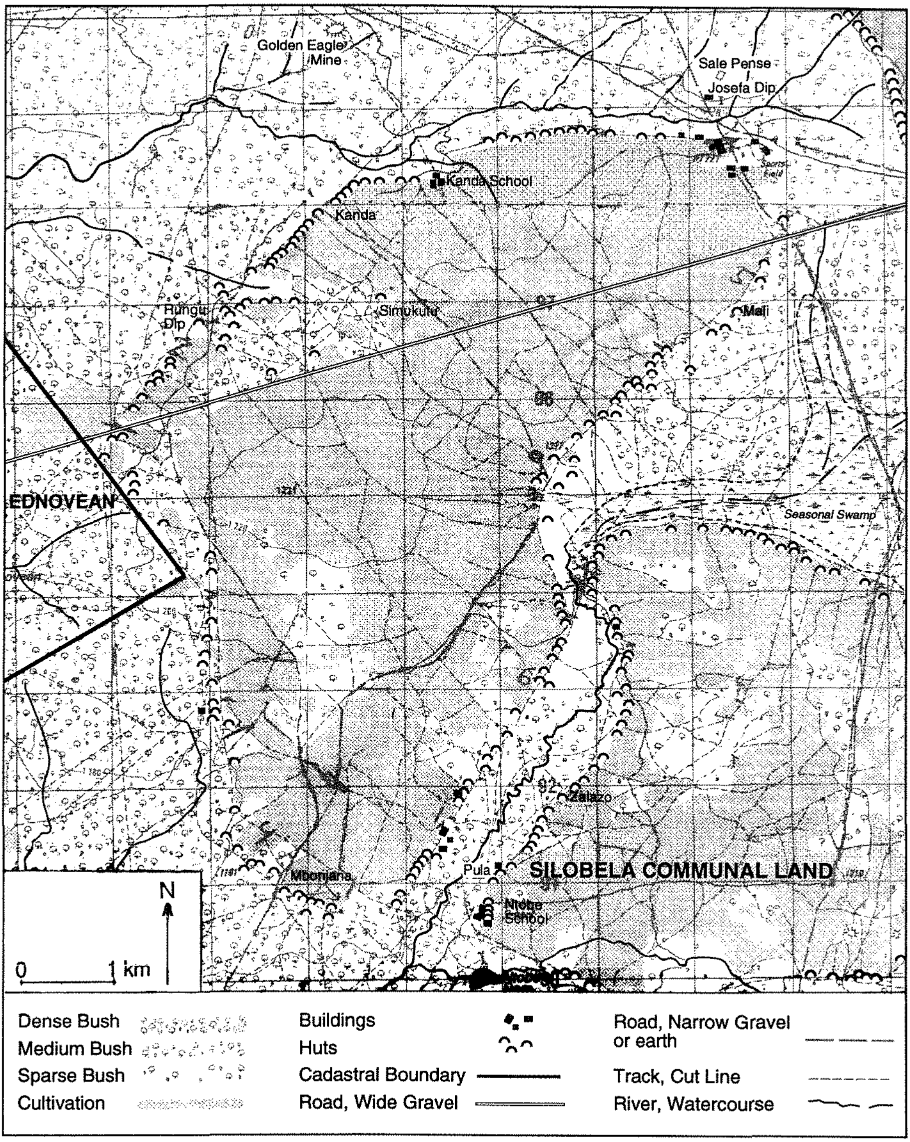
Silobela communal area is officially divided into 7 wards: Msokeli, Kushinga, Makaba, Hlanganisa, Ihalangano, Sebenzani, Mtshikitsha. These are again sub-divided into 36 village development committees (vidcos) which each consist of 4–5 kraals. The official leadership is not generally held in much respect in the peasant community. The hostile attitude towards officials has its root in the civil unrest which strongly affected the area in the period from independence to the signing of the unity accord between ZANU and ZAPU in December 1989. During this period, the Ndebele speaking majority of the population experienced severe repression, as they were caught between the dissidents and the police force. The tension culminated in 1985, when many houses of Ndebele speaking people were burned down throughout the Midlands Province, including Silobela communal area. A young shona speaking ZANU member who was installed as councillor during the elections in 1985 is still surrounded with much hostility and not in a position to organize people to work in common development activities.

Map 3. *Silobela communal area*



Silobela communal area is today in a transitional, intermediate period, characterized by a power vacuum. On the one hand, the peasant community does not recognize or trust the official administrative structure, and on the other hand, the traditional power structure has no official power to make or implement decisions. The kraal head, the lowest level of the traditional power structure, is, however, still the authority in issues related to allocation of land or solving disputes.

Map 4. *Enumeration area*



Box 6. Settlement history

Mr. Nsindo Dube was forced to move to Silobela in 1936. Until then, he and his family had lived in Ford Rixon until they and all other black families in Ford Rixon were forced to move because the area was to be used for white, large-scale commercial farms. Ford Rixon is an area with a significantly higher and more secure rainfall pattern and higher soil fertility.

Mr. Dube recalls that his family had only 12 acres in Ford Rixon, but claims that they produced more than he does today on a much larger area, and he would be willing to move back where he came from any time.

The circle was first settled in 1933, while the present settlement pattern was established in 1948. Mr. Nsindo Dube settled in Mbonjani in 1936, but later chose to move to Malikraal in 1944.

Farmers from Kande kraal voluntarily resettled in 1974. A major reason for the resettlement was that extensive soil erosion had taken place causing most and in some places all of the top soil layer to disappear after 40 years of cultivation.

Moreover, because of the increased number of settlements, the arable rainfall pattern is unstable and unevenly distributed. An area between the settlement and the main road had an annual rainfall ranging from 400 to 600 mm and insufficient to meet requirements. The farmers resettled further into what then was then the outfield, e.g. from the higher to the middle part of the catena.

A new local government system was introduced in the early 1980s which abolished the traditional power structures. The village development committee, vidco, headed by a vidco chairman, was given authority to allocate land. In Silobela communal area, the government succeeded in demolishing the traditional power structure. Because of the civil unrest and dissident activity in the area, which continued until the unity accord in December 1987, no new power structure acceptable to the peasants in Silobela communal area has yet been established. In this situation of power vacuum, the lowest level of power in the traditional system, the kraal head, has de-facto continued to allocate land and judge in land disputes between neighbours.

The power vacuum is partly to blame for the fact that only very few development activities have taken place in Silobela communal area during the first decade after independence. Four Agritex extension workers have the insurmountable task of serving up to 2000 households each. In fact, only approximately 10% of the peasants in Silobela participate in Agritex extension groups. Also in terms of seasonal credits from AFC, Silobela communal area is in a marginal position. District Development Fund (DDF) and ORAP, a Zimbabwean NGO, have implemented a few isolated development projects, such as drilling bore holes for domestic water supply (see box 7).

Box 7. Availability of water for domestic and livestock use

The availability and quality of water are perceived as major problems by people in Silobela. The ground water table is up to 35 metres below surface and thus out of reach with locally available well digging technology. Farmers claim that the water table has sunk during the droughts of the 1980s and that for this reason many of the old wells run dry shortly after the onset of the dry season.

Water becomes a major problem during the dry season, when some or all shallow wells dry out. The few bore holes which are deep enough are very salty and not suited for human consumption (not even for washing). The nearest source of water is 10 km away in some years. Farmers use ox-carts with 2 drums on each and a total capacity of 400 litres for water transport. A household of 12 members fetches water every second day, e.g. 8.3 litres per person per day. Fetching water takes about 6 hours per trip.

During the rainy season, farmers use their private shallow wells. These seasonal wells have a depth of up to 4 metres only. In most years, they dry up during the dry season.

When the seasonal shallow wells dry out, livestock have to walk to Ntobe dam, located 8–12 km away from the circular. Instead of drinking 3 times per day, as is common for livestock, they only drink every second day. To solve the problem of water availability during the dry season, a group of farmers in Mali kraal had joined together to start a project of constructing a small dam. By the 1989/90 rainy season, the dam measured 15 x 15 x 3 metres, only sufficient to meet the water demand of livestock a few weeks during the dry season.

The District Development Fund, DDF, has drilled a deep bore hole in Kande kraal, operated with a hand pump with a 10 meter long arm. The pump functions satisfactorily, has never run dry and yields good quality water. The demand for the bore hole is demonstrated by continuous long queues of farmers waiting for water. One farmer interviewed in the queue came from as far away as Mbonjani, approximately 6 km away. He left his home with his ox-cart at 5 am and did not expect to return home before 11 am. 6 hours to collect one 200 litre drum of water. The water from the bore hole is used for three purposes:

- It serves an estimated 300 households with water for domestic purposes.
- It serves an estimated 600 livestock.
- It serves as water source for brick moulding, which is done on an open area some 100 metres away from the bore hole.

For capacity reasons, farmers living close to the bore hole are prohibited from using it for irrigating their gardens or fields.

Agro-ecological conditions for agriculture

Silobela communal area is situated within Natural Region (NR) IV (see map 1). NR IV is subject to periodical seasonal droughts and severe dry spells. According to the description of NR IV, it is suitable for livestock production only, and arable cropping is regarded as unreliable. The climate in the survey area is characterized by short and variable rainy seasons and long dry winter periods. The mean annual temperature is about 17°C, and frost may occur during the months of June and July.

Table 6. *Annual rainfall in natural region IV, 1980–86*

	Rainfall (mm)	Average (%)
1979/80	470.0	90.0
1980/81	833.1	159.5
1981/82	306.5	58.7
1982/83	433.6	83.0
1983/84	423.5	120.1
1985/86	562.5	107.1
average 1980–86	522.4	100.0

Source: Central Statistical Office. Rainfall data were recorded in Bulawayo.

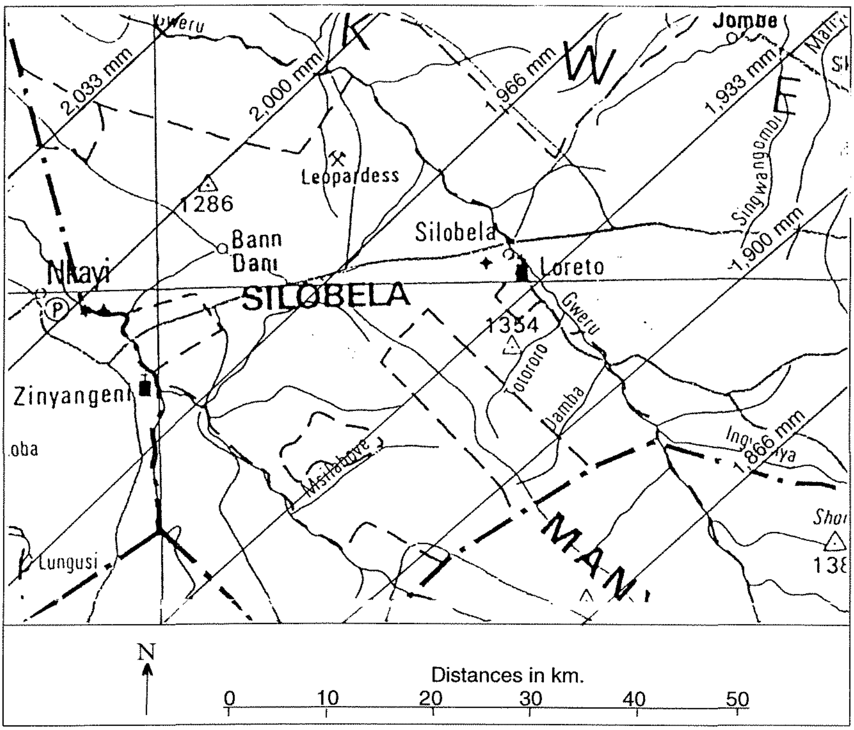
Table 6 shows that the annual rainfall pattern is highly unstable. First rain will normally fall in late October and continue until mid-March. If dry spells occur, it will commonly be during mid-season, in January or February. Given the high level of potential evaporation (see map 5), the distribution of rainfall over the season greatly affects the potential for crop production. The length of the growing season is too short to permit successful growing of late-maturing crop varieties in most years. This is aggravated by the tendency of more erratic rainfall in January.

The variability of rainfall is not only important over time, but also over space. During the 1988/89 season, Ihangansa ward received late rain facilitating winter ploughing. Sebenzani and Mtshikilsha wards did not receive late rain and no winter ploughing took place. Winter ploughing (April-May) combined with the use of manure, results in improved water retention. This is especially important for farmers cultivating the Kalahari sands, where leaching is at times a big problem. Peasants maintain that application of manure without winter ploughing does not increase the water retention capacity.

The rain pattern in 1989/90 differed greatly from previous seasons. By February 1990, Silobela communal area already received more than normal rainfall for a whole season: 600 mm; it rained from 25 October to 10 December. There was then a dry spell until 15 January. Since then, the rains have again been above average. Many peasants thought that 1989/90 would be another drought year, because the mid-season drought does not normally occur before January-February. One peasant therefore planted the household reserve of retained sorghum and millet seed. Some peasants who were late in planting suffered, as they did not finish planting before the rain stopped in early December and could not plant again before mid-January.

Under the fairly uniform climate of Silobela communal area, the characteristics are mainly determined by the nature and mineral composition of the parent rock from which the soil is derived. The presence of large quantities of relatively unweatherable quartz in the parent material will give rise to sandy, coarse textured soils. The presence of easily weathered feldspars and mafic minerals will result in the formation of soils with a high clay content, usually reddish in colour under conditions of good internal drainage. Silobela communal area is dominated by three types of soil: brown to red

Map 5. *Mean annual evaporation in Silobela communal area (in mm)*



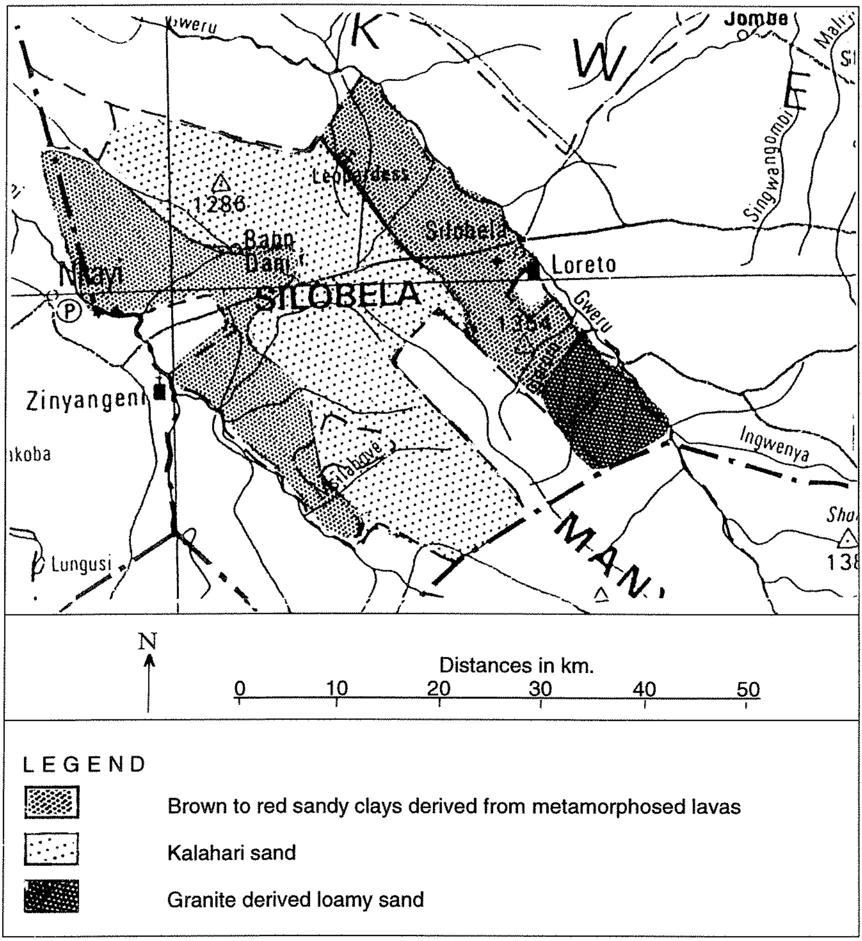
Source: The Agricultural Authority 1974. Agro-economic survey of Central Midlands

sandy clays, Kalahari sand and loamy sand (see map 6). One notes that the Kalahari sand dominates in the central part of Silobela communal area, while sandy clays are found in the western and eastern border areas, with the exception of loamy sand located in the southeast.

The brown to red sandy clays derive from the metamorphosed lavas of the gold-belt areas. They are of moderately high fertility and have good depth. Water holding capacities are adequate and with good farm management, the productivity of these soils can be maintained for long continuous periods. The soils are usually inter-bedded with sediments and include a certain amount of silt. This can cause surface capping and thus restrict water infiltration and hamper crop emergence. Although the inherent fertility is rather high, a dense and mottled subsoil horizon indicates restricted internal drainage and unfavourable growing conditions during the rainy season.

The loamy sands derive from granite and are generally greyish brown. The effective soil depth varies considerably from very shallow to deep, depending upon exposure and degree of erosion. Some of these soils have a sodic subsoil which commences less than half a meter under the surface.

Map 6. *Soil map of Silobela communal area*



Source: The Agricultural Authority 1974. Agro-economic survey of Central Midlands

These soils are highly erodible and disturbance of the sparse vegetation may cause serious sheet and gully erosion.

The Kalahari sands are very deep and medium grained, of very low fertility and water holding capacity. The water infiltration capacity is high.

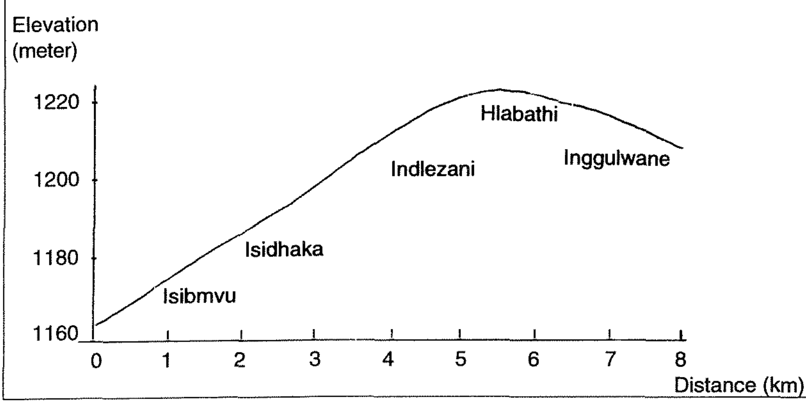
Four types of vegetation dominate Silobela communal area, *Brachystegia speciformis* woodland, *Acacia* tree savanna, *Deciduous terminalia sericea* tree savanna, and *Deciduous colophospermum mopane* savanna woodland. As shown in map 7, *Acacia* savanna is the dominant vegetation in Silobela communal area, except in the southern and northern parts.

Box 8. Local vernacular knowledge of soils

Farmers in Silobela know a lot about the local soils in their area. The level of detail and specialization of the ndebele words for local soil categories reveal considerable knowledge about soils. The following list of words for soil categories is not complete, but describe the most common soils in Silobela:

Hlabathi	Soil similar to pit sand located on the top of the catena.
Indlezani	Soil located in the lower level of the catena where the fertile top soil layer has been removed leaving the b-horizon.
Inggulwane	Mixture of red and black fertile soil located in the middle part of the catena.
Isidhaka	Black cotton soil. Fertile, heavy soil with high water retention but low water infiltration capacity, located in the lower middle of the catena.
Isibmvu	Red fertile soil located in the lower part of catena. Requires much water for cultivation.

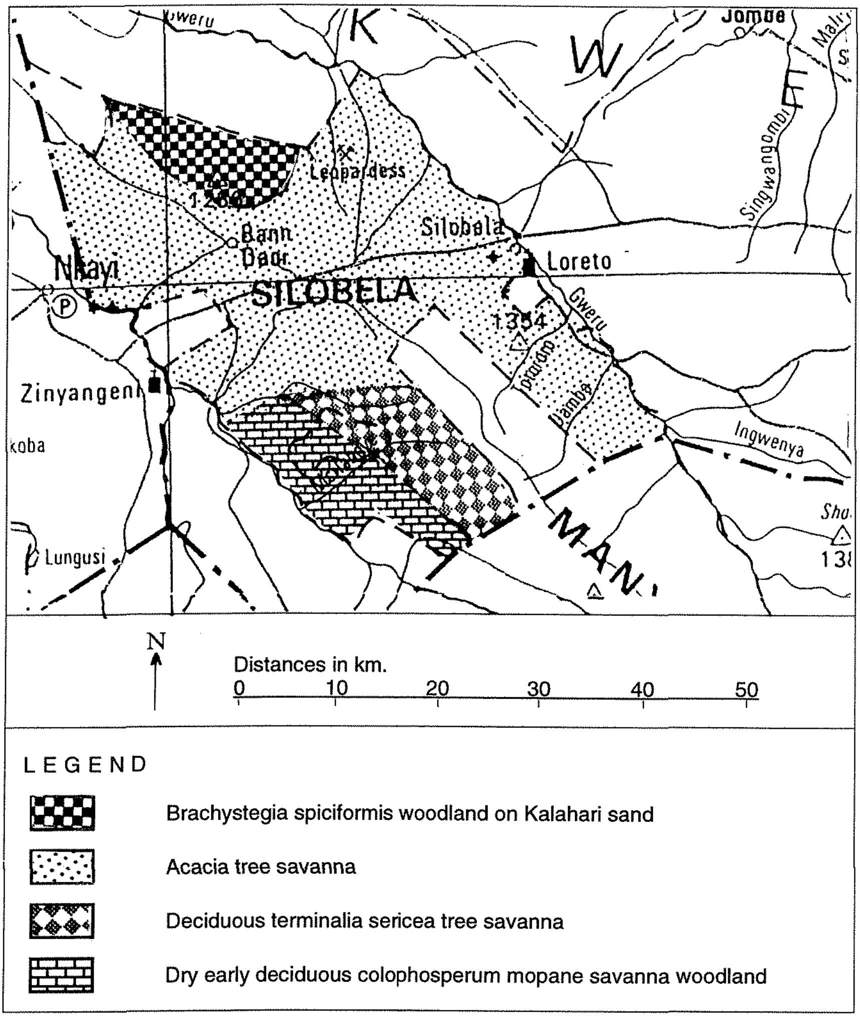
Elevation profile of enummeration area with indication of soil types—profile from north west to south east.



Acacia tree savanna includes *Acacia gerrardii, Acacia nilotica, Acacia karroo* and *Acacia rehmanniana*. Acacia trees are primarily found on the red sandy clays and are associated with local trees such as Mubondo, Matshabela and Muuzhe. The grass cover is predominantly perennial, with *Themeda triandra* in association with *Heteropogon contortus, Cymbopogon, Eragrostis* and *Bothriochloa insculpta.*

The *Brachystegia speciformis* woodland is confined to Kalahari sand and the trees are usually tall. A number of local trees are associated with Kalahari sand, such as Musasa, Mupfura and Mususu. The grass cover is rather poor, and the main species present include *Aristida, Eragrostis* and *Andropogon*.

Map 7. *Vegetation cover in Silobela communal area*



Source: The Agricultural Authority 1974. Agro-economic survey of Central Midlands. Elaborated from map 6.

Terminalia sericea diciduous tree savanna is usually indicative of very sandy, coarse grained soils. *Burkeea africana* is the dominant tree, in association with *Peltophorum africanum, Protea gaguedi, Faurea saligna* and others.

The *Colophospermum* mopane can grow under very adverse soil conditions, such as sodic influenced subsoils. Isolated termite mounds serve as foci from which mopani spreads into the surrounding areas. The grass cover under monane trees is very poor and confined to a few annual grasses such as *Aristida* and a number of short-lived herbs.

The end of the growing season continues beyond the end of the rains as crops draw upon stored moisture reserves in the soil. To calculate the end of the growing season, the time it takes to evapotranspire this stored water is added to the end of the rainy season.

Table 7 shows that the mean length of the growing season starts later, ends earlier and is shorter when one moves from NR III over NR IV to NR V. There is also a marked increase in the percentage incidence of intermediate and no seasons, when moving from NR III to NR V. The incidence of mid-season drought is similar in all three NR, indicating that mid-season drought occurs throughout the country and is not confined to the driest areas alone.

Table 7. *Comparison of season parameters in natural regions III, IV and V*

Season parameter	Region III	Region IV	Region V
Mean median start of season	10 Nov	18 Nov	3 Dec
Mean median end of season	31 Mar	28 Mar	24 Mar
Mean median length of season (days)	131	121	96
Mean % occurrence of drought season	18	16	18
Mean % occurrence of intermediate season	5	15	30
Mean % occurrence of no season	0	1	5

Source: Agritex 1988.

The mean growing season in Nkayi, which is neighbour to Silobela communal area and has a similar climate, starts 13 November and ends 18 March and lasts only some 115 days (Agritex 1988:12).[1] This is two weeks less than required for the earliest maturing hybrid maize (R200) to reach maturity in Silobela communal area's altitude of 1200 metres. Crop cultivation in Silobela communal area is thus associated with a considerable amount of risk. Agritex has calculated that the probability for the growing season to last more than 120 days in Nkayi is 43% (Agritex 1988:19).

Soil conditions influence the ability of the peasant to take full advantage of the growing season, as illustrated by the following examples from the survey area.

Peasants from Mbonjani kraal, which is situated on red clay soils, were late in planting during the 1989/90 season, because the first rains were very gentle and not sufficient to soften the soil sufficiently to commence tillage. For this reason, many farmers were late in planting. A contributing factor was the fact that all livestock were very weak after being insufficiently fed during the dry season. Most livestock are not able to pull the plough before 2–3 weeks after the rain has commenced. The fields which had been winter ploughed were the first ready for tillage, as their infiltration capacity is better than average.

[1]The standard deviation in the length of the season is ±17 days.

The situation is different in Mali kraal, which is situated on sandy soils and where the water infiltration is good. Yet peasants without draught oxen were delayed in planting, because they had to rent from neighbours. Some farmers, especially those who practised staggered planting, had limited their planted area and were thus cut short by the early-season drought.

Chapter 6
Economic and Social Development

Economic options

The options for economic activities in Silobela communal area are very few. All households are involved with agricultural activities as their most important economic endeavour. The primary household production goal is self-sufficiency in food, and grain is only marketed after the household requirements have been met. No household in the survey marketed grain as long as the household production was less than two tons. This reflects the primary objective of the household which is to produce sufficient food for subsistence. Crop marketing is not an option before subsistence requirements are secured for the coming season, preferably for two seasons. As the new season gets under way, the peasant will judge whether the harvest will be sufficient to meet the family subsistence requirements; if so, he/she may sell the stored surplus maize above the immediate subsistence requirement until the new crop can be harvested. Marketing of crops amounts to approximately 60% of the average household income. Maize is the only important commodity, while sunflower, sorghum and pearl millet are sold in minor quantities. Livestock production is only commercialized to a limited extent. Local agriculture-related employment of casual labour for weeding and harvest, rental of ox teams for tillage, and opaque beer brewing are also limited.

The majority of households are self-sufficient in food during years with reasonable rainfall patterns but net buyers of food during seasons of unstable rainfall. There are no reliable time series data for crop production in Silobela communal area, but GMB has kept reliable files over officially marketed production since 1972.

Table 8 shows that the marketing of grain is highly variable from season to season, depending largely on the rainfall pattern.

After independence, sales were low for four years, 1983, 1984, 1985 and 1988. These figures reflect severe crop losses following droughts in 198285 and 1987/88, when a large proportion of peasants in Silobela communal area were net buyers of grain. As will be discussed in detail later, the marketing of maize is distributed very unequally between households; many peasants were also net buyers of maize during the 1983 and 1987 marketing seasons. Many peasants are thus only self-sufficient in food one year out of three, and during food deficit periods are dependant on savings, remittances or government food relief.

Table 8. *Crop sales from Silobela communal area to GMB, 1981–89* (tons)

	Maize	Sorghum	Mhunga	Rapoko
1981	581	3	0	0
1982	2416	7	0	0
1983	341	2	0	0
1984	11	0	0	0
1985	442	5	14	0
1986	4614	206	68	43
1987	1395	10	19	5
1988	2	1	0	0
1989	6185	34	229	6

Source: Data drawn from GMB central computer in Harare.
Mhunga is pearl millet; Rapoko is finger millet.

Approximately one-third of the maize harvested in 1990 was marketed, while the remaining two-thirds were consumed by the community. The limited scope of agriculture has mostly to do with the unstable rainfall regime. An important additional factor, though, is the low fertility level of the soil, resulting from a combination of the following conditions: poor quality sandy parent soil; low levels of manure application because of insufficient livestock fodder capacity; and very limited use of mineral fertilizers because of risk-averting behaviour, problems of cash flow and unfavourable fertilizer/grain price ratios.

Even though the 1989/90 season was a good one by Silobela standards, more than one-third of the households did not sell maize. This estimate is based on household survey data (see table 13). If these data are extrapolated to cover the whole of Silobela communal area,[1] it would mean approximately 10,000 tons of maize were marketed in 1990. This is 40% more than what was recorded by GMB in the previous season, which was the record for the 1980s, and indicates that the GMB figures generally are too low. The reason for this is not that a black market exists for maize (in fact, the private traders pay less than GMB). A possible explanation may be that the GMB marketing data are based on maize sales from persons with a GMB producer registration card issued in Silobela communal area, and that a substantial part of the marketed production in Silobela may in fact be bought by private traders and resold to the GMB depots in Nkayi, Kwekwe or Gweru. This differentiation in (marketed) production has primarily to do with differences in access to resources, notably cash, livestock and land. These production constraints is further discussed in chapter 7.

Besides the limited scope for increasing crop production for marketing under the present technology and social organization, marketing of the existing surplus production already poses problems to the peasants. The two

[1]There are 42,772 inhabitants in Silobela communal area; with an average household size of 7.5 persons, that is 5,703 households. If each of these marketed 1770 kg of maize in the 1990 marketing season (the mean of the household survey), it would result in a total marketed maize of 10,094 tons for Silobela communal area.

main problems are transport from Cross Roads, the growth point in Silobela communal area,[1] to a GMB depot and the availability of bags.

The nearest GMB depot is Nkayi, situated 35 km south of Silobela. Transport cost per bag by the District Development Fund (DDF) lorries to Nkayi is officially Z$1.2/bag, but the drivers of the DDF lorries are unwilling to transport the grain to Nkayi (presumedly because they can not make an extra profit by taking passengers on the way back from Nkayi to Silobela, since there is not much demand for transport on this route). Peasants therefore have to send their produce to the GMB depot in Kwekwe, although this means longer transport (70 km). As the DDF charges transport cost per kilometre, the price per bag from Silobela to Kwekwe is approximately Z$3/bag.

An alternative is to let private contractors transport the produce to Nkayi. They charge Z$2/bag and have limited capacity. An application to establish a GMB depot in Silobela communal area was rejected because the potential marketed production was judged to be too low to justify such an investment.

The peasants sell some of their produce to the private retailers at the Cross Roads store in order to acquire the cash needed to buy bags for marketing the maize surplus. These are approved buyers, who will pay peasants reduced rates, but in cash. There is an acute shortage of bags; peasants have the option to buy used bags, but then they may be refused at the GMB and face the problem of transporting the crops somewhere else.

The local non-agricultural activities consist of a formal and an informal sector. The formal sector is limited to a few percent of the work force and includes the extension staff, teachers, police, ORAP (an NGO), the Catholic mission and employees in shops and bars. The income from this formal sector employment is high, however, and in the survey amounts to some 20% of the total average income. The informal sector includes exchange within the community, such as brick moulding and thatching. The level of specialization is low, and although these activities play an important role within the community, the exchange within the community is limited in economic terms to a few percent of the total earnings. A fundamental structural problem preventing many small entrepreneurs from starting activities is the sharp competition from industrialized products and stiff pre-colonial regulations. Who can start a local diary plant, when cheap, subsidized pasteurized milk is sold in plastic bags from refrigerators in rural retail shops?

The last sector of the economy consists of income from sources external to the community. The migrant labour system, described in chapter 4, plays an important role in Silobela communal area and contributes to up to 40% of average household earnings. Most elder men have been migrant workers at one time or another, and more than half of the households represented in

[1]In Zimbabwe, growth point is the term used for rural service centre. It is government policy to support growth points.

Table 9. *Household income by income groups (in Z$)*

	Low		Middle		High		Mean	Std. dev.	Min	Max
Crops	78	17%	300	36%	2487	68%	681	1627	0	6860
Livestock	45	10%	134	16%	132	4%	93	220	0	1000
Beer brewing	9	2%	10	1%	8	0%	9	26	0	130
Local informal activities	0	0%	48	5%	58	2%	30	96	0	480
Sub-total agriculture	*132*	*29%*	*492*	*58%*	*2685*	*74%*	*784*	*1626*	*0*	*6860*
Est. remittances and use of savings	311	69%	351	42%	4	0%	145	256	0	1030
Formal employment	0	0%	0	0%	952	26%	215	574	0	1800
Other income	9	2%	2	0%	0	0%	4	22	0	120
Sub-total non-agricult.	*320*	*71%*	*353*	*42%*	*955*	*25%*	*382*	*584*	*0*	*1800*
Total income	452	100%	845	100%	3641	100%	1167	1855	0	8660

Source: Household survey 1989/90. No. of households = 32.

The collection of this sensitive information was connected with considerable difficulties and prolonged interviews. Because of incomplete information with regard to remittances, they are in some cases estimated taking into consideration the pattern of expenditure for the households concerned. The sample received remittances from relatives working outside the community. Given the present high level of unemployment, the option of finding migrant work has been severely reduced over the last decade.

Household economy

Table 9 shows the social differentiation in household income from agricultural and non-agricultural sources. The table reveals a clear difference in income level between the three strata as well as a significant difference in source of income.

As shown in table 9, there is great variation in level of income from all sources, illustrated by the fact that the standard variation is two to three times higher than the mean income. The very low level of income from informal activities underlines that the process of proletarization is indeed limited or non-existent. Most agricultural or non-agricultural exchange activities have the character of barter and are carried out through reciprocal or share-cropping labour arrangements, including beer parties where cash payment is usually not involved.

The high income group is the least difficult to describe, since it consists of peasant households which have either formal employment (bus driver, NGO workshop instructor and village councillor) or cultivated areas significantly larger than average. Table 9 shows that for the high strata households with agriculture as the major source of income, this source accounts for an average of three-quarters of their total income. Another important difference for this group is the presence of peasants with formal income. In four out of the seven households in the high strata, the head of household had formal employment. The high strata thus consists on the one hand of peasants with exceptionally high crop production and sales, and on the other, peasants with formal employment.

Although the annual income of the middle income strata households is twice that of the low strata, the differentiation between these strata is less clear. Peasant households in both strata are more or less in the same position, and the difference between them may have more to do with stage of the life cyclus and variations over time than any more substantial reason.

The middle income strata households have in common that they are all involved in commodity production, and the average annual income which derives from sale of agricultural produce accounts for more than half of the total average household income (see table 9). Although they are basically self-reliant in terms of food and involved in marketing some surplus, they are still dependant on remittances to meet a substantial part of their household expenditures, notably school fees.

The poor strata households are only involved to a minor degree in commodity production, and only some households have surplus crop production during above average rainfall years. A large number of the peasants in the low income strata are regularly net buyers of food. They depend on remittances for the major part of their household expenditures. Table 9 reveals that the most important source of income for the low strata households is remittances from relatives outside the community. These transferred incomes amount to more than two-thirds of the total average income for peasants in this strata, while proceeds from crop sales are as low as 17% of total income or Z$78.

Table 10 shows the social differentiation in household expenditures. Two features are immediately striking. The first is the proportion of expenditures on education. While primary school fees are relatively low (Z$20), secondary school fees are relatively expensive (Z$126) as they include board.

Still, most households in the survey had one or two children in secondary school, and thus used two to three times more on education than on recurrent agricultural expenditures. That this is a universal trend is seen by the fact that the standard deviation in expenditures for education is lower than the mean. The high priority of education, even in poor households which do not always have surplus food production, can be explained by the peasants' lack of confidence in agriculture as a means to prosperity. This is not likely to change as long as the minimum salary for one person is three times higher than the total income of the poor strata peasant household, even after subtracting the value of food produced for subsistence.[1]

[1]The minimum salary was Z$1800 in 1990, while the value of subsistence production of an average household can be estimated as Z$500 (two tons of maize at a price of approximately Z$400 and Z$100 for other crops).

Table 10. *Household expenditure by income groups (in Z$)*

	Low		Middle		High		Mean	Std. dev.	Min.	Max.
Fertilizer	10	2%	0	0%	68	2%	19	77	0	432
Seed	37	8%	57	8%	70	2%	51	30	0	98
Pesticides	1	0%	4	0%	5	0%				
Livestock	2	0%	0	0%	8	0%	3	12	0	60
Implements	65	15%	26	3%	13	0%	40	152	0	850
Rented tillage	6	2%	9	1%	0	0%	6	22	0	100
Hired labour	2	0%	0	0%	5	0%	2	8	0	36
Sub-total agriculture	*123*	*27%*	*96*	*11%*	*169*	*5%*	*122*	*181*	*0*	*870*
Infrastructure	20	4%	3	0%	29	1%	16	43	0	176
School	284	63%	298	35%	387	11%	334	329	0	1046
Residual available for household consumpt.	14	3%	304	36%	2758	75%	714	n.d.	0	1800
Transport	8	2%	40	5%	164	4%	47	108	0	598
Other	3	0%	104	12%	134	4%	57	120	0	409
Sub-total non-agricult.	*329*	*73%*	*749*	*89%*	*3472*	*95%*	*1176*	*n.d.*	*0*	*1800*
Total	452	100%	845	100%	3641	100%	606	496	52	2229

Source: Household survey 1989/90. No. of households = 32.
Despite the considerable efforts that have gone into collecting these data, it was not possible to obtain reliable information on general household spending. This category was therefore added to the saving category and defined as a residual category estimated as income less expenditures other than this category, and including possible underestimates of other expenditures. This has had consequences especially for the high strata income group.

The second feature is the low level of recurrent expenditures in the sphere of production, especially for the high strata peasant households, which according to the data collected have plenty of capacity for further investments. The most obvious explanation is that the technologies available to the peasants are either not appropriate or not regarded as worthwhile investments by the peasants. The continuous deterioration in the price ratio of fertilizer to grain has made the seasonal use of fertilizer a doubtful investment for the household economy (see Ashworth 1990 for at detailed analysis of fertilizer economy), especially in an erratic rainfall area such as Silobela. Other suggestions by the Agritex extension service, such as pen-fattening of cattle for sale with purchased standardized improved fodder has been rejected by most peasants as uneconomical.

Table 11 shows a significant difference in ownership to heavy farming equipment between the three income groups. The high income group own more than twice as many heavy farming tools as the low income group. It is interesting to note that all households own a plough, and that the constraint for timely tillage is caused by non-availability of draught oxen and not by lack of implements. There is no clear pattern of distribution with regard to hoes and scotch carts. Hoes are primarily used for weeding, while scotch carts are used for all types of intra-community transport.

Table 11. *Household ownership of implements by income groups*

	Low		Middle		High		Mean	Std. dev.	Min.	Max.
Plough	1.4	41%	2.2	55%	2.3	30%	2.0	1.3	1	6
Cultivator	0.6	18%	0.9	23%	1.5	19%	1.1	1.0	0	4
Harrower	0.6	18%	0.8	20%	1.1	14%	0.9	0.7	0	2
Other	0.8	23%	0.1	2%	2.9	37%	1.2	2.7	0	9
Total heavy farming tools	*3.4*	*100%*	*4.0*	*100%*	*7.8*	*100%*				
Hoes	5.0		6.2		6.3		5.9	2.9	0	10
Scotch carts	0.8		1.8		1.2		1.3	1.2	0	7

Source: Household survey 1989/90. No. of households = 32.

Table 12. *Household harvest by income groups (in kg)*

	Low	Middle	High	Mean	Std. dev.	Min.	Max.
Maize	1887	3579	6831	3653	3402	455	16835
Pearl millet	77	102	10	67	227	0	910
Groundnuts	9	343	286	179	477	0	2307
Beans	0	12	13	7	23	0	91
Sweet potatoes	0	0	0	0	0	0	0
Sorghum	174	249	275	224	305	0	1365
Finger millet	28	150	94	81	265	0	1356
Cotton	19	0	180	49	230	0	1265
Sunflower	157	755	1707	701	1376	0	6490
Bambara nuts	27	150	169	94	204	0	910
Cowpeas	2	2	0	1	6	0	27
Melon	30	0	0	11	63	0	350
Other	0	10	26	9	37	0	182

Source: Household survey 1989/90. No. of households = 32.

Table 12 shows a significant difference in household harvest between the three household income groups. The high income group harvested in average more than three times as much maize as the low income group, and ten times as much sunflower, which is a purely commercial crop. There is a less clear pattern of harvest per household for the smaller crops, although the low income group has the lowest harvest per household for all crops. 1989/90 was a good agricultural season and the average maize harvest of the low income group of 2 tons is sufficient for self-sufficiency plus a surplus for marketing, as shown in table 13.

Table 13 shows the end use of the three major crops in Silobela communal area. Note that the high income households are considerably more commercialized than the low income households. While the high income group marketed some two-thirds of their maize harvest, the low income group marketed only one-quarter of their maize. As mentioned earlier, table 13 confirms that sunflower is primarily a commercial crop, with an average of 87% marketed.

Table 13. *End-use of household crop production by income groups (in kg)*

End-use	Low	Middle	High	Average	Min.	Max.
Maize						
Eaten green pre-harvest[1]	302	428	398	364	0	1592
Milled[2]	110	446	192	237	0	1274
Harvested dry[3]	1475	2885	6241	3006	0	16380
Total harvest	1887	3579	6831	3549	0	16835
Net purchase[4]	176	0	0	79	0	364
Marketed[5]	507	1622	4504	1770	0	14560
Retained	902	1529	1929	1336	0	4277
Sunflower						
Total harvest	157	755	1707	701	0	6490
Marketed[5]	112	598	1556	612	0	6270
Retained	45	157	151	89	0	565
Sorghum						
Total harvest	174	249	275	221	0	1365
Marketed[5]	91	136	79	103	0	819
Retained	83	113	196	118	0	546

Source: Household survey 1989/90. No. of households = 32.

[1]*Eaten green pre-harvest* is an estimate of the green maize culbs which are eaten fresh directly from the field, little by little as needed by the households.
[2]*Milled pre-harvest* includes the dry maize harvested dry from the field before the maize harvest and milled for home consumption.
[3]*Harvested dry* includes the crops brought from the field to the homestead during harvest.
[4]*Net purchase* is an estimate of the average purchase of maize calculated as the difference between total harvest and marketed plus retained.
[5]*Marketed* includes the crops sold either to the marketing board or privately. The marketing figures given by the peasants during the survey have been adjusted, so that marketed is equal to total harvest less retained.

Household composition, work force and division of labour

The household, defined in a narrow sense as those persons for whom the compound is home, is used as the basis for analysis. This definition of the household limits its size to a family unit consisting of man, women and children. In the Silobela communal area context, a household in which the husband and wife are middle aged might include some of their parents, while a household in which the husband and wife are older might include grandchildren. The relationships within the extended family are of importance for the social reproduction of the single household, but have only limited influence on the household's decision-making process with regard to income and agricultural production.

The household, as defined in this study, remains the unit of labour for agricultural activities. Table 14 shows household composition. One notes that approximately two-thirds of the households' members are children. Some 26% of the children have left their parents' households to establish

Table 14. *Household composition by social groups*

	N	Average	Percent	Cumulative percent
Husband	27	0.9	12	12
Wife (wifes)	34	1.1	15	27
Children	149	4.8	64	91
Grandchildren	18	0.6	8	99
Relatives	4	0.1	1	100
Total	231	7.5	100	
Male and female defacto headed	27		87	87
Female headed	4		13	100
Monogamous household	28		90	90
Polygamous household	3		10	100
Children:				
None	0		0	0
1–3	5		16	16
4–6	11		36	52
7–9	10		32	84
10–12	5		16	100
Grandchildren:				
None	25		81	81
1–2	4		13	94
3–6	2		6	100
No relatives	27		87	87
Relatives	4		13	100
Members of household:				
4–6	8		26	26
7–9	9		29	55
10–11	6		19	74
12–15	8		26	100

Source: Household survey 1989/90. No. of households = 31.
Male and female defacto headed households are shown as one category, because the situation changes over time.

their own families and are not included as members of household. The table also reveals a very high fertility rate, with 84% of the households having four or more children.

The division of labour may be analysed in terms of inter-household differences (i.e. between different types of households and the extent of coopera tion between them) and intra-households differences (i.e. gender relations and relations between children and parents).

There are three different types of households in Silobela communal area: *male-headed, female-headed* and *defacto female-headed* households. The male-headed household is the most common form of family unit in Silobela communal area. Here, the man usually has the last say in major decisions, and is therefore the one who decides the cropping pattern and organization of household labour. Female-headed households are headed by either single mothers, or divorced or widowed wives. Female-headed households are not very common in Silobela communal area and make up 13 per cent of the survey sample. Defacto female-headed households are households headed by the woman while the man is away on migrant work or has left for an indefinite period. During certain parts of the year, defacto female-headed households can be the most common form of household in Silobela communal area. During periods when the man is not present, the woman usually makes all decisions on the farm.

90 per cent of male-headed households are *monogamous*, while some 10 per cent are *polygamous* (three out of the thirty-two households represented in the sample). In the monogamous household, the man and wife cultivate the fields together. The stereotype of the man enjoying leisure while the woman undertakes all productive as well as domestic work is not valid in Silobela communal area. Both males and females work in the fields, and there is no obvious division of labour. Without data to substantiate the claim, I observed a tendency for men to be dominant during tillage, while women dominated the weeding of the fields. But this sexual division of labour in the monogamous household is by no means an unbreakable norm. The division of labour in the de facto female-headed monogamous household differs from this picture, as the wife and children are left with all the farm labour during the period when the husband is away from home.

In polygamous households, fields are usually divided between the husband and each of the wives. The husband has his own fields, which are the lion's share in terms of size and quality. Each wife has her own fields, smaller in size than those of the husband. The wives' allotments are usually of equal size. A polygamous household usually consists of one sleeping compound, one kitchen hut and one grain storage for each of the wives, and an additional grain storage for the male head of household.

The sexual division of labour within polygamous households takes different forms and is not fixed. In some polygamous households, work in the fields and household reproduction are both carried out cooperatively by the two wives and their respective children. In other polygamous households, the division of labour is more clear-cut, and each wife cultivates her fields with her children. It is common for all members of polygamous households to contribute to the work in the fields belonging to the male head of household. The harvest from these fields is marketed in good rainfall years, since the man is responsible for payment of school fees and other household expenditures.

In one of the polygamous male-headed households in the sample, the wives did most of the work together with the mature children. The man spent most of his time joining the beer parties of neighbouring peasant households. According to the wives interviewed, he participated in practically no farm work in his own household, but came once in a while and to 'supervise' their work. During the interview, the wives said frankly that they preferred that he stayed away and did not interfere with their work.

Box 9. Division of labour in a defacto female-headed household	
Tillage:	Grown-up children plough in the morning before school hours
Planting:	Wife plants alone during the day, works jointly with the children in the fields after school in the afternoon
Weeding:	Children weed with cultivator while the wife uses a hand hoe
Harvest:	All members of the household participate
Source: Household survey 1989/90.	

Both female-headed and defacto female-headed households, face serious labour constraints. Children in these households play a crucial role in assisting their mothers overcome their agricultural tasks. If the rains are late, children have returned to school by ploughing time and the wife will have to work alone during part of the day. Women are alone during most of the growing season while the children are in school, although the children often help in the morning and afternoon.

Social relations between neighbouring peasants have been distorted by the psychological damage done to the community during and after the war. The burning of peasants houses in 1985 by ZANU Youth forced many peasants to move to Bulawayo or to relatives to escape the civil war. Some returned in 1988 after the reunification of ZANU and ZAPU in December 1987. Some houses are still in ruins. The biggest expenditure for the returned households is to rebuild their houses and re-establish their household inventory. Many peasants complained that their implements were stolen while they were away, and that they now had to start again.

Despite the grievances within the community, beer parties are widely practised. Beer parties are in essence reciprocal labour arrangements in which work on each other's fields is done in cooperation in a system where the participating peasants owe each other labour time. It is a very dynamic system in which the balance of labour exchange between the peasant households changes continuously. In the long term, it is a reciprocal labour arrangement in which all labour efforts made for others by a given household are eventually returned. The households call upon the participants in the work group to perform a specific task and brew beer for the occasion. As mentioned earlier, the brewing may attract people who are not members of any of the participating households, but who join the work because of the beer.

One group of five defacto female-headed households in the survey practised a more elaborate and permanent reciprocal labour arrangement. All five households faced serious labour constraints, and the women tried to overcome the work load by cooperating and helping each other. The cooperation went beyond work in the fields, including development activities such as constructing a compost pit or Blair toilet. The women kept strict account of the hours they worked for each other. Sometimes children participated in the work instead of their mother. The five households expressed their satisfaction with the arrangement, which had been functioning for two years at the time of the household survey.

Division of labour is a dynamic feature, changing over time, and interrelating with changes in the farming system. The work group described above, for example, functioned well during the 1989/90 household survey, but during a follow-up visit in 1990, each of these defacto female-headed households worked for itself.

Household livelihood strategies

The goals and priorities of peasant households vary greatly from family to family, but some trends can be identified which are common for all. The inter-household variation in survival strategies varies to an even greater extent, since the options available to the individual peasant are highly dependant on his or her access to resources such as land, livestock, capital, labour (and knowledge).

We know from the pattern of expenditure in table 10 that non-agricultural expenditures, especially for education, have higher priority than recurrent production costs. This reflects an overall goal among peasant households in Silobela communal area based on the conviction that education, and implicitly wage labour outside the community, is the best investment to secure a stable future income. This is so despite the fact that more than half of the Form I to IV students fail their examinations and only a fraction of those who pass actually achieve formal employment. The difference between the minimum salary and the average household income for low and medium income households, however, is simply too great for the option not to be attractive.

There are at least two conflicting household goals, with accompanying conflicting production strategies: on the one hand, the goal to maximize total household production in order to secure a surplus for marketing, and on the other hand, the goal of household food security. Because of the uncertainty of the climate in Silobela communal area, production strategies which seek to maximize resource efficiency and production will very certainly conflict with production strategies which seek to avert risks.

There are differences in the possible production strategies available to the three household income groups. Both in the social context and with respect to options for manoeuvring within the farming system, households that are better off have more strings to play on than poor, resource constrained households. The overall room for manoeuvring within the farming system by peasant households in response to a period of drought is generally limited. Still, peasants may react in a number of ways when farming conditions change. In the following, social strategies to minimize risk are discussed, while risk minimizing strategies for livestock and crop production are discussed in chapter 7.

Box 10. Livelihood strategy for poor, newly established households

John Ndhlovo is 32 years old, his wife 30 and their child 11. The family has been established for more than a decade but still has not been able to establish a sustainable basis for livelihood.

Access to draught power is a major problem for the family. John's father previously owned livestock, but most of it died during the early 19802 from anthrax or from eating mkausani, and after initially receiving help during the first five years of marriage, John was asked to manage on his own. John's household today still has no livestock and is dependent on borrowing or renting from neighbours, which is not always possible. He failed to rent an ox team in 1989 and consequently could not cultivate anything during the 1989/90 season. The underlying problem is poverty. When trying to rent an ox team, since John cannot pay cash, he instead offers his help to others for mutual benefit.

As a livelihood, John offers to do casual labour for neighbouring farmers for payment in kind. The demand for such casual labour and the ability of farmers to pay for it is limited. John only manages to work a few periods of two to three weeks annually, typically with tasks such as weeding. The payment is one bag of maize for two weeks of labour, equal to approximately Z$2/day.

Several times previously, John has tried to get a formal job in Harare, but has failed until now. There are also very limited possibilities for non-agricultural activities in Silobela. John has been engaged in making axe and hoe handles and moulding bricks, but the income earned from this work has been too little to sustain his family. Bricks are sold locally for Z$50/1000 and require 5 to 7 full days of labour to mould.

During reasonable rainfall years (such as the 1989/90 season), peasant households refrain from marketing all surplus production at once, but try to retain sufficient maize to feed the household for two seasons. One peasant interviewed had harvested 40 bags of maize in 1988; he sold 10 bags to the GMB and retained about 20 bags for family consumption and the last 10 bags as a strategic reserve in case of drought the following season. In January, when the peasant judged that his crops would give a reasonable yield during the 1989/90 season, he sold the extra 10 bags to GMB.

The most obvious reaction to food deficit is to buy maize to meet consumption requirements. The low income households do not have money to buy food during drought years; therefore, they may seek remittances or borrow from relatives or neighbours. In serious drought years, nobody in Silobela communal area has surplus maize to lend. Peasants who own Scotch carts and have sufficient capital travel to surrounding areas such as Zhombe, Ntingwe, Gawere, Dendera or Gokwe and buy up maize to sell to Silobela peasants in need of food. Peasants in these areas almost always have maize surplus years. They sell maize at about Z$3.20 per tin. This is equal to Z$15–18 per bag. Cash outlays for communal peasants in Silobela are always high during drought years. In one case, a peasant spent Z$200 on 9 bags of maize to feed his family. In some cases, poor families with minimum remittances or no other source of income sell or exchange livestock for maize. This has implications for the availability of draught power, especially after recurrent droughts.

Most households in Silobela communal area have participated over the years in the government food-for-work programmes. All those interviewed in the survey complained that the programme was insufficient, though it alleviated the worst suffering. The households were not properly informed about the purpose of the projects in which they participated, and the work done was regarded by some as useless. One peasant claimed that, on one occasion, trees were cut down for no reason. All peasants regarded the salary of Z$2/day to be too low and some complained that they were not paid for part of their work. Allocation of food relief was limited to families in which no member worked in the towns. The food relief allocation amounted to 54 kg maize per month (three tins) per household, which is a supplement but far from sufficient to meet household food requirements. During 'normal' years, the average family of 8 household members consumes more than twice that amount of maize. A special type of 'sadza', made with pumpkin mixed with mealy meal (white maize flour received as food relief or bought from the shops), is made during drought years, called Nhopi in Shona.

Chapter 7
Farming System Analysis

Characteristics of the farming system

Energy flow in the farming system. The farming system in Silobela communal area is an excellent example of an infield-outfield and shifting cultivation system. The system is in principle sustainable in itself and only a low level of external inputs are used. The fundamental principle of the infield-outfield system is to use cattle to transfer plant nutrients from the outfield to the infield. The extra supply of plant nutrients to the infield, all other factors being equal, raises the productivity of crop production.

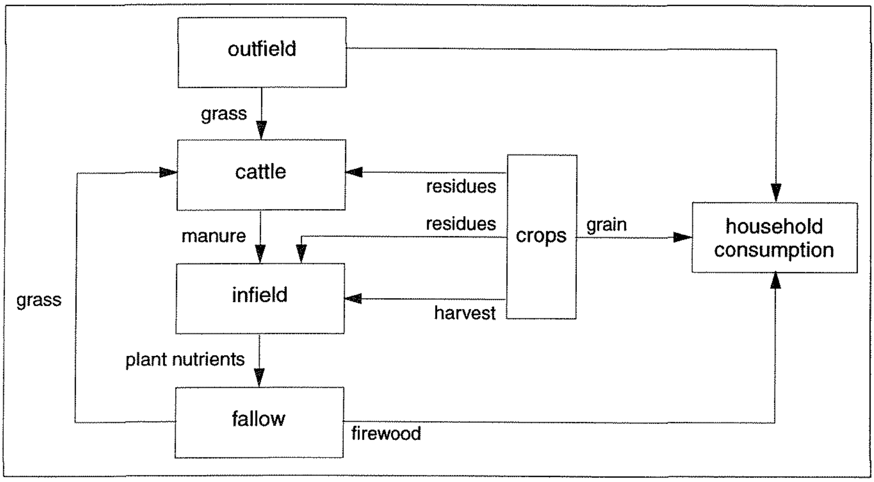
There is a strong degree of inter-relatedness between the cropping and livestock components of the farming system of Silobela communal area. These include the following four components:

1. draught power through animal traction
2. manure for improving and maintaining crop yields from poor sandy soils
3. crop residues as a major source of supplementary fodder for livestock during the dry season
4. draught animals, including donkeys, for transporting harvested crops from the fields to the homestead, and manure in the opposite direction.

Figure 4 illustrates this aspect of the farming system in Silobela communal area. The outfield provides fodder for the livestock and firewood for the household, as well as poles and other building materials. The livestock are herded to the outfield during the day and stay in pens within the household compound during the night. Livestock are given supplementary fodder in the form of plant residues and graze on fallow vegetation. The manure is processed as compost and applied on the infield to add plant nutrients and regenerate soil fertility.

In addition, soil fertility is maintained through fallow rotation. If the productivity level of a field declines under a certain level after a number of years of continuous cultivation, it is left fallow for a period to regenerate soil fertility. While the fields lay fallow, they are grazed by the livestock and provide firewood for household consumption. Soil fertility is finally also maintained through taking crop residues back into the soil. This is done either through mulching, where crop residues are ploughed into the soil as

Figure 4. *Energy flow in the farming system of Silobela communal area*



green manure, or through composting, where plant residues are mixed with manure and processed before being applied to the fields.

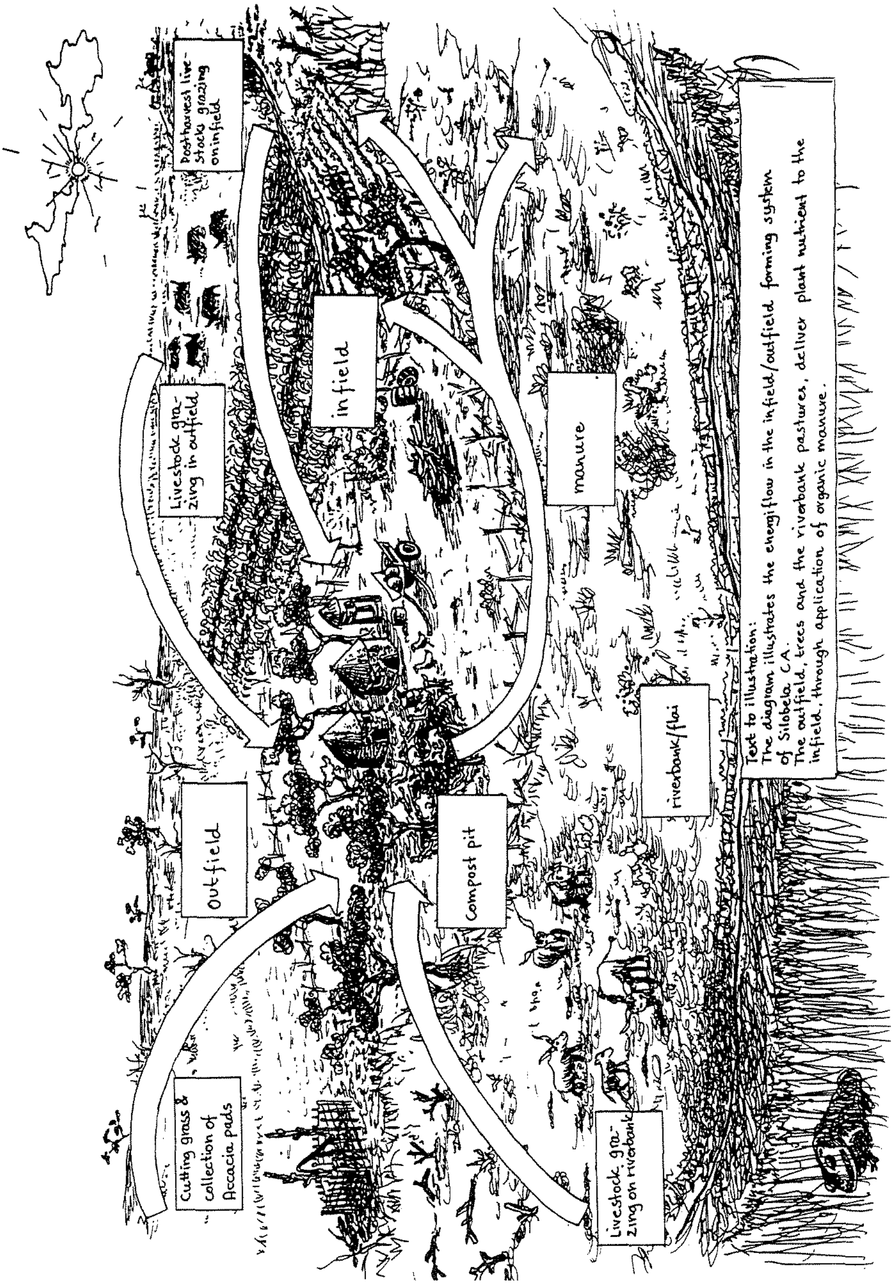
Grain is either consumed by the household as food for subsistence, or marketed to meet the household's cash requirements. Part of the grain harvested from crops other than maize is retained and used as seed, while hybrid maize seed is bought externally. The energy flow on the household level is illustrated in Figure 5. Cultivation of the infield is the major labour task, but labour is also allocated for composting cow manure, crop residues and other organic material, and applying it to the infield.

Land use

The present settlement structure as shown in map 8 was planned by the colonial administration after World War II, and peasants living in Silobela communal area were resettled according to the plan in 1948. The households of Lontiwa kraal came to Silobela in 1939, and the families from Mali and Kande kraal came in 1945. The circular shape of the settlement enabled the peasants to follow a classical infield-outfield land use system in which each household is situated on the borderline between the arable land and the grazing areas. Most peasant households in Silobela communal area today still have sufficient land for cultivation, and because of the settlement pattern have relatively easy access to all land use categories.

Land use may be divided into a number of categories (see maps 8 and 9). The fundamental principle is that land inside the settlement circle is arable land, while land outside the circle is for grazing and firewood. Maps 8 and 9 sub-divide the arable land in the inner zone into three land use categories: cultivated fields, fallow vegetation and bush vegetation. Since these categories are based on a rough aerial photo interpretation, there might be

Figure 5. *Energy flow of the household*



some overlap between the three categories. Land classified as cultivated includes both actually cultivated land and land in short-term fallow, and patches of the land categorized as fallow vegetation may be under cultivation. Some of the vegetation characterized as bush was cultivated 25 years ago. This area is today inhabited with wild pig, kudu, impala, jackal and monkey. The risk of crop loss due to vermin is too high for this land to be cultivated.

The impression received from walking in the inner circle today is of correspondence between the use of fallow and distance to the settlement. Cultivation is intensive near the settlement, where most fields are cultivated annually, while the use of fallow increases the further into the circle one gets.[1] The age of the fallow vegetation also increases with distance to the settlement. The age of fallow vegetation within a few hundred metres of the settlement is usually 1–2 years, and may be up to 5–10 years one kilometre into the circle.

The area outside the circle is used for pasture and firewood. All peasants agreed that the quality of the grazing area had seriously declined over time and especially over the last decade. According to the peasants, the vegetation cover has changed from predominantly grasses to bushes and trees. The area is serious degraded and there is up to one meter between the bits of scattered grass. The soil is predominantly Kalahari sand, and gully erosion is developing in several locations.

Some peasants cultivate gardens along the river bank, on land which is usually used for dry-season grazing. Crops grown here are beans, cabbage, tomatoes, sweet rids and rape. The peasants take advantage of the high soil moisture content close to the river banks to plant in the dry season and harvest at the beginning of the rainy season. This functions as a food bridge between the harvest of the main season and eating maize fresh from the fields during the new main season.

There are clear signs that the area under cultivation has been expanded during the last decade. One indication is the large increase in marketing of surplus production. The main reason for this increase has been access to marketing through GMB. Before independence, the local retailers were the only marketing channel, and a bias of marketing arrangements towards the communal sector (at that time the Tribal Trust Lands) gave peasants little incentive to produce surplus grain for marketing.

Another indication is the judgement of the peasants themselves. Households interviewed during the survey felt that they cultivate a larger acreage now than during the 1970s. According to the peasants interviewed, the expansion of area cultivated has been facilitated through increased use of oxen mechanization.

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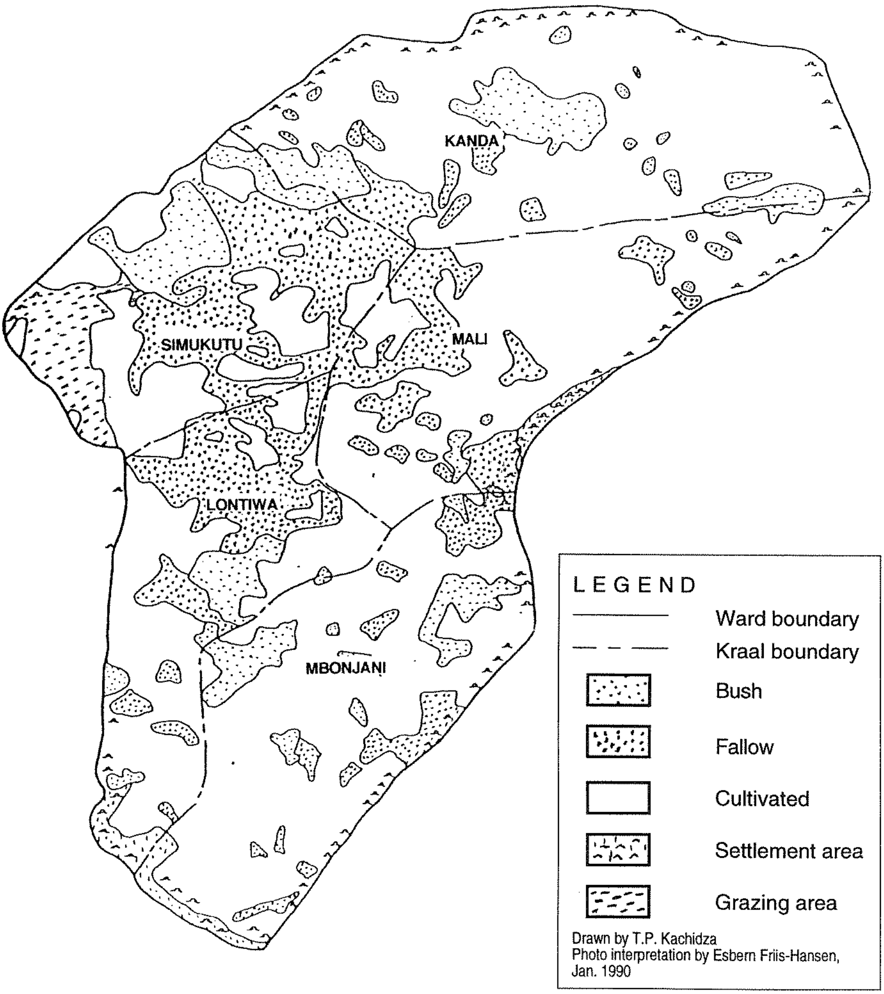
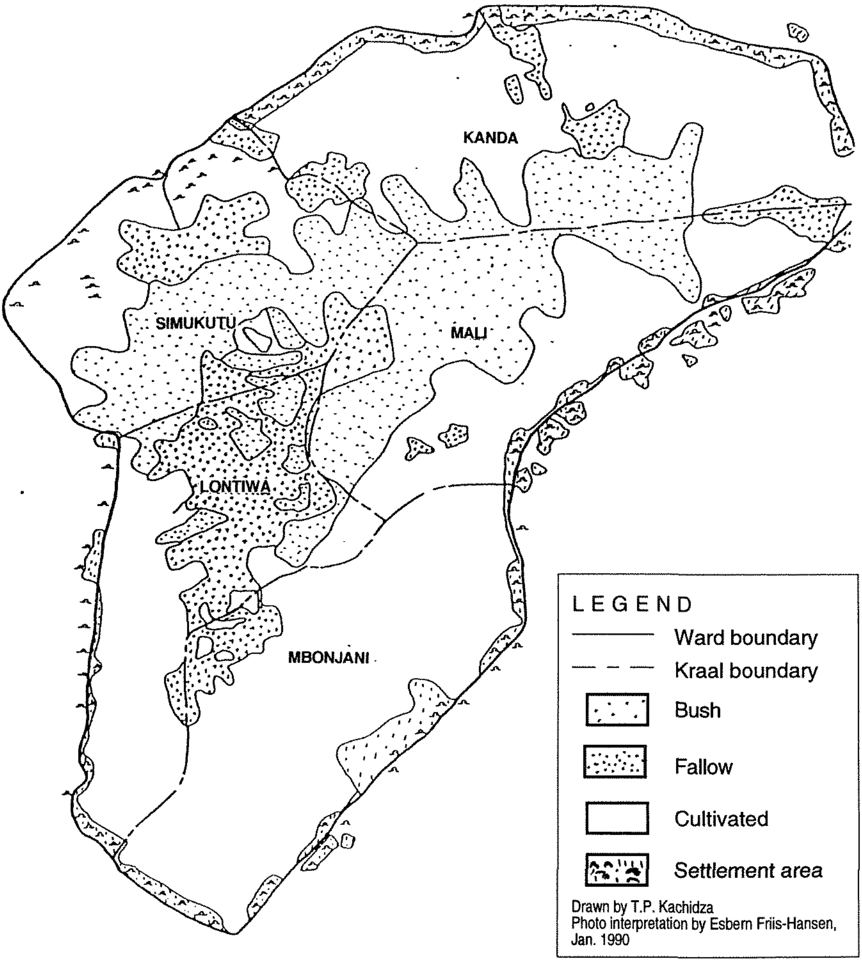
[1]These observations are consistent with the classic theory of the geographer, Von Thünen, who observed that the intensity of land use diminishes with increase in walking distance.

Map 8. *Land use in the survey area, based on air photo interpretation, 1971 and 1974*



The expansion of cultivated area cannot be substantiated through the available aerial photos. By comparing the land use maps drawn from air photos in 1974 and 1985, the opposite can be concluded; the area under cultivation in 1985 is less than in 1974. The explanation for this is that 1985 was not a typical year, because of the civil war in the area. A curfew was in force then, during which peasants were only allowed to be outside their compound from 9 am to 4 pm. During this period, water had to be fetched, firewood collected and fields cultivated. This labour limitation clearly had an effect on the cultivated area.

Map 9. *Land use in the survey area, based on air photo interpretation, 1985*



Land tenure

The right to use land in the infields has traditionally been allocated to the peasants by the paramount chief and through his chiefs, the headmen, and the krall heads. This right was usually given to the male head of household at the time of marriage. The right could also be inherited from father to son. Under the traditional system, the use right could be withdrawn from the peasant if the land was no longer used. Land tenure on the outfields is common, that is, all peasants in the community may freely graze their livestock and otherwise utilize the outfields.

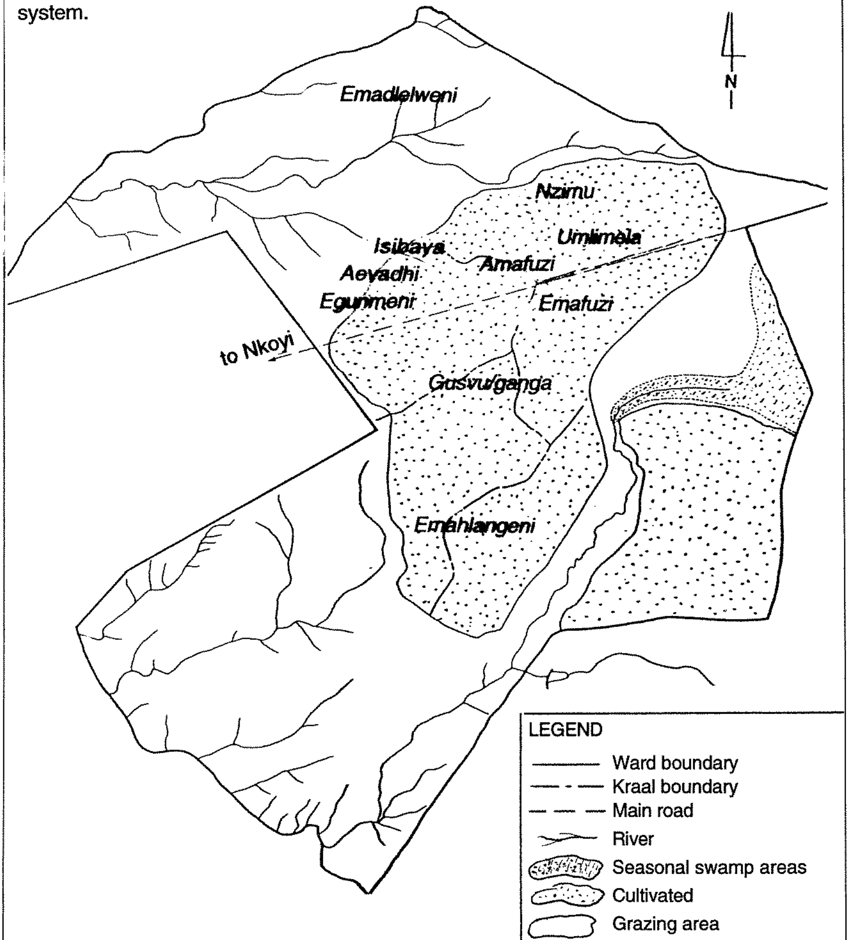
As discussed below, there are considerable differences in the area under cultivation among the households in the sample. Approximately half of the households cultivate between 5 and 10 acres with an average of 8.5 acres; some 30% of the households cultivate less than 5 acres; and some 20% cultivate between 10 and 25 acres. The difference among households in size of cultivated area is not a direct effect of difference in use rights to land, but rather a question of differences in the capacity to cultivate.

While most households do not regard access to land as a major constraint for production, land shortage is beginning to be felt by households of newly married couples. New households are today allocated land in the inner zone, distant from the homesteads. This land is more prone to attack by vermin than land closer to the settlement area and is more demanding of labour because of the time used reaching the fields. Some young households manage to acquire plots of land in the grazing area (outfield) for their homesteads. There is a tendency for them to cultivate one or two acres around their houses, thus further reducing the size of the already over-grassed pastures.

The tendency by some peasants to expand their gardens along the river banks at the expense of the common pastures causes conflict over land rights between peasants with many cattle who depend on sufficient grazing areas during the dry season on the one hand, and predominantly resource-poor peasants who wish to cultivate vegetables to supplement their diet during the rainy season, and for whom access to dry season pastures has lower priority, on the other.

Box 11. Vernacular names for land use categories

The Ndebele language contains a wealth of words which are very precise expressions of the peasants' distinctions between land use categories in the complex farming system.

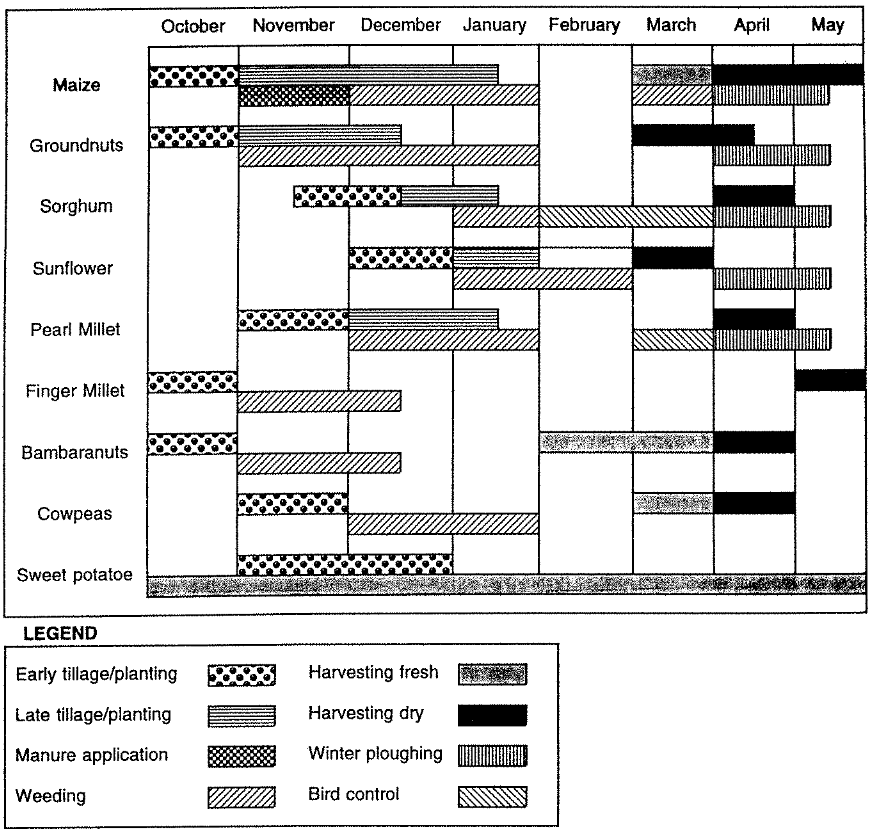


The following list of expressions is far from complete and merely what a foreign researcher could pick up during a period of field work:

Nzimu	Fields which are continuously cultivated with rotational application of manure.
Amafuzi	Fields cultivated in fallow rotation with no application of manure.
Umlimela	Strip cultivation, e.g. alternate strips of fallow and cultivated fields.
Emadlelweni	Grazing area.
Emahlangeni	Fields which are grazed post-harvest.
Emafuzi	Fallow used for grazing.
Gusvu/ganga	Bush, e.g. areas where cultivation has been given up and which now is occupied with natural vegetation.
Egunmeni	Area on which the homestead is located
Aeyadhi	Area on which the homestead and surrounding fields are located.
Isibaya	Area where the livestock kraal is located.

> *Box 12. Land allocation to a new household*
>
> A newly married young man from a well-established family was recently allocated land in the inner area by the kraal head. When he married, he was dissatisfied with the quality of the land allocated to him, claiming that it had been exhausted by previous cultivation and was therefore laid long-term fallow by the previous users. Moreover, he did not want to build a house for his family on the fields allocated to him, because they were located far from the existing settlement and from the grazing area. Therefore, he will approach the kraal head again through his father some time in the future and request another land allocation. He has a plot in mind, which he judges to be more productive and suitably located near the road. The young man was uncertain whether he would be successful in obtaining the land in question, but argued that his family came to the area in 1948 when much of the area was forest, and that they had been living in the area even before the kraal head himself.

Figure 6. *Crop calendar for Silobela communal area*



Household labour force and constraints

As discussed in chapter 6, the economy of Silobela communal area is heavily dependent on income from migrant labour. This has serious repercussions for the availability of labour during the cropping season. If the husband is working as a migrant, all work has to be done by the wife and children.

Figure 6 shows the agricultural calendar for crop production in Silobela. The cropping season starts in October/November, continues throughout the rainy season, and ends in May/June. During the off-season from July to September, the majority of activities take place on the homestead, including transport of the harvested crops to household storage, processing and marketing, securing of seeds and tools and, if required, chemical inputs.

Tillage is done by means of ox-plough (and to a lesser extent by tractor) for all crops cultivated in rows. For some crops, such as sweet potatoes, where cultivation takes place in mounds, tillage is done with a hand hoe. Planting is usually done at the same time as the tillage. Typically, the husband ploughs the field and the wife follows behind him and plants, using her feet to cover the seed. As shown in Figure 6, an additional tillage, the winter ploughing, is done on some fields. Winter ploughing is immediately after the harvest while the soil is still soft after the rainy season.

Application of manure and mineral fertilizers is done in conjunction with tillage and planting. As the extent of fertilizer used is very limited and the volume of manure applied also small, this is not a demanding labour task.

Peasants cultivating small grains have to guard them against attacks from birds throughout February and March. Although it is light work, bird guarding is a very time-consuming task.

Weeding is done three times. Inter-row weeding is usually done by means of an ox-drawn plough or cultivator, while weeding between the plants is done by means of a hand hoe. As shown in Figure 6, weeding competes with both finishing tillage and planting, bird guarding and harvesting of round nuts and groundnuts.

Harvesting is carried out in different ways: little by little, fresh from the field as needed for subsistence consumption, and after the crops have dried. Post-harvest, fields are cleared and crop residues collected. These are then transported to the farm in Scotch carts to be used as livestock feed or compost. Peasants burn off the sunflower stems on the field, as they are not suited for livestock feed.

Most households experience labour constraints during the growing season from December to March. Tillage and weeding demand most labour and labour bottle-necks frequently occur when because of the timing, these tasks compete with each other or with other tasks. Because of the short duration of the growing season, early planting is crucial for achieving high yields. The period following immediately after the first rains is therefore the busiest of the year. Tillage, planting and weeding often compete for labour in December and January, when weeding is required before all fields are ploughed.

The second major labour constraint is in February/March, when groundnuts and bambaranuts are mature and should be harvested if there is plenty of rain, before weeding is completed. Labour constraints also occur during harvest. This is especially the case if the schools are open while there is still a lot of work to be done. If harvest is delayed, there is an increased risk that livestock will encroach on the fields and eat from the crop in May and June, when the children are not there to head them off. Under such circumstances, some peasants harvest part of their maize while it is green because they fear that otherwise the mature maize will be eaten by livestock. During harvest, all the maize stalks are cut line by line and stacked in bunches for later collection.

The size of the labour constraints varies from season to season. In case of an early season dry spell, tillage may be delayed thus enhancing labour competition between different tasks. When the season is delayed, both ploughing and weeding take place while the schools are open, which creates extra labour constraints for households where the husband is away on migrant labour and the wife depends on the contribution of their children.

Because of labour constraints, many fields are weeded late or insufficiently and the weeds compete with the crops in terms of resources. The consequences of labour constraints are reduced yields and reduced cultivated acreage, resulting in reduced total household production.

Peasants in Silobela communal area apply several strategies to overcome labour constraints. The most common is to work in reciprocal labour exchange groups, so-called beer parties, as described in chapter 6. With the low level of mechanization, there is seldom economy of scale in working together in groups. Still, many peasants stated that this helped them overcome their work loads. The advantage is primarily psychological in that working together keeps the labour morale high. Another solution to labour constraints is to work harder, for example, preform the task during the evenings while the moon is full. In migrant labour households, it is common for the wife and one of the older children to plough in the moonlight. Another common strategy, when time is constrained at the start of the growing season, is to strip-plough. This minimum tillage technique is only viable on fields were the level of weeds is naturally low.

Outfield capacity

Livestock in Silobela communal area graze in the outfield during the rainy season, and post-harvest, during the dry season, in the infield on fallow land and crop residues. Livestock is allowed to graze in the outfield only from 1 January to 15 July. The reason for this is that all peasants are occupied with labour tasks in the fields and do not have time for herding, and that new green grass has then emerged in the outfield. After 15 July, the livestock is allowed to graze on the arable land, where there is plenty of fodder during this time, either in form of maize stalks or fallow fields. Later, in the dry season, the livestock is given supplementary fodder consisting of crop residues, mainly maize stalks, which are collected and stored on the homestead.

While the livestock graze in the outfield, they are herded with a minimum use of labour. Herding is done in groups on rotational basis. All livestock belonging to the group are brought to a certain location every morning, and led into the outfield by two to three adults or children. If the size of the group is some 30 households; each household contributes one day of labour for herding twice a month. The herding is not intensive and the livestock is allowed to graze freely. The purpose of the herding is primarily to ensure that all livestock return to the homesteads in the evening. When allowed to return to the infield in mid-July, the livestock is allowed to graze freely without being herded for a three-month period. To protect the newly planted fields, the livestock are once again herded from October until January. Herding is done by adults until early December, when the work is taken over by the children who then start their holiday from school.

The grazing pressure on the outfields has been increased drastically over the last four decades. In 1936, only four households lived in Mbonjani krall. This is 5% of the population density in 1972, when 76 households lived in Mbonjani krall. Before the establishment of Silobela as Tribal Trust Land after the World War II, part of the circle and what is today outfield was also used by the Cold Storage Commission (CSC) for grazing livestock on commercial basis.

Burning the pasture in the outfield at the end of the dry season was commonly practised as a method to improve and maintain the quality of the pasture for the coming season. The logic of the practice is two-fold. Burning the vegetation at the end of the dry season does not harm the new grass seed which is protected by the soil, while it supplies plant nutrients (phosphorous) to the soil which improve the germination of the new grass. Secondly, burning prevents trees and bushes from growing and expanding, yet without destroying them. The practice of burning the outfield is thus a sustainable system of fertilizing the pasture. It subdues the growth of bushes and trees so that they do not expand at the expense of the grasses, and at the same time they can provide shade, windbreak, and firewood.

The practice of burning grass was stopped in 1948 by the colonial administration, which saw the practice as uncontrolled destruction of the environment. According to elder peasants interviewed, the composition of vegetation in the grazing areas has changed slowly since the practice of burning was stopped. Trees and bushes began to expand at the expense of grasses, which over the last four decades have gradually become exhausted and scarce. The tree and bush cover is today the dominant vegetation in the centre of the circle and in the outfield. Today, the common pastures in the outfield are also seriously degraded, to the extent that there is more bare soil than grass between the trees. The grazing capacity has declined accordingly.

There has in the past been some controversy in Zimbabwe about whether high stocking rates combined with poor management of the outfield are causing irreversible environmental degradation. Ecological carrying capacity can be defined as: the maximum number of animals the land can hold without being subject to density dependent mortality and permanent environmental degradation (Cousins 1990).

Commentators in Zimbabwe, since the establishment of the first Tribal Trust Lands in the 1930s, have claimed that the grazing areas were 'over-grazed' and that this led to irreversible environmental degradation. In their arguments, these commentators have compared actual approximate stocking rates with the ecological carrying capacity based on single-function commercial beef production. This is like comparing apples and pears and ignores the fact that there are qualitative differences between the two systems in terms of ranging management. The concept of ecological carrying capacity is not simply related to natural regions, but to a specific livestock farming system, i.e. the system of grazing and herding.

As discussed below, direct density-dependent livestock mortality is not common in Silobela communal area. The number of livestock has possibly declined over the last decade, but for reasons which are only indirectly linked with the density of livestock.

Regarding the relationship between livestock density and environmental degradation, the picture is unclear. International writers have recently suggested that there is no direct relationship between high stocking rates and rates of soil erosion (Blaikie 1985). The explanation of the very serious process of degradation which is taking place in the outfield is complex and includes four interrelated elements which will be expanded on in the following: the imbalance between number of livestock and outfield capacity; the destructive stripping of the branches of trees for firewood; sedimentation of soil eroded from the infield; and gully erosion in the outfield.

The 'imbalance' between the number of livestock and outfield capacity results in what is sometimes termed 'over-grazing', i.e. when the fodder requirements of livestock seriously exceed the capacity of the pastures and lead to destruction of vegetation, soil compaction and soil erosion.

As shown elsewhere, the number of livestock most probably increased over the first three decades of settlement (1948–1978), while it has been decreasing over the last ten to fifteen years (1978–1992). The number of live stock is not controlled and the individual peasant has no incentives to limit the number of livestock owned and grazed in the commons.

The capacity of the outfield has been decreasing at an increasing pace. There are several reasons for this. As discussed earlier, the changed composition of the vegetation has caused trees and bushes to expand at the expense of grasses, and thus decreased the outfield grazing capacity. Also discussed earlier, continuing land allocation expands the arable land at the expense of the common pastures. Cultivation is expanded partly through settlement of new households as the population grows, and partly through expanded cultivation of vegetable gardens along the river bank. The decrease in the area of the outfield clearly limits its grazing capacity.

The high and increasing population density over the last four decades has led to serious deforestation. Since the women are prevented from cutting down whole trees, they strip the trees and bushes of branches. This increases the wind while diminishing shade, and thus makes the area prone to erosion. The run-off is high around the village because the soil is compacted by much livestock. The consequence is serious gully erosion during heavy rains. Meanwhile, a considerable volume of top soil is eroded from the cultivated areas of the infield, despite the fact that the slope is gentle and a reasonable amount of contour ridges exist. The foot paths through the fields seem to be partly to blame for the erosion, as they serve as streams during the heavy rains. Part of the material eroded from the infields, primarily sand, is sedimented in the outfield. These processes have a negative effect on the growth of grasses in the outfield and thus limit the grazing capacity.

Peasant households in Silobela communal area adapt their livestock herding strategies to changes in environment. The imbalance between number of livestock and the grazing capacity of the outfields has had serious consequences for the ability of peasants to provide sufficient fodder to keep their livestock healthy and fit for work as draught oxen.

The rainy season is today the most serious deficit period, for the grazing capacity of the outfield cannot cope with the livestock population's food requirement. There are therefore increasing incidents of livestock encroaching on the arable land. Some peasants have solved the problem by fencing their fields with thorn bushes.

The shortage of fodder for the livestock is especially grave from April to July, since during this period, the livestock only grazes in the outfield. Browsing on leaves and pollen pods from the trees is then an important source of food for the livestock. *Acacia albida*, gonde (a local tree species with red edible leaves) and a number of local species are abundant and serve as an important source of fodder for livestock.

Box 13. Privatization of post-harvest grazing in the infield

Environmental degradation of the outfield has seriously limited grazing capacity and increased the pressure on livestock owners to look for alternative sources of fodder for livestock.

Mr. Dube from Mali kraal was one of the first farmers to fence some of his cultivated fields. The fence consists partly of barbed wire and partly of thorn bushes. The purpose of the fence is two-fold, Mr. Dube explains. It helps him supply his livestock with grazing during the dry season, since he takes advantage of the general rule of common grazing on the infield. At the same time, the fence prevents other people's livestock from entering his fields. Secondly, the fence alleviates the time pressure on him and his family to finish harvesting and collecting the crop residues before the date commonly agreed upon for livestock to enter the infield.

The end of the dry season has traditionally been a period when fodder is in short supply. During this period, peasants' herding strategies have taken maximum advantage of exploiting variations in the microclimate through the use of 'key resources', defined by Scoones (1990) as "patches that offset critical constraints either of forage quality or quantity". In the communal areas of Zimbabwe, these consist of pastures along river banks, vleis, drainage lines or sinks. The pastures along the river banks in Silobela communal area constitute such a key resource. In December, when there is no more vegetation on which to graze in the infield and while the new green grass is yet to emerge in the outfield, grazing takes place on the pastures along the river banks. Here, there is still green grass because of the high soil moisture. Livestock grazes during the morning, goes to drink water in the afternoon, and returns on its own to feed on maize stalks in the evening.

As discussed earlier, some peasants have begun to cultivate these pastures as vegetable gardens (see Map 10). This is a source of potential land use conflict between cattle owners who depend on these patches to offset the dry season shortage of fodder, and poor and hungry peasants who need to cultivate gardens as a food bridge between the two main food seasons. It aggravates the need for supplementary livestock feeding during the dry season which today is considerable. This need arises already at the start of the dry season and increases throughout the period. Maize stalks collected post-harvest make up the main supplementary feed. Since most of the time this exists in insufficient quantities, the following categories of livestock are favoured: 1) cows with calves; 2) draught oxen; and 3) livestock which are fed for commercial sale.

Draught oxen are given priority for supplementary feeding during ploughing time, when they are fed with maize and other crop residues after they have finished the day's work. Other livestock get little or no supplementary feeding and have to survive on what they can eat on the overstocked common grazing area.

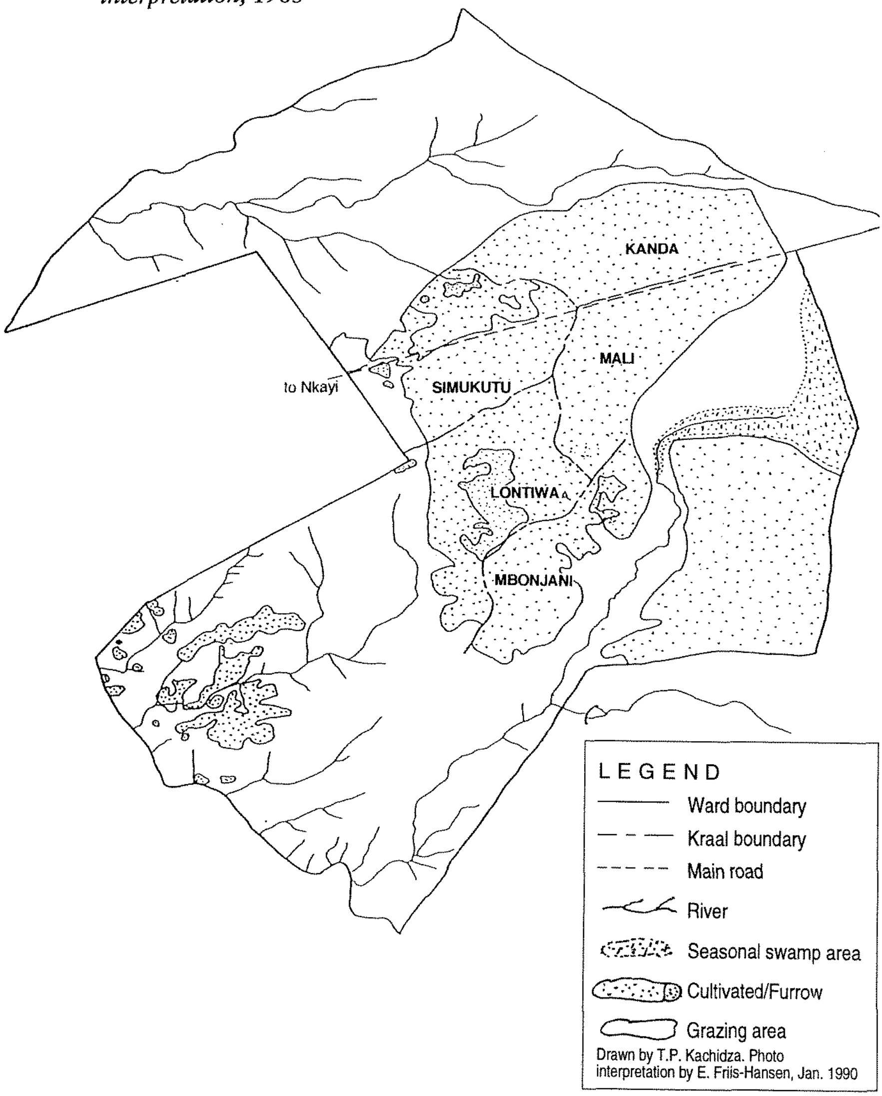
Livestock production

Trends in size, composition and distribution of livestock herds in Silobela communal area

According to the peasants interviewed, the number of livestock have been diminishing over the last two decades. It has not been possible to collect reliable data on numbers of livestock over time, and the claim is not verified by other sources. The explanations for this decline in number of livestock are varied and to a great extent have to do with factors beyond the control of the peasants.

In the mid-1970s, there was widespread depletion due to cyanide pollution from two derelict mines. Further depletion took place during the period immediately before and after independence, when the veterinary system virtually broke down and anthrax disease resulted in high mortality. The

Map 10. *Cultivation and grazing in the survey area, based on air photo interpretation, 1985*



successive droughts since 1982 sparked off another depletion of livestock, which was further aggravated by livestock dying from eating the poisonous Mkauzani plant (see box 14). Some livestock also died because of the civil war.

The krall head stated during an interview that the decline had accelerated in the 1980s. As a typical example, he told of a household which possessed 40 head of livestock in 1982 and only 8 head now.

Box 14. Mkauzani increases livestock mortality

Mkauzani is the local name for a poisonous plant causing considerable problems for livestock holders in Silobela, where a large area is infected by the plant. The scientific name for Mkauzani is *Dichapetalum cymosum*. It is known in South Africa as Gifblaar or Poison Leaf. In Zimbabwe, the plant is found on Kalahari sand in areas of Matebeleland, Midlands. The leaves are about three inches long and grow alternately from the stem. New growth starts in early spring (August to November), when it is most dangerous. The younger the growth the more toxic it is. The plant was first described in 1909 and reported to cause many animal deaths in Rhodesia and Transvaal in South Africa. It is mentioned in many annual reports by the Director of Veterinary Services in Rhodesia.

Its poisonous ingredient was first identified in 1944 as monofluoroacetic acid, a strong poison. Animals that have eaten the plant may drop dead soon after a drink of water. The active ingredient is rather soluble in water and animals die of heart failure. Affected animals have cramps and stagger around. Respiration is heavy and the heart weak. Animals should be kept away from water and as quiet as possible. Sub-lethal doses of Mkauzani can cause death if cattle are driven. The best available preventive measure is to keep livestock away from Mkauzani infected areas from August to November. Best of all, affected areas should be fenced off and over-grazing should be avoided. No antidote has been developed and such a solution is unlikely (Dept. of Veterinary Sciences 1971).

Drought seriously affects the quality of grass, and grazing areas are clearly insufficient to feed the livestock. The animals are therefore kept on the arable land, where they can graze on the fallow vegetation and fodder trees. These practices greatly increase the demand for herding which often cannot be met, since the children are in school during the day. Livestock are therefore left unguarded and may damage themselves or the crops. Since Mkauzani is one of the only trees with green leaves from August to November, it attracts livestock. Mkauzani kills large numbers of livestock in Silobela yearly.

No livestock have died during the 1989/90 season due to Mkauzani, because the rains have been plentiful and the grazing area sufficient. Nearby, during the colonial period, a white commercial peasant tried to dig the root up but it returned the following year. According to Drummond and Shone (1965), Mkauzani can have roots up to 80 metres long and the only viable means of prevention is to fence off the affected area.

Table 15 shows peasant households' access to livestock and draught power equivalents. It should be noted that no significant differences exist between the three groups in average ownership of cattle, although for the high income strata of households the composition of the herd is biased towards draught oxen. The average for the high strata households hides large differences, since this group consists of both large cattle owners and households with formal sector employment as their main source of income. There is a significant correlation between the number of small stock per household and ascending social groups.

Table 15. *Composition of livestock by income groups*

	Low		Middle		High		Average	Standard deviation	Min.	Max.
Bulls	0	0%	2	13%	0	0%	1.1	3.8	0	20
Cows	5	46%	3	20%	3	25%	4.1	6.7	0	36
Oxen	3	27%	5	33%	6	50%	4.5	4.5	0	16
Heifer	0	0%	1	1%	1	8%	0.9	2.2	0	9
Steer	0	0%	1	1%	0	0%	0.5	1.9	0	9
Calves	3	27%	3	2%	2	17%	2.7	4.0	0	19
Sub-total cattle	*11*	*100%*	*15*	*100%*	*12*	*100%*	*13.8*	*18.3*	*0*	*73*
Donkeys	3		6		3		4.0	7.7	0	40
Goats	7		9		12		8.8	7.8	0	27
Sheep	2		0		3		1.8	4.4	0	16
Pigs	1		1		0		1.3	4.1	0	16
Rabbits	0		0		11		0.6	2.2	0	9
Chickens	19		21		18		20.1	19.3	0	100
Ducks	0		3		0		1.3	5.5	0	30
Pigeons	0		1		0		0.5	1.9	0	9
Small stock	13		16		29		11.8	10.5	0	36
Birds	19		25		18		2.4	7.12	0	30

Source: Household survey 1989/90. Number of households = 32.

Net return from livestock production

Livestock fulfil multiple functions in the farming system: input to arable production in terms of draught power; nutrient transfer from the outfield to the infield; transport, milk and meat; and an asset to income security. Only households with herd sizes exceeding what is required to regenerate a draught oxen team and provide sufficient manure would possibly be interested in ranging livestock for the sole purpose of marketing. The off-take rate[1] in communal areas is generally as low as 5% or less, compared with 16–26% off-take rates on large-scale commercial farms. One reason for the generally low level of commercialization of livestock in communal areas is that some 70% of households owned less than 6 head of cattle in 1985 (CSO 1986), while less than 10% of the households owned more than 10 head of cattle (Jackson 1989). A more profound explanation of that very limited commercial sale of livestock is that the use value of keeping the livestock is high compared with the cash income from selling it. The peasants clearly preferred the net benefits of the existing multi-function ranching system to the single-function ranching system that concentrates on raising cattle for sale as beef.

Livestock productivity has commonly been measured from a commercial beef production system point of view. As sale of beef animals is not an important reason for having cattle in Silobela communal area, this method

[1]The off-take rate is defined as the number of livestock sold per year over the total number of livestock.

results in a wrong valuation of livestock production. Livestock productivity and valuation of output should instead be determined on the basis of their multi-function for the household's livelihood strategies. In his Ph.D. thesis on livestock in communal areas of Zimbabwe, Scoones (1990) develops a different approach to valuation of livestock using a replacement cost method. He use four measures of economic net return: net present value; internal rate of return; pay-back period; and gross margin. Scoones arrives at a net return of Z$113/ha/year for livestock in the communal areas. A conventional estimate based on commercial beef ranching in NR IV is Z$12/ha/year (ARDA). There are four reasons why Scoones' figure for net return is a factor ten higher than conventional measurements:

1. different assumptions about prices
2. actual communal area stocking rates are used, which greatly exceed the officially recognized ecological carrying capacity of livestock in NR IV; ARDA uses the recommended stocking rates for their calculations
3. actual communal area biological reproduction rates are used, which are considerably higher than assumed in the official model
4. use values such as transport, draught power and manure are included, also goats and donkeys—a major difference.

Although details of Scoones' method of valuation can be questioned, his study represents the first attempt in Zimbabwe to calculate the use value of livestock for peasants in communal areas. It clearly shows that the benefit of keeping livestock in the communal areas is considerably higher than one might expect from conventional economic net return calculations based on commercial livestock management.

Nutrient transfer capacity

The major source input for regenerating soil fertility is use of organic manure. Peasants use organic matter from livestock as manure for their fields. Grass is cut and added into the kraal to increase the volume of manure. In addition, many peasants compost some of their crop residues, together with ash from the fire and household waste. Composting is done twice a year and both increases the volume and the quality of manure.

During the rainy season, maize stalks left over from the previous season and fresh crop residues are mixed into the wet manure in the livestock kraal. Houses within the compound are thatched after every 2 or 3 years and the grass from the old thatches is added to the compost pit.

During the dry season, daily ash and household waste are put in a pit together with crop residues from processing maize, sunflower, groundnuts, bulrush millet etc. Water availability limits the possibilities of dry season composting. The nearest water source is far away during the dry season and some peasants practice water harvesting—collecting grey water from washing and cooking etc. to add to the compost pit.

The effect of fallow rotation in terms of fertility is limited, as fallow vegetation is scarce. Perhaps more important, fallow is regarded as a means of reducing or eliminating the weed population. Moreover, fallow vegetation is an important source of supplementary feeding for livestock.

Use of mineral fertilizer is regarded as hazardous by many peasants. Because of the uncertainty of the rainfall pattern, application of basic fertilizer carries the risk that instead of adding nutrients to the soil, the seeds might be 'burned off' and no long able to germinate. The potential benefits of mineral fertilizer use are regarded by many peasants as insufficient to take the risk. When mineral fertilizer is applied, it is commonly in the form of top-dressing.

A group of peasants interviewed during the survey agreed that the minimum required amount of manure per acre for regenerating soil fertility is three Scotch-carts, equivalent to some three and a half tons of manure. This matches almost exactly the average application during the 1989/90 season of 3.6 tons/acre.

The nutrient transfer capacity of livestock is primarily confined to cattle. According to the data collected in the sample, the average nutrient transfer capacity of cattle is approximately half a ton of manure per year. In average, manure was applied on 1.7 acres per household in the sample, which amounts to some 19% of the total cultivated area. 90% of the area with manure applied was cultivated with maize while the remaining 10% were fields with groundnuts, sorghum, cotton and sunflower.

To make up for the limited supply of manure, peasants stretch the effect of manure application as much as possible by engaging in labour intensive methods of application. Manure is applied on a rotational basis to the fields most in need of it. Since the production and application of manure is so labour intensive, only the parts of the selected field having the lowest fertility are selected for application. Especially the digging of kraal pitches and transport to the field demands much labour. The first crop after application of manure is usually maize and occasionally groundnuts.

Table 16. *Use of manure in Silobela communal area, 1988/89*

Manure applied (tons)	No. of fields	% of all fields
0	131	86
1–5	8	5
8–9	6	4
9–14	9	5

Source: Household survey Silobela 1989.
Number of households = 32; number of acres = 234.5.

During interviews, the peasants were asked to estimate the residual effect of manure application on soil fertility. There was general consensus among the peasants interviewed that the residual effect of manure on the fertility level of the soil lasted 2 years on Kalahari sand soils and 4 years on Mupane clay soils (see table 22).

In order to calculate the minimum required application of manure for maintaining the fertility level for continuously cultivated fields, it is reasonable to use the two judgements by peasants in Silobela communal area discussed above: that the minimum required volume of manure is 3.5 tons/acre, and that the residual effect of manure application on the fertility level of soil under cultivation is 3 years.

The present nutrient transfer capacity of cattle in Silobela communal area only meet 54% of this minimum requirement. If manure shall continue to be the dominant source of regenerating soil fertility, two options are available: either to increase the nutrition standard of the cattle and thereby improve the nutrient transfer capacity of each head, or increase the average head of cattle per household. The latter option would require an average increase from the present level of 13.8 to approximately 21 head per household. Needless to say, both options would require improved availability of fodder for livestock. This is further discussed below.

Draught power capacity

Table 17 shows that more than 95% of the area was ploughed with the use of draught power. The strength of draught animals is especially needed on the red clay soils, where a minimum of 2 spans of oxen are required (4 animals). Peasants with sufficient draught power may choose to use 6 oxen in front of the plough, in order to reduce the time used for tillage. One hectare can be ploughed in 1.5 days using 6 oxen. On Kalahari sands, however, ploughing can be accomplished by using only one span. Heavy red soils also require more rain than the lighter sand soils to soften the soil sufficiently to facilitate ploughing.

Table 17. *Methods of tillage on maize fields by income groups* (acres)

Methods of tillage	Low	Middle	High	Average	Standard deviation	Min.	Max.
Winter-ploughing	52%	42%	81%	3.9	5.9	0	26.3
Ploughing at first rains	35%	17%	19%	1.6	2.2	0	6.0
Delayed ploughing	5%	25%	0%	0.8	1.9	0	8.0
Tractor ploughing	3%	15%	0%	0.5	1.5	0	8.0
Hand hoe	5%	1%	0%	0.1	1.6	0	3.5

Source: Household survey Silobela communal area, 1989.
Data include 99 fields or 224 acres cultivated by 32 households.

The maximum depth of ploughing using oxen or donkeys as draught power is 20 cm, 5 cm less than the optimal recommended by Agritex. Peasants are only able to plough to the recommended depth by using a tractor, which is an expensive and unreliable source of draught power.

More than half of the fields are winter ploughed, which illustrates that peasants have been quick to adopt the technology only recently introduced by the extension service. Winter ploughing is done in April. When manure is

Table 18. *Methods and number of weedings in Silobela communal area, 1988/89, by income groups* (acres)

	Low	Middle	High	Average weeded	Average total
Weeding method					
None	–	–	–	–	13%
Ox-cultivator	8%	0	0%	8%	7%
Hand hoe only	19%	17%	2%	11%	9%
Combined hoe and plough	73%	83%	98%	82%	71%
Number of weedings					
None	–	–	–	–	13%
One	60%	53%	17%	49%	43%
Two	40%	37%	71%	35%	30%
Three	0%	10%	12%	16%	14%

Source: Household survey Silobela communal area 1989.
Data include 99 fields or 224 acres cultivated by 32 households.

applied during winter ploughing, the early rains can penetrate into the top soil more easily. Neither winter ploughing nor manure application alone has this effect. Winter ploughing thus facilitates early planting.

In Mbonjani, where Mupane clay soil is predominant, many peasants practice winter ploughing. The fields are ploughed in the dry season, after the livestock have been allowed to graze on the maize stalks. Otherwise, run-off of the early rains because of hard top soil is a major problem in Mbonjani. During drought years, crop growth is more seriously affected in Mbonjani than it is in Mali, where the sandy soils facilitate easy penetration of water into the top soil. In Mali, where Kalahari sand soil is predominant, winter ploughing is less common. Peasants claim that winter ploughing causes crunching and subsequent water logging; also, livestock can sink into the sand. The soil sometimes gets too compact when livestock walk on winter ploughed fields; therefore, peasants who have resource surplus may plough an extra time after the early rains have softened the soil. More advanced peasants harrow their fields immediately after ploughing.

As shown in table 18, oxen are used as draught power for weeding 78% of the area cultivated and 89% of the area weeded. For only 11% of the area weeded was the hand hoe used alone. Table 18 shows a clear relationship between intensity of weeding and income groups. While almost all high income households combined ox-cultivation and hoe weeding, this applied for only 3/4 of the low income households. Moreover, some 60% of the maize area cultivated by low income households were weeded only once, while 83% of the area cultivated by the high income households were weeded twice or more.

The first weeding usually takes place when the maize plants are 15 cm high using a combination of inter-row cultivation with a cultivator or plough and intra-row weeding with a hand hoe. Second weeding takes place just before the maize plants tassel and are approximately one meter high. Most peasants perform the second weeding by hand, but some combine

Table 19. *Cattle, donkeys and draught power equivalents (DPE) by income groups*

	Low	Middle	High	DPE<1	DPE>1
Bulls	0	2	0	0.1	1.5
Cows	5	3	3	1.6	6.0
Oxen	3	5	6	1.0	7.4
Heifers	0	1	1	0.1	1.2
Steers	0	1	0	0.0	0.5
Calves	3	3	2	1.1	3.8
Total cattle	*11*	*15*	*12*	*3.9*	*20.3*
Donkeys	3	6	3	1.7	5.7
Potential DPE	1.1	1.8	1.8	0.5	2.6
Actual DPE	0.6	1.4	2.4	0.0	2.1

Source: Household survey 1989/90. Number of households = 32.
DPE is defined as ownership of either four draught oxen or eight donkeys.
Only complete DPE units are counted.

hand weeding with use of a cultivator, just as for the first weeding. These peasants use a locally designed yoke, which is higher than the normal yoke and enables the oxen to walk in the fields without causing damage to the high maize plants.

As shown earlier, 91% of the area is tilled by using oxen despite the fact that 44% of the households do not have access to draught power. The average size of ploughed area per draught power unit in the sample is 6.5 acres. This can be explained by extensive renting and hiring. Well-off peasants own two or more spans of oxen, ploughs and cultivators. It may take a well-off peasant a whole month to plough his fields. These peasants often work in their own fields in the mornings and rent out their ox teams in the afternoons. The ox teams will also be rented out after the peasant has finished ploughing his own fields. The price for renting draught oxen in the 1988/89 season was Z$15–20/acre. The price for renting implements was Z$20 per operation.[1] As discussed in chapter 2, agricultural assets such as ploughs, cultivators, harrows and Scotch carts are lesser constraints than draught power itself. The well-off peasants even have planting machines and groundnut shellers.

Some households who have some draught power, but not enough to establish a full ox team, share it with other households in a similar situation. During the time of tillage, the shared draught team is exchanged on a daily basis. This strategy contributes somewhat to alleviate the shortage of draught power for households with insufficient numbers of cattle or donkeys.

[1]A range of hiring arrangements exist which do not involve cash payment, i.e. different forms of share-cropping arrangements (of which the exact terms are not known to the author). Since the peasants interviewed were not very willing to discuss these arrangements, the survey did not go deeper into the subject. It should be noted that rent/hire of draught power is not included as income/expenditure in chapter 6.

Box 15. Donkeys instead of oxen as draught power—a sign of progressive degradation

Family Dube in Mali kraal suffered a serious set-back during the 1980s when their entire herd of livestock died, except for two oxen. Two oxen provide insufficient draught power for the heavy ploughs; therefore, Mr. Dube bought two donkeys to assist the oxen with the plough. The donkeys are substituted for the oxen because they cost much less and can more easily be sustained on the degraded grazing areas, as they demand less food and are able to eat leaves from the thorny acacia bushes.

The general degradation of the grazing area and the household-specific shortage of cash are thus the two main reasons for choosing to replace the dead oxen with donkeys. The consequences of the change in composition of livestock are generally negative:

- Draught power of donkeys is half that of oxen and they work much slower. On the other hand, because of their better nutrition, donkeys work harder than oxen in the very first part of the rainy season.
- Donkeys are significantly less efficient than cattle in transferring nutrients from the outfield to the infield.

Limited access to draught power is the major production constraint for households with no livestock. A common reason for delayed ploughing and planting is limited access to draught power. Peasants who do not own oxen and ploughs have to wait until the owners have finished using them. One peasant interviewed was not able to rent draught power before mid-December, which had serious consequences for yields. Because Mupane clay soils demand more draught power, delayed ploughing because of draught power shortage is more common among peasants with predominantly clayish soils than those living in sandy areas.

The minimum herd size required per household to sustainably reproduce a draught team of two oxen has been estimated as 10 head of cattle in Zimbabwe's communal areas (Sandford 1982). By simply doubling this estimate for Silobela communal area, a minimum herd size of 20 head of cattle per household would be required, since four draught oxen are required to pull the plough; however, taking into account the fact that the herd size required to regenerate one oxen decreases as the size of the herd increases, the minimum herd size to sustain four draught oxen can approximately be estimated to be 16 head of cattle per household.

The average number of cattle owned per household in Silobela communal area is 12.4 cattle per oxen-based DPE. This may indicate that the herd size in Silobela communal area today is too low to regenerate the existing level of draught power.

Infield capacity

Cropping pattern

Table 20 shows the social differentiation in access to land and the accompanying cropping pattern. It should be noted that the high strata households cultivate double as much as the low strata households. Maize is the most important crop for both subsistence and marketing. Maize is grown on approximately half of the total cultivated area for all three strata of households. Table 20 reveals some differences between the three groups with regard to cultivation of food and cash crops. Cultivation of pearl millet and sorghum, both drought-tolerant food crops, decreases by ascending social strata, while the cultivation of cash crops such as sunflower and groundnuts increases by ascending strata.

Table 20. *Cropping pattern by income groups* (acres)

	Low		Middle		High		Mean	Std. dev.	Min.	Max.
Maize	3.4	55%	4.0	47%	6.3	51%	4.3	2.5	0	12.0
Pearl millet	0.3	5%	0.1	1%	0.0	0%	0.2	0.5	0	2.5
Groundnuts	0.0	0%	0.6	7%	0.7	6%	0.4	0.8	0	3.8
Beans	0.0	0%	0.2	2%	0.0	0%	0.1	0.4	0	2.0
Sorghum	1.0	17%	0.7	8%	0.7	6%	0.8	1.5	0	8.0
Finger millet	0.1	2%	0.1	1%	0.2	2%	0.2	0.3	0	1.3
Cotton	0.1	2%	0.0	0%	0.6	5%	0.2	0.8	0	4.0
Sunflower	0.5	8%	2.2	26%	3.7	30%	1.8	3.0	0	15.0
Bambaranuts	0.1	2%	0.6	7%	0.2	1%	0.3	0.9	0	5.0
Cowpeas	0.3	5%	0.0	0%	0.0	0%	0.1	0.7	0	4.0
Other	0.2	3%	0.0	0%	0.0	0%	0.1	0.3	0	0.5
Total cultivated area	6.1	100%	8.6	100%	12.4	100%	8.3			

Source: Household survey 1989/90. Number of households = 32.

Mono-cropping is the most common form of cultivation, though intercropping is also practised in Silobela communal area. One peasant interviewed cultivated the following crop arrangements, which were repeated for the whole field: 4 rows of maize; 2 rows of sorghum; 1 row of bambaranuts; 1 row of groundnut; 3 rows of sunflower.

Most peasants cultivate their crops in sequence over time. Maize is commonly the first crop to be cultivated after manure is applied to a field. Groundnut, bambaranuts or sorghum are cultivated on the field the following year. The most common sequence is cultivation of maize and groundnuts on the same field in subsequent years.

Crop productivity

Table 21 shows that there is considerable differentiation in yields between the three income groups. For the three largest crops—maize, sunflower and sorghum—there is a clear relationship between increasing yield and higher income group. For maize, the average yield for the high income group is more than 50% higher than the average yield of the low income group. For the less important crops, the yield patterns are more unclear. As the field size for these crops are often low, the uncertainty of the figures is greater.

There is no single or simple explanation for the variation in yield registered in the survey. It has thus not been possible to establish any significant correlations between yield and any single factor. The sequential decision-making process characterizing the farm management of peasant households, combined with the high uncertainty of the data collected, makes it practically impossible to establish a reliable production function. In the following, we will limit the analysis to examine the possible effects of soil type, fertility level and timing of planting.

Table 21. *Yields by income groups* (kg/acre)

	Low	Middle	High	Mean	Standard deviation	Min.	Max.
Maize	618	846	1081	834	497	91	1089
Pearl millet	279	925	720	523	448	0	1080
Groundnuts	0	527	421	426	411	32	1025
Sorghum	169	313	406	415	349	18	1456
Finger millet	256	1111	474	504	438	48	1356
Sunflower	307	313	457	383	279	54	880
Bambaranuts	235	216	945	660	941	0	3640

Source: Household survey 1989/90. Number of households = 32.

Differences in soil type

As discussed in chapter 5, two soil types dominate the infield in Silobela communal area, Kalahari sand soils and Mupane clay soils. The Kalahari sand soils have low yield potential because of their low fertility. Crops cultivated on Mupane clay soils tend to yield higher than on Kalahari sand soils in good rainfall years. During drought years, the run-off from the clay soils will be very high for the first scattered rain, while the rains will easier penetrate into the sandy soils. Cultivation on the sandy soils will normally yield better than clay soils in drought years. The run-off from clay soils during drought years can prevent the successful growth of any crops.

Differences in soil fertility level

During a group interview, peasants arrived at consensus on the following estimates for average maize yields for well-managed fields during years of reasonably good rainfall conditions (see table 22).

Table 22 shows that yields rapidly decline and reach their 'naturally' low state in three years for Kalahari sand soils and four years for Mupane clay soils. The survey data confirm the correlation between use of manure and yield. Table 23 shows a significant correlation (on a 1% significant level in a chi-square test) between maize yield and use of manure. Yield categories below or above 600 kg/acre have been used, each comprising approximately half of the cultivated area. The average maize yield on fields applied with manure is 953 kg/acre compared with 802 kg/acre for fields without manure. In average, application of manure thus increased maize yield by 19%.

Table 22. *Peasants' estimates of average maize yields for Silobela communal area*

a. Yields for maize on Kalahari sand soil	
1st year 45 bags/ha	application of 10 tons of manure
2nd year 15–20 bags/ha	no additional applications of inputs
3rd year 4 bags/ha	no additional applications of inputs
4th year 3 bags/ha	no additional applications of inputs
b. Yields for maize on Mupane clay soil	
1st year 48 bags/ha	application of 10 tons of manure
2nd year ?	no additional application of inputs
3rd year ?	no additional application of inputs
4th year 10 bags/ha	no additional application of inputs

Source: Group interview in Silobela communal area, August 1989.

Table 23. *Correlation between maize yield and use of manure*

	0–500 kg/acre	>500 kg/acre	Percentage
No manure	50 acres	41 acres	70%
Use of manure	11 acres	29 acres	30%
Percentage	46%	54%	100%

Source: Household survey 1989/90.
Number of households = 32; number of acres = 130.

Differences in timing of planting

Sowing is done by hand in a rill made by a mouldboard plough with removed mouldboard. The timing of the planting is of the utmost importance for the yield. The optimum planting date varies from season to season. Earlier planting can result in the highest yields. As peasants know from experience that the early rains are highly unstable, early planting involves an element of risk. Early planting is thus not alone a question of whether the household has draught power and resources to plant early, but also a question of accepting higher risk. The risk for resource-poor households can be total crop failure, while better-off households have the capacity to replant if the early crop fails.

As shown in table 23, planting before or immediately following the first rains is predominant for the high strata households, while less than 10% of the area cultivated by the low strata households is planted early. Some peasants complain that they cannot start planting until other peasants' livestock are off the arable land, as there are no fences around the fields and livestock graze freely on the arable land until early January. Young plants which are easily destroyed emerge on the early planted fields, and therefore early planting creates problems of protecting the fields from livestock during the first weeks and can result in conflicts related to land use.

Table 23 also shows that late planting is as high as 70% for both the low and middle strata households. The major reason for late planting is that the fields are not tilled in time because of limited access to draught power.

Box 16. Planting sequence during the 1988/89 season

- Groundnuts and bambaranuts were the first crops planted at the end of October.
- First maize (R201/215) was planted 13 November.
  Finger millet and sorghum were planted at the end of November.
  Second maize (R201) was planted 8–12 December.
- Sunflower was the last crop to be planted at the end of December.

The effect of the timing of planting on yields is difficult to determine, as it varies from season to season and is different from crop to crop and variety to variety.

The finger millet varieties used in Silobela communal area have to be planted early as they have medium to long season maturity. Finger millet can tolerate to be planted on fields near the grazing area, as the finger millet will germinate even if it has been disturbed by livestock because it grows in bunches. They are therefore less affected by encroaching livestock than maize.

The peasants who were late in planting sunflower during the 1988/89 season because of draught power limitations experienced low yields, because the sunflower received too much rain immediately after planting with the result that the sunflower seed did not germinate. The peasants who managed to plant sunflower early in the season, experienced reasonably high yields.

Crop production strategies

Peasants have developed a number of skills for forecasting whether the coming season will be a good rainfall year or a drought year. Peasants follow closely the signs in nature and claim to be good at forecasting whether there will be light or heavy rains. Among the signs of good early rains is the occurrence of winds from opposing directions (North-South), which causes isolated thunderstorms in the late dry season. If they conclude that the coming season will be prone to drought and that no rain will come in November/December, they react by altering their farm management in a number of ways.

The most common reaction by all groups of households is to increase the acreage of drought tolerant crops including sorghum, sunflower, pumpkin, bulrush millet and sweet potato. Even though most peasants do not cultivate millet any more, or only to a very limited extent for beer brewing, most

Box 17. The cultural context of indigenous plant breeding:
Secular knowledge of indigenous rice selection among the Susu tribe in Sierra Leone

The Susu tribe of northwest Sierra Leone and southern Guinea is agriculturalist and practices a striking degree of variation in cultivation strategies. Farmers have a detailed agro-ecological knowledge, making use of natural variations in soil moisture conditions along the soil catena, carefully matching rice varieties to the particular niches where they are known to grow best. Longley and Richards (1993) show through their study that only part of the indigenous knowledge is commonly known in the community, while some indigenous knowledge is secular and for cultural reasons only known to particular groups in the society.

The knowledge relating to the maintenance and use of a local landrace of rice (*Oryza glaberrima*) called *disi kono*, is an example of indigenous knowledge commonly known in the community. The *disi kono* variety is characterised as

> ... a resilient and drought-tolerant type, capable of withstanding competition from weeds (page 55).
>
> Indigenous technical knowledge is not a single coherent body of knowledge shared by all members of the community. Some secrets are treated as private possessions and closely guarded secrets. Such secrets certainly exist among Susu farmers: on several occasions interviewees bluntly refused to answer specific questions because the information was considered confidential (page 56).

The use of mixed seed of two local landraces *disi kono* and *samban konko* (*Oryza sativa*) as a rotation crop by wealthy groundnut farmers is given as an example of secular indigenous knowledge. According to Longley and Richards, the reason this knowledge is kept secret is that "wealthy Susu men are reluctant to reveal their detailed and well-informed knowledge of the natural world in order to maintain their status as good Muslims" (page 56).

peasants households have millet and sorghum seeds in storage, specifically for use in case of the drought. Even if the rains slow down in December after an insufficient start in November, these crops will still yield something. Drought susceptible crops may be excluded altogether during drought years. If the rain has not begun by December, cultivation of groundnuts will be given up.

If the peasant households predict that the rainfall pattern will be below average and not drought as such, they may use less drastic measures such as planting drought tolerant *R201* and 'three-month' maize varieties instead of *R215*. In addition, the peasants may change farming practices such as their method of tillage. Instead of planting in rows, the households can construct ridges and heaps in order to conserve soil moisture. Manure application may also be shifted from the maize field to the sorghum or sunflower field.

Table 24 shows that planting of 21% of the area of the low strata households was purposely staggered, while no fields cultivated by the high strata households were staggered. This shows that the low strata households adopt risk avoiding behaviour, while the high strata households are willing to risk crop failure following early planting in order to achieve potential higher yields.

Table 24. *Timing of planting by income groups* (number of acres)

	Low	Middle	High	Average	Standard deviation	Min.	Max.
Before first rains	7%	4%	17%	0.6	2.2	0.0	12.0
Following first rains	2%	21%	49%	1.6	4.9	0.0	26.3
Staggered	21%	5%	0%	0.5	1.3	0.0	4.5
Late	70%	70%	34%	3.6	3.7	0.0	14.0

Source: Household survey 1989/90.
The survey includes 32 households cultivating 199 acres.

Households commonly apply staggered planting on some of their fields for the purpose of minimizing the risk for total crop failure due to a short dry spell. Generally, the trend is that early planting (in October) is more common among households predominantly cultivating sandy soils than households with fields consisting of clay or loam soils. This is explained by the fact that early rain will penetrate and soften sandy soils much faster than clay soils. Even during years with limited first rains, peasants may continue to plough fields with sandy soils and wait to plough fields with clay soils until the main rains set in by November or December. High strata households that have made the effort to winter plough their fields with clay or loam soils, in case of drought, may apply minimum tillage techniques (e.g. rows for sowing are made with a plain plough without sheer and seeds are covered with a harrow).

Another available option is to increase the area of watered gardens. This is a labour intensive task, as the river is dry during drought years and the peasants would have to dig small shallow wells on the river bank to provide watering. This primarily done by the poor strata peasants.

During drought years, such as 1987, the grass on the pastures is insufficient to sustain the livestock population and the period during which the livestock are fed from the grazing area is shortened. Livestock are moved to graze on the fallow fields earlier than during non-drought years, which is made possible by increasing the quality of herding.

The supply of supplementary fodder for livestock is especially a problem for the low income group of peasant households, as their volume of maize stalks for supplementary feeding are very limited and far from adequate. When possible, peasants seek other forms of supplementary feeding. Insect-infested, low grade maize is ground and fed to the livestock mixed with salt. De-shelled maize cobs also play an important role as supplementary livestock feed during drought years. Some peasants may also expand the area cultivated with crops which can substitute for maize stalks as supplementary feed. Such crops are pumpkins, sorghum and sweet reeds.

Poor households with no or limited cash for buying supplementary fodder, apply labour intensive strategies. Livestock are brought from the kraal early in the morning in order to be the first to graze in the fields or on

Box 18. Local methods of fighting Striga weed

In some parts of Silobela communal area, a very resistant type of parasitic weed, Striga, (locally named Sona), causes serious problems. It is very fast growing and seriously reduces yields of maize, sorghum, bambaranut and other crops. A bambaranut field belonging to one of the peasants interviewed, was affected with Striga to such an extent that the bambaranut crop failed to mature and its leaves turned yellow.

Some peasants also claim that the existence of Striga is the major reason for putting fields in fallow. A number of years in fallow and subsequent burning clearly reduces the volume of the weed.

A local informal method of reducing the volume of Striga is to dig out termite hills and spread them out on the affected fields. According to the peasants interviewed, this is a very effective herbicide. When peasants have applied a dug out termite hill to the fields during the dry season, they can not winter plough that year, as this will turn over the termite hill located on the surface. The termite hills are found in the bush and are labour intensive to dig out. A hard-working peasant can dig out 2 tons (4 Scotch carts) of termite hill per day. If peasants dig termite hills as herbicide, they apply a total volume of 7–10 tons/ha. Also because termites are scarce in the area, it is a rather labour intensive exercise.

the sparse grass along the rivers. Another labour intensive strategy is to collect supplementary fodder by gathering the pods of the *Acacia albida* trees.

High strata households owning large herds send their livestock on migrant grazing with relatives living in high rainfall areas. In one case, livestock went on migrant grazing in August and did not return until mid-December.

Goats and donkeys are generally better adapted to the dry climate and can better cope with drought than cattle. There is a tendency among low

Box 19. Soil erosion causes siltation of dam

Cultivation of the infield over the last three decades without proper conservation measures has resulted in extensive loss of top soil because of erosion. The infield constitutes the top of a catena and even though the slope is only slight and most peasants contour plough, the footpaths through the fields become small streams during heavy rains, and considerable material transport takes place. If proper conservation measures are not taken, cultivation near or on the river banks can also cause erosion and loss of top soil.

The result of the erosion is that large volumes of soil are washed into the river yearly. This is causing sedimentation of the dam downstream, where the only supply of drinking water over a large area exists for the livestock during the dry season. There is presently no legislation to stop expansion of cultivation, which also causes considerable erosion. The eroded soil is washed into the river contributing to the siltation of the dam. Already now, the first 1–2 metres on the side of the dam consist of silt. When livestock come to the dam to drink, they sink into the sedimentation of silt and sand and have to be pulled out or starve to death. Some unattended livestock have died after being stuck in the silt.

strata households to substitute livestock with donkeys as a source of draught power. Without adequate food, donkeys can go astray, travel long distances and fail to return to the compound. To prevent this, peasants store pumpkin and outer shells of beans at the homestead for supplementary feeding in the evenings. Goats are not released from the pens before 12 noon, as they otherwise may not come back in the evening.

Resource constraints in the farming system

The infield-outfield farming system has for decades served as an excellent way of utilizing the limited resources available in Silobela communal area. The farming system now, because of pressure of production on resources, is in a dilemma. On one hand, the number of livestock exceeds the capacity of the outfield to supply sufficient fodder to reproduce the herd size. On the other hand, the number of livestock is insufficient to reproduce the required crop production in terms of draught power and supply of manure.

As discussed above, the average number of cattle per household is 13.8, while the minimum required herd size to sustain the required draught power and nutrient transfer capacity is estimated to be around 20 head of cattle. It is therefore with good reason that many resource constrained households strive to maintain or even increase their herd size, regardless of whether the grazing capacity of the outfield is sufficient to support more livestock. The changes in the farming system are part of a vicious circle (see Figure 7).

Too many livestock degrade the outfield, which further undermines the basis for reproducing the existing herd size. This will eventually result in a decrease in the number of livestock, which will affect the crop production negatively and thus reduce the capacity for supplementary fodder.

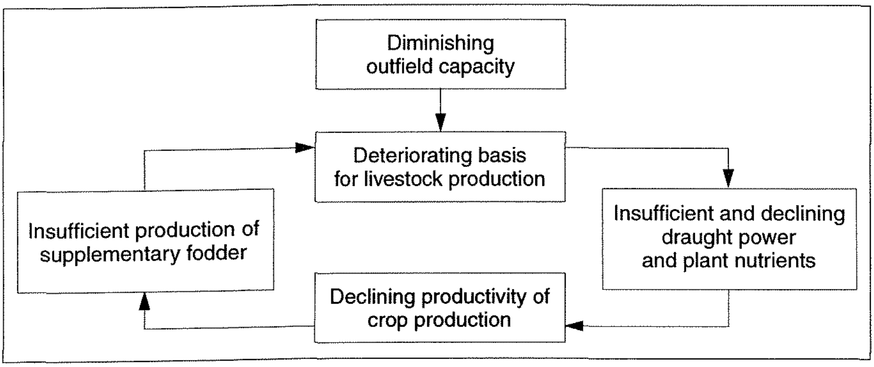
The study has identified a clear social differentiation between peasant households with respect to access to resources. Moreover, the study shows a correlation between household income and farm management, e.g. timing of planting, method and number of weedings. It is possible to identify constraints within the farming system which are common for all and constraints which are especially severe for specific groups of households.

Access to land is generally not a constraint for peasant households in Silobela communal area, but is related to the ability of the individual household to cultivate the land, e.g. availability of labour and draught power. (There is a correlation between cultivated area and DPE on a 3% significant level.)

Table 19 shows that 44% of the households do not have access to draught power of their own, and that a majority of these households are from the low income group, which on average has 0.6 actual DPE of their own.

Deficit nutrient transfer capacity is a general problem for all households in Silobela communal area. The number of cattle is fairly equally distributed

Figure 7. *Major constraints in the farming system of Silobela communal area*



between the three income groups, and the NPC is approximately sufficient for 4.5 acres. There is therefore a strong indication supporting the argument that the problem of sufficient plant nutrients is much larger for the high income group, which on average cultivates 12.4 acres, than for the low income group, which on average cultivates 6.1 acres (see table 20).

Access to grazing on the outfield is a common problem for all three income groups. The problem of sufficient grazing is more severe for households with large herds of livestock than for households with few livestock. As discussed above, 56% of the households have on average more than 20 cattle, while the remaining 44% has less than 4 cattle. Households with few cattle can find individual solutions (such as waking early in the morning to find the best locations for grazing) more easily than the large livestock owners.

Access to supplementary fodder for livestock is especially a problem for the households with low yields and thus low harvest of crop residues. The requirement for supplementary fodder is approximately the same for all three income groups, while there are substantial differences in access to supplementary fodder. Table 12 showed that the harvest of maize for the low income group was approximately 2 tons, while it was 3.5 tons for the middle income group and 7 tons for the high income group.

Appropriate technical options

The technical options for overcoming the resource constraints in the farming system of Silobela communal area have been developed through discussions with peasants during the 18-month period of field work, taking into account the available agricultural technology in Zimbabwe.

Options for rehabilitation of the outfield as grazing area

Two different systems of livestock management were put forward by the peasants interviewed:

1. Rotational grazing could be practised by selective herding of the livestock. The idea behind this herding system is to periodically allow selected areas to regenerate without the strain of grazing. Selective herding would clearly increase the work load connected with keeping livestock and would also demand more of the skills of the herdsman than the present system, in which the livestock more or less are allowed to grass freely. The advantage of selective herding is that it does not require any external inputs or capital.
2. Continue the existing livestock herding practice but divide the outfield into paddocks which would be fenced off. This would allow some parts to regenerate while others are being utilized. This would require a sizeable labour input for fence construction. Capital input would also be required if barbed wire or solar powered electrical fencing were to be used instead of thorny bushes. The advantage of paddocks is that the herding will not require more labour than the present system of herding.

These two options for improving the quality of grazing in the outfield rely on the assumption that by leaving parts of the pastures unused for a period, the natural regeneration process alone will be sufficient to restore the quality of the grass. This assumption might be questionable for at least two reasons: the process of environmental degradation and the changing composition of the vegetation.

As discussed above, one of the reasons why it is difficult for the grass in the outfield to regenerate naturally is that the soil erosion of the infield is sedimenting in the outfield. Only one serious attempt to mobilize the peasants to establish contour ridges to counteract soil erosion has been undertaken since independence. Many contours were established, but only few have been maintained, and today most are damaged by erosion. Winter ploughing has since independence become a popular method of cultivation, and has to some degree prevented run-off by improving the ability of water to be absorbed by the fields.

Much could be done in Silobela communal area to improve soil conservation, but most of the options available demand relatively high labour input for construction and continuous maintenance to be efficient. For this reason, the attitude to soil conservation measures among peasants in Silobela communal area is generally negative. The fact that part of the support for the independence struggle was linked to the peasants' resistance towards conservation measures (such as construction of contours forced upon them during the colonial era) adds to the attitude problem. The councillor and the vidco staff today represent the authority which seeks to enforce conservation measures. These attempts are likely to be unsuccessful, because the present leadership is not elected by the community and in general not trusted.

One of the conservation measures enforced by the vidco staff, under threat of fines, is to prevent peasants from cutting down whole trees. This is strongly opposed by many peasants, who are of the opinion that the density of trees on the outfield is preventing the grass vegetation to regain its natural condition. The vidco authorities have no capacity to enforce such a rigid undifferentiated prohibition efficiently, and a very destructive habit of stripping the trees for everything but the stem has developed in the community. Some peasants interviewed in the survey suggested an alternative. Cutting of firewood could be organized on rotational basis, in connection with dividing the outfield into paddocks. This would give the trees in specific parts of the outfield a chance to regenerate and provide a sustainable source of firewood, while other parts of the outfield could be cleared for pastures.

Replanting a combination of improved and indigenous grasses could be a valuable contribution to re-establishing the pastures in the outfield. The grass could be planted in paddocks in the outfield and these areas would not be herded for a minimum of two seasons to allow the new grass to establish itself. There is no tradition for planting grass in Silobela communal area, but peasants expressed interest when discussing the idea of establishing pastures in the outfield.

Indigenous grasses could easily be collected locally, while seeds of improved grass could be harvested from one of the commercial farms in the area.

Options for solving the problem of Mkauzane

The only solution to the Mkauzane problem is to fence off the area where the poisonous plant grows. The fencing of the Mkauzane area would prevent the livestock from eating the Mkauzane leaves when they are grazing on the infield during the dry season after the harvest. Fencing of the affected area would also give the community an extra grazing area, which would diminish the pressure on the common pastures from January to May. If the Mkauzane area was fenced, the livestock could be moved inside the fenced area during the rainy season. The Mkauzane plants are not poisonous before August-September, when the fresh leaves emerge. If the livestock could graze in the fenced Mkauzane area, this would alleviate the pressure of grazing on the outfield and a project of planting grasses there could more easily be imple mented.

During the drought in 1982, when the problem of Mkauzane first became serious, representatives from all kraals in the circle held a meeting and decided to construct the fence. They estimated that they needed 8 km of barbed wire and that the total cost per household at that time would be Z$10. A decision was made to erect a fence, and households which could not pay, could contribute by collecting thorn bushes. Another decision made at the meeting was that until the fence was constructed, no cultivation should take place in the areas of Mkauzane, as this increased the volume of Mkauzane plants. Because of the civil war and dissident activities in the area, the fence was never made.

Options of cultivating supplementary fodder for livestock

There could be considerable potential in improving fallow vegetation through sowing improved grasses and legumes with high fodder value and nitrogen-fixing ability, such as lucerne. During discussions about this, peasants responded positively and claimed to be willing to try the idea. Two questions were raised by the peasants: 1) which crops and varieties would be appropriate and how to get access to the seed, and 2) what would be the labour requirements.

Direct cultivation of fodder-crops on the infield is another option for solving the problem of in-adequate supplementary fodder during the dry season. Cassava has been suggested as a fodder crop in Silobela communal area and the local Agritex extension staff and their farmer groups have shown great interest.

Options for increasing household crop production

The options for increasing household crop production through expanding the area under cultivation are very limited under the present resource constraints in terms of draught power and availability of labour during peak periods. Expansion of the cultivation area thus relies on improvement of the conditions for livestock, especially the alleviation of the periodic shortage of fodder and a solution to the problem of Mkauzane. Increasing productivity through improving soil fertility is limited by the nutrient transfer capacity, which likewise depends on the number of cattle and the supply of fodder. Use of mineral fertilizers is regarded by most peasants as highly risky and only a viable option for the better-off households. Moreover, the economic viability of mineral fertilizers in NR 4 has declined over the later years (Ashworth 1990).

A range of soil conservation and water harvesting techniques exist in Zimbabwe and there is considerable scope for their implementation in Silobela communal area. The potential trans-evaporation is approximately 200 cm annually, and it is therefore of crucial importance to maximize the efforts to conserve the limited water available for crop production. The wind blows continuously during the first part of the rainy season, and the establishment of wind breaks on the often large fields would help conserve soil moisture. The most obvious options for increasing crop productivity are through adoption of improved seeds and crops other than maize. This option is discussed further in the following.

Socio-political conditions for change

The resource constraints and agricultural problems facing the peasants in Silobela communal area are in part problems common to the whole community and in part problems specific for resource constrained groups. Some of the options for development should therefore be based on the participation of the whole community, while other should be based on individually tailored solutions.

The existing common ownership and use rights to the outfield and the co-operative system of herding livestock are unable to regulate and set limits for the pressure of production on resources. The implementation of the technical solutions suggested in this section will require a higher degree of community organization than presently exists.

In 1985, a serious incident occurred which destroyed the confidence of the people settled in the circle in the vidco leadership: One day, many of the Ndebele speaking peasants' houses were burned down by the ZANU youth assisted by the local police, who accused the peasants of collaborating with dissidents. Many innocent peasants lost all their property in this way, as they were trapped between the dissidents and the government. Many peasants fled the area to live in Bulawayo or other cities, and many of them have not yet returned.

At this point, the issue of fencing off the area infected with Mkauzane became a political issue. The local councillor had never been elected, as the election in 1985 was disturbed by the violence in the area. He was therefore appointed to his post by the ZANU party. Peasants in the circle therefore had no confidence in the leadership, and when the councillor in the mid-eighties ordered them to contribute money or collect thorn bush to fence in the Mkauzane area, he was met by widespread resistance. Meanwhile, the livestock continue to die.

The informal organization of peasant households in self-help groups, as discussed in chapter 8, is evidence that the will and ability to organize themselves does exist in Silobela. There is clearly a potential for the community to organize into purpose-specific groups, such as a grazing group with the purpose of establishing paddocks, or a Mkauzane group with the purpose of fencing off the poisonous plant. Mkauzane is a common problem for all households in the circle and fencing the area off would mean that the inhabitants from all five kraals in the circle (see map 9) would participate with labour or kind. Such an undertaking would probably require the active support of a political leadership which is approved and elected by the community. Moreover, considering the present state of disillusion, effective implementation would most probably require some kind of subsidy from the state or donors, e.g. in the form of capital input for purchasing the fence and provision of transport.

Chapter 8
The Role of Seed in Peasant Agriculture

Seed is probably the most important single input for arable cultivation, as it determines the potential production and thus the productivity of all other inputs. Moreover, seed plays a crucial role in the processes of commodification of agricultural production and intensification of cropping patterns and land use, which are on-going in many less developed countries. Access to appropriate seeds can provide an option for peasants to maintain or improve productivity. It is also possible that seed can contribute to an increase in productivity, independent of the use of other bio-chemical inputs.

This chapter analyses the role of agricultural seeds in the farming system of Silobela and makes an attempt to draw lessons with wider application for peasant societies. The first section discusses peasants' access to seed and estimates the importance of different seed sources for all major crops. Each of these sources of accessing seed is then discussed in terms of organization, timing and security of delivery and cost. The social differentiation in patterns of seed use are then analysed by correlating the varieties used with the three major resources: income, cultivated area and draught power equivalence. The third section analyses how the different varieties used are adopted into the farming system. Peasants' own qualitative characterization of the varieties used are combined with quantitative analyses of the farm management under which they are cultivated and their performance during the 1989/90 season in terms of yield and end use. The economy of seed use for peasants in Silobela is analysed, and conclusions are discussed about the role of seed in peasant agriculture. The final section seeks to determine the optimal seed requirements for peasant societies.

Peasants' access to seed

With the important exception of maize, improved seeds are commonly used to only a very limited extent. Table 25 gives an overview of crop varieties used in Silobela communal area. The physiological quality and level of adaptation to the farming system of seed varieties, varies from crop to crop. For *groundnuts*, the retained seed are earlier releases from DR&SS (Department of Research and Specialist Services, under the Ministry of Lands, Agriculture and Rural Resettlement) which are not particularly well suited to the agro-climatic conditions of Silobela communal area. Because of

Table 25. *Improved and indigenous crop varieties used in Silobela communal area*

Variety	Type	Characteristics
Maize		
R 200	1	three-way hybrid
R 201	1	three-way hybrid
R 215	1	three-way hybrid
SC 501	1	three-way hybrid
PNR 743	1	double-cross synthetic
California	2	open-pollinated
Groundnut		
Valencia R2	2	self-pollinated
Natal common	2	self-pollinated
Butter	2	self-pollinated
Sorghum		
Cheda	3	open-pollinated white
Segaolani	1	hybrid white
Chibuku	3	open-pollinated red
Long white	3	open-pollinated white
Short white	3	open-pollinated white
DC75	1	hybrid white
Sunflower		
Peridovic	2	open-pollinated
Masasa	1	hybrid
Local black	2	open-pollinated
Local striped	2	open-pollinated
Finger millet		
Chidundu	3	open-pollinated
Pearl millet		
Long plain	3	open-pollinated
Short bird proof	3	open-pollinated
Long bird proof	3	open-pollinated
Bambaranut		
Brown Wankie	3	self-pollinated
Cowpea		
Indumba	3	self-pollinated
Red seeded	3	self-pollinated
Pumpkin		
Yellow	3	self-pollinated
Green striped	3	self-pollinated
Sweet potato		
White	3	vegetative-propagated
Red	3	vegetative-propagated
Yellow	3	vegetative-propagated
Local root		
Ndumba	3	vegetative-propagated

Source: Household survey 1989/90. Number of households 32.
1 = annually purchased improved variety;
2 = retained improved variety;
3 = retained indigenous variety

the break-down of seed delivery of groundnuts, many households have not been able to buy new seed of high physiological standard for several years. Recurrent droughts in the 1980s, moreover, have resulted in a deterioration of the physiological quality of groundnut seeds to the extent that a high proportion of the seed planted do not germinate. For *sunflower*, the retained seed also stem from earlier releases but have been well maintained by peasant households and are well adapted to the agro-climatic conditions. Most peasants in the survey were content with these varieties and preferred them to those available from the seed industry of both open-pollinated and hybrid varieties. For *sorghum*, *pearl millet*, *finger millet* and *bambaranuts*, well adapted indigenous varieties exist in the peasant community and are widely used and maintained through retention.

The conclusion is that a range of local landraces exists which plays a dominant role in the supply of seed in Silobela communal area for crops other than maize. Some of these landraces stem from earlier DR&SS releases, while others are indigenous and have been grown in the region for centuries. Common for all landraces is that they are maintained and adapted to the farming system through selective retention. For some crops, the landraces are well suited to compete with improved varieties, while in the case of groundnuts, there is a distinct need for a fresh supply of high quality seed.

Table 26 shows the proportional distribution between the different sources of seed, based on estimates from interviews with peasants and rural retailers. The use of external improved seed is only dominant in the case of maize, while peasants predominantly depend on retained varieties or local seed exchange for other crops. In the case of maize seed, table 26 shows that local retailers are the most important means of access to maize seed with an estimated 40% share of all seed trade. More than half of the total seed purchased is from wholesalers with retail outlets or retailers located in the district or provincial towns, either by individual purchase or through autonomous self-help groups or Agritex marketing cooperatives. Only a small proportion of maize seed is retained from the peasants own harvest.

In the case of sunflower, groundnut, sorghum, legumes and tubers, table 26 shows that only approximately 10 per cent of the seed used is purchased annually, and all of it through individual purchase from urban-based retailers. The absence of seed trade by the official cooperatives in Silobela communal area is noteworthy. The cooperatives erected a medium-sized storage go-down close to Crossroads in Silobela communal area in the mid-1980s, which for unknown reasons has never been in use. The six means of access to seed available in Silobela communal area shown in table 26 are discussed in detail in the following. It should be noted that the first three sources involve maize only.

Table 26. *Sources of seed access in Silobela communal area* (% of market share by source)

	A	B	C	D	E	F
Maize	40	25	5	25	5	0
Sunflower	0	0	0	10	80	10
Groundnuts	0	0	0	10	60	30
Sorghum	0	0	0	10	80	10
Finger millet	0	0	0	0	90	10
Pearl millet	0	0	0	0	90	10
Legumes	0	0	0	0	90	10
Tubers	0	0	0	0	90	10

Source: Household survey 1989/90 and qualitative interviews with rural retailers, Agritex staff and self-help groups in Silobela communal area 1989/90. The figures in the table are based on qualitative estimates and as such contain a high degree of uncertainty.
Means of access are: A) individual purchase from rural retailers, B) autonomous local self-help marketing groups, C) group development areas, D) individual purchase from district and provincial retailers, E) retention from own harvest and F) local seed exchange.

Individual purchase from rural retailers

The most common source of seed open to individual peasants is purchase from local businessmen operating as rural retailers. Three rural retailers operate from Crossroads, one of the two business centres in Silobela communal area. The rural retailers buy improved maize seed from either Manika Freight in Gweru or Peasants Co-op in Kwekwe. The seed is transported in their own trucks, and the retailers do not receive any form of credit or discount from the wholesalers in town.

Acting as approved buyers for GMB and transporting the peasants' produce is a major business for retailers. An estimated three-quarters of grain purchases in Silobela communal area are handled by the three retailers. Many peasants cash their GMB checks in the shops of the three retailers, and at the same time use part of the money to buy their input requirements.

Compared with buying and transporting grain, seed sales are a minor business activity, although the three retailers, as indicated in table 26, handle approximately 40% of all seed sales. The price for hybrid maize seed at the rural retailers varied from Z$60–70/50 kg. bag. All three shops have sufficient facilities for safely storing seed for a shorter period.

Part of the hybrid maize seed was illegally repacked[1] on location and sold in small packs by weight during the 1989/90 season. The retailers explained that the reason for this was that no small packs of maize seed were available in Gweru and that they consequently repacked themselves in order to meet

[1]The hybrid maize seed is sold as certified seed in sealed packs, guaranteeing that the seed is of the correct variety and of high quality standard. It is illegal according to the Seed Act to repack the seed before reselling it to farmers, as the seal is then broken and the farmers have no longer any guarantee that the seed has not been mixed with seed of lower quality.

the peasants' demand. The seed was sold directly out of the original 50 kg. bag at a per kg. price.

Timing of seed delivery is crucial if the peasants are to sow at the optimal time. The turnover of seed is concentrated during the period immediately after the first rains, by which time all peasants have made up their mind about which variety to buy. If the rains are early, more peasants will buy *R215*, while *R201* is predominant later in the planting season. The rural retailers are reluctant to buy seed before the demand exists. Early purchase by the rural retailers would entail bearing the cost of storing the seed until it is sold and the risk of being left with carry-over stocks if seasonal variations change the projected seed demand. The businessmen are not willing to take such risks.

The rural retailers' strategy is to restock with hybrid maize seed only little by little, before the major planting season. In this way, they claim to be able to satisfy the demand of those peasants who want to buy their seed in good time before the planting season. Most peasants do not demand seed before after the first rain, immediately before the optimal time for planting, and the rural retailers do not restock seed before the peasants are literally lining up in front of the shop to buy seed. Access to maize seed from local rural retailers entails three problems:

1. Seed is in short supply in ample time before the rainy season. The rural retailers claim that because of limited availability of capital, they cannot afford to buy seed before the peasants' have an immediate demand for seed. As a consequence, the progressive peasants who can afford to buy seeds well before the start of the rainy season cannot depend on the rural retailers as a secure seed source.
2. Sufficient seed is not continuously available during the peak sales period, immediately after the start of the first rains. The main reason given by rural retailers is the same cash-flow problem as mentioned above. The rural retailers interviewed added that seed was not always available from their suppliers, the wholesalers located in the district and provincial towns. One of the businessmen recalled two occasions in 1988 and one in 1989, when he went to Gweru with a truck, but could not buy any seed.
3. Seed is often not available towards the end of the planting season. The explanation given by the rural retailers is that they cannot risk carry-over seed stocks during the winter season, and that they thus practice a conservative approach to restocking seed at the end of the planting season.

Maize is the only crop for which improved seeds are marketed by rural retailers. The explanation for this varies from crop to crop. In the case of improved sunflower seed, the reason is simply that demand is non-existent, as peasants are content with the retained varieties. For white sorghum, the retailers would not deny that there could be a market for improved seeds.

The explanation why the improved sorghum varieties *SV1* or *SV2* were not marketed by the rural retailers is partly that during the 1989/90 season, the varieties were not yet easily available in Gweru or Kwekwe. Moreover, *SV1* and *SV2* are not known varieties in Silobela communal area so a considerable extension effort would be needed to market the varieties through rural retailers. There is a strong demand for a short season groundnut variety, and the businessmen are willing to sell this seed if it were available from urban wholesalers. Finally, the rural retailers stated that they regularly tried to obtain vegetable seed, but most often failed.

Autonomous local self-help marketing group

There is an unknown number of autonomous self-help marketing groups in Silobela communal area. They are typically organized locally within the traditional kraal demarcations, and usually consist of between 20 and 50 families. They are autonomous organizations, cooperative in a classical sense, and are seldom registered or known of, nor are they supported by the local authorities. The purpose of the self-help groups is to benefit from economy of scale by solving common problems through cooperation rather than by individual solutions.

The following analysis is based on interviews with a local autonomous marketing self-help group with members from Mali and Mbonjani kraals, located in the enumeration area (see map 9). The self-help group, which consists of 35–45 peasants, organizes the marketing of surplus production and purchase of inputs for its members.

Approximately half of the peasants in Mali and Mbonjani are members and buy seed through the self-help group. The self-help group only started in 1987, after the civil war had ended, and it is still not very known. The group has been functioning for the 1988/89 and 1989/90 seasons only. It is not officially registered by any authority and the local Agritex staff was apparently unaware of its existence. The self-help group has elected a chairman and a secretary who conduct their work on a voluntary basis. The chairman is a hard working master peasant who is highly respected in the community, while the secretary is a younger peasant with secondary education.

The self-help group has no assets and the meetings are conducted in the shade of a large acacia tree; minutes of the meeting and payments etc. are written into a book on the spot. Instead of collecting fees, the members of the self-help group cultivate a common field and use the proceeds to cover small expenses. An example of such an expense is rental of a grain weight from businessmen at Crossroads to weigh the crops post-harvest and premarketing. If the money for such small expenses should be collected among members, it would cause problems, as some peasants would not have cash available at a given time. Cultivating a common maize field instead of collecting member fees seems to function well.

The main function of the self-help group is to market surplus crops to GMB. A meeting is held to collect orders for the empty bags necessary for the surplus to be marketed, and the bags are bought. Those peasants who are not registered as producers with GMB are helped to become so by a certain member of the self-help group. Transport is arranged with the local businessmen and the grain is transported to the Nkai depot, where GMB issues a bank check and separate receipts are written for each individual peasant, stating name, volume sold, grade, and price paid. Some peasants go to town, e.g. Kwekwe or Gweru, to cash their GMB bank checks, others cash them in the shops of local businessmen. Unconfirmed information indicates that the retailer charges a high commission for cashing GMB checks.

Seed purchase has become an increasingly important activity for the self-help group, as its economic benefits have become obvious to all members. In September, peasants hold a meeting and access their seed requirements. During the first meeting, the members decide where, how and when they will buy seed. Each peasant places her seed order at the meeting, and the figures are entered into the account book by the secretary. When retail seed prices and transport rates are calculated, money is collected among the peasants in the group. Two to three members are elected to handle the seed purchase.

The local self-help group undertakes activities other than marketing crops and buying inputs. The group holds regular meetings where current agricultural activities are discussed. The group is part of Seed Co-op's competition to be the best communal peasant of the year and has selected four men and two women to inspect and comment on each member's fields.

Group Development Area

The peasants in Agritex extension groups, called Group Development Area (GDA), hold regular meetings concerning extension issues. There are 31 Agritex extension groups in Silobela communal area. Each of these groups consist of between 18 and 50 peasants, in total approximately 1000 peasants. Only some of these peasants order seed through their GDA groups.

In September, the GDAs involved in seed trade hold meetings to arrange the annual purchase of hybrid maize. During these meetings, the peasants give orders for their seed requirements in a way similar to that of the self-help groups. When retail seed prices and transport rates are calculated, money is collected among the peasants in the group and the seed is bought. The GDAs use Manika Freight in Gweru, a wholesaler of seed for Seed Co-op. One or two persons are sent to buy the seed. Transport is rented from the leading local businessmen in Crossroads.

Individual purchase from district and provincial retailers

The fourth option is for individual peasants to buy seed directly form the Peasants Co-op or private shop in town. Daily busses are used for transport.

These peasants may typically buy two 50 kg bags of seed and will have to hire transport from the Peasants Co-op to the bus station. The cost is Z$1–2/bag. Loading onto the bus costs 50 cents–Z$1/bag. Transport on the bus costs Z$2/bag. The capacity for transporting seed on the bus is very limited and peasants who have bought seed often have to wait a day or two to get the seed on the bus. The bus fare is Z$6 one-way. If the peasant has no relatives or friends in Kwekwe and no money, she will have to sleep outdoors and try to secure space on the bus the following day.

Table 26 shows that while individual purchase of seed comprises one-quarter of hybrid maize purchases, it is the only source for the purchase of high quality improved groundnut, sorghum and sunflower seed. Part of the reason why the volume of sales is low for these crops is, in the case of the non-hybrid, that these varieties may be retained by the peasants for some years without significant reduction in performance. Another reason is that the seed industry has failed to supply sufficient high quality seed. Insufficient volumes of the two improved, open-pollinated sorghum *SV1* and *SV2* have been available, and the quality of the open-pollinated Peridovic has been questionable, while both quality and volumes available have been highly insufficient in the case of the short-season groundnut varieties.[1]

Retention of seed

After having discussed the sources of access to purchased improved varieties, we now turn to retention of seed as a source of access. According to table 26, retention as seed source supplies an estimated 60–90 per cent of the total seed use. As mentioned earlier, one can distinguish on the one hand between retained and periodically purchased improved varieties, and on the other hand, retained indigenous varieties. There are distinct differences in the method of development and maintenance between these two types of retained seed.

In the case of sorghum, sunflower and groundnut, the peasants in Silobela communal area use a number of the retained improved varieties which were originally developed and released by DR&SS. To the extent that these varieties are still produced and marketed by the seed industry, the peasants in principle can periodically choose to purchase high quality planting material. They do this when they judge that the quality of the retained planting material has fallen to such a level that it pays to buy new seed. In reality, it has been very difficult for peasants in Silobela communal area to purchase new high quality stocks of their retained improved varieties, as discussed in the previous sub-section.

Common for all crops cultivated in Silobela communal area is the existence of local landraces which are developed and maintained through a system of indigenous plant breeding. These varieties have been developed

[1] An in-depth analysis of these shortcomings on the part of the seed industry can be found in Friis-Hansen (1992).

over time by the peasant society through a deliberate selection process. The method of retaining seed differs from crop to crop, and peasants are more or less skilful in selecting the best seed from the harvest, storing and treating them properly. Selection of seed is done both directly from the field and from the household's grain storage. The retained seeds are often stored in the ceiling of the kitchen hut, where smoke from the fireplace enhances their storability. In this way, indigenous seeds can be stored for many years. Seed of drought tolerant crops such as pearl millet can for example be stored for long periods for strategic use in the case of an early season drought.

For some crops such as sorghum and millet, the process of mass-selection has been an on-going process for centuries, while landraces of other crops like maize and sunflower have a more recent history. It can be quite difficult to determine the history of a given landrace, and the distinction between a landrace and a retained improved variety is unclear, as the two types of varieties interact with each other. The option of purchasing high physiological quality of a given variety is used in this study as a criteria for distinguishing between the types of varieties. Improved open-pollinated varieties which are no longer supported by the seed industry are thus classified as landraces. For example, this is the case for California, an open-pollinated maize variety which was originally released more than 20 years ago by DR&SS under the name of Salisbury white but has not been produced by the seed industry for many years.

There are usually no supply problems for indigenous varieties, and most households have their own store of retained seeds. Retention as source of seed does include an element of risk in a semi-dry area such as Silobela communal area. For this reason, most households have stored more than one year's supply of seed in case of a drought resulting in harvest failure. An exception is the case of groundnut seed since independence. Many peasants in Silobela communal area have not been able to retain groundnut seed during recent years, because recurrent droughts during the mid-1980s destroyed the crop for successive seasons and thus exhausted their seed stock. This has contributed to a decline in cultivation of groundnut.

Local seed exchange

According to table 26, local seed exchange amounted to an estimated 10–30% of the total turnover of non-maize seed in Silobela communal area. Most local seed exchange transactions take place between members of the extended family or between neighbours and friends. The system of local seed exchange in Silobela communal area is thus a highly imperfect market. During the survey, we found no sign of specialization among peasants regarding producing and selling local retained seed varieties. Despite this, peasants interviewed "knew who to go to and who not to go to" if they needed to buy seed locally.

Box 20. Indigenous plant breeding: the case of Mende rice farmers in Sierra Leone

Longley and Richards (1993) analyse the indigenous farming systems in Mende, Sierra Leone and conclude that

> ... arming strategies focus on development skills to match environmental conditions (exploitation of natural variation in soil moisture conditions along the soil catena) rather than investments in technologies to control the environment (land shaping and water control).... Mende rice farmers discovered that it makes more sense to develop the 'software' possibilities (manipulate germ-plasm) than to rebuild the 'hardware' of agriculture (level fields and reshape the land for water control, etc.) (page 52).

By selecting for both long-duration flood-tolerant rice varieties and short-duration seed types, the farming strategies help to minimize labour bottlenecks at planting and harvest, and maximize the period during which food (rice) is available in the field. Longley and Richards state that "farmers are explicit about the need to maintain the pool of germplasm diversity for rice through such experimentation and exchange."

The activity level of local seed exchange for groundnut is higher than for other crops, because of the collapse of the crop retention system because of successive droughts, and because of the irregular and inadequate supply of improved groundnut seed from the formal seed industry.

Perspectives for better access to improved seed in Silobela communal area

Peasants in Silobela communal area face serious problems regarding access to improved seeds at the time when they are required. Improved seeds of crops other than maize are simply not available from the rural retailers. In the following, options are discussed for improving access to improved seeds in Silobela communal area. For an extensive in-depth analysis of the seed industry in Zimbabwe, see Friis-Hansen 1992.

The private seed retailers are reluctant to buy seed as early as September, as they are occupied with marketing grain and have limited cash available. If the retailers were offered some incentive, such as lower transport rates, discount for early bulk purchases, or credit facilities, they could perhaps be convinced to buy seed early and have stock ready by the time of the first rain. Another problem is the unavailability of seed at the end of the planting season. This happens because the retailer does not want to take the risk of having to store possibly unsold seed during the winter season. This problem could be solved if the wholesalers and seed companies allowed rural retailers to return unsold seed to the wholesalers/Seed Co-op.

As discussed earlier, it is difficult for the local autonomous self-help marketing groups to obtain transport for seed, as most trucks are occupied transporting grain from the communal areas to GMB depots. The obvious option for increasing the efficiency of the existing transport capacity is to coordinate the need for transport out of the area with inbound transport requirements for such items as improved seed. If depots for seed were located at the GMB depots in Nkai and Kwekwe, the trucks travelling from the GMB depot to Silobela communal area to collect grain could easily carry seeds! This would go a long way toward solving the transport constraints facing the autonomous self-help marketing groups. Another option would be for seed to be transported by some of the trucks from private companies that regularly travel to the retailer to deliver goods (groceries, Diary Board, bread, cigarettes, National Breweries and Chibuku Breweries).

At present, improved seeds of sunflower, groundnuts, sorghum and pearl millet are not available or used in Silobela communal area, although varieties have been released long since from research stations. As discussed elsewhere (Friis-Hansen 1990), one of the major reasons that the formal seed industry has not organized multiplication and delivery of these seeds to the communal areas has been that for a number of reasons it has not been profitable to do so. The improved seeds are open-pollinated and the peasants are thus able to retain the seed for a number of years, before they have to purchase new seeds. The market can therefore quickly be reduced to an economically unviable, low level. As an alternative and supplement to the formal seed industry, improved seed could be produced on a small-scale by peasants themselves for consumption within the community. Small-scale seed multiplication could be organized in three ways in Silobela communal area:

1. Local autonomous self-help groups could cultivate improved seeds on their common field. The improved seeds could them be used by the members of the self-help group and sold to non-members within the community.
2. Better-off farmers, such as master farmers, could cultivate a seed field and sell to other peasants in the community.
3. Agritex extension groups, the Group Development Areas, could bulk seed under the guidance of the extension staff.

Social differentiation in seed use

This section analyses the social differentiation of seed use, by crop and variety. Three criteria have been used to differentiate between groups of peasants' seed use:

1. annual household income
2. household access to livestock (draught power equivalents, DPE)
3. household access to land (cultivated area)

The household survey has only collected quantitative data for the most important varieties of the four main crops: maize, groundnuts, sorghum and sunflower. The use of varieties of less important crops such as millet, legumes and tubers is assessed qualitatively.

Box 21. Examples of indigenous plant breeding in Sudan and Ethiopia

The following two examples of indigenous selection methods are extracted from Trygve Berg's work (1993) in southern Sudan in the early 1980s before the current civil war, and in Tigray, northern Ethiopia in 1991 after the termination of that country's civil war.

Indigenous selection of seed in southern Sudan is based on observations during the growing season, when all the farmers may be involved in assessing the performance of the crops. During the ripening period, boys are posted in the fields as bird scarers, keeping a watchful eye on the sorghum heads and chasing away intruding birds. They are overseen by their fathers who check on them from time to time and survey the whole field, examining the sorghum heads for signs of bird damage. During the same period, women and girls regularly come to the fields to gather intercropped vegetables and edible weeds. They also carefully observe the sorghum plants, looking for candidates for selection. By the time of collection of planting material for the following season, the women already know the best sorghum plants from a long period of observation and from family discussions.

The common procedure for indigenous seed selection in Tigray, northern Ethiopia, is to observe the performance of the crop from germination and throughout the entire growing season. Discussions are regularly held within the family and neighbourhood on the performance of seeds. Seed performance is a common subject for conversation as farmers walk through cultivated fields. They also watch the fields of their neighbours and may request seeds they are interested in planting. Farmers who select seeds at the time of harvest are regarded as lazy by the community.

These observations reveal the existence of a culture where seed selection is supported by great knowledge, interest, discussion and the devotion of much time to these activities. Children are always involved, and the transmission of skills to the next generation is emphasized. It is likely that such communities would respond with great interest to offers of training in improved selection skills, if they understand that this will help them achieve their own objectives.

Maize

Survey results show that hybrid maize seed are planted on 98% of the area occupied with maize. Despite the fact that peasants during interviews mentioned five local retained maize varieties, only one variety (*California*) was actually grown in the sample, occupying 2% of the total area of with maize. Early maturing varieties (*R200*, *R201*, *PNR 473*) predominate, occupying 70% of the total area cultivated with maize. Medium maturing varieties (*R215*, *SC501* and *California*) are used on the remaining 30% of the maize area.

The survey shows that the use of varieties differs between social groups. The survey reveals that while 88% of the varieties used by peasants without access to draught power were early maturing, this was only so for 62% of the varieties used by households with one or more draught equivalents. The explanation may be that households owning draught power are able to plant earlier than those having to rent draught power from others. The owners of draught power therefore have better chances for success if they cultivate medium season varieties, which generally have a higher yield potential than those which mature early.

Based on survey results, the use of maize varieties is correlated with the three household income groups. It can be noted that there is a marked difference between the three groups' use of early and medium maturing varieties. While for the group which annually earns less than Z$250, 80% of the varieties used are early maturing, the percentages for the Z$250–1000 and >Z$1000 groups are 74% and 57% respectively. The decrease in use of early maturing varieties by increased income is because poorer households are more concerned with minimizing the risk for crop failure than better off peasants. Moreover, it is interesting to note that the diversity in choice of maize varieties is higher for the better off peasants than for the poor peasants. The two newly introduced varieties, *SC501* and *PNR473*, were only used by peasants earning more than Z$1000 annually.

A similar picture unfolds with regard to size of cultivated area. The survey shows that the smaller the total cultivated area per household, the higher the proportional use of early maturing varieties. The percentage use of early maturing varieties for the three groups, <5 acres, 5–10 acres and >10 acres, is respectively 83%, 77% and 58%.

Groundnuts

Three varieties are cultivated in Silobela communal area: *Natal Common*, *Valencia R2* and *Butter*. Although mentioned during qualitative interviews, the newly released improved variety, *Plover*, was not represented in the sample. *Natal Common* is the most used variety, cultivated on three-quarters of the total area cultivated with groundnuts.

There are clear differences in use of groundnut varieties between different groups of peasants. Survey results shows that while peasants without draught power use *Natal Common* only, households owning draught power use all three varieties. The reason for this may be that in order to achieve reasonable yields, *Valencia R2* requires planting with the first rains in October and harvesting in February/March. Peasants without draught power are less likely to be able to overcome the labour constraints during these periods.

While peasants in the highest social strata cultivate all three varieties, other peasants cultivate *Natal Common* only. An additional explanation why the use of varieties among the better social strata are more diverse might be that the better off peasants are more mobile and thus more likely to obtain seeds available on an erratic basis in town centres only. Unavailability of seeds is no doubt a major limiting factor for cultivation of groundnuts.

Sorghum

Cheda, a local landrace, is the dominant sorghum variety grown. *Cheda* is a popular productive sorghum variety and until now, none of the hybrid varieties introduced has been able to out-yield it under the present low/no input conditions of cultivation. The other three varieties in the survey did not have a history of cultivation in the community, but were cultivated by innovative peasants who wished to test them.

While not included in the survey, the improved open-pollinated variety *SV2* had been tried by some peasants in Silobela during the 1988/89 season. They claimed that the *SV2* had a better maturity than *Cheda* and that yields were high. Many peasants in the survey expressed interest in buying *SV2*, but claimed that until now it had not been available from the rural retailers.

The survey support the argument that better-off peasants are innovators, who try.out varieties other than the local *Cheda*. No peasants without draught power or with a transformed income under Z$250, used the two external varieties *Sengalani* and *Chibuku*.

Sunflower

The bulk (80%) of sunflower grown were local varieties: *Peridovic*, *local black* and *local striped*. Only two peasants grew *Masasa* (of which one used retained seed). If cultivated with the use of inputs, *Masasa* yields are considerably higher than the local varieties, while the yields are about the same if no inputs are applied. There is no clear correlation between use of seed and social class. The local varieties are evenly distributed between the owners and non-owners of draught power as well as between land and income categories. Survey results indicate an upward bias in the use of hybrid sunflower, although the figures are based on only two peasants.

Other crops

As already mentioned, no quantitative data are available on social differentiation in the use of the less important crops such as pearl millet, finger millet, cowpeas, bambaranut, pumpkin, sweet potato and local roots. Indigenous varieties are predominant for all these crops. It is the author's assessment that the social differentiation of seed use for these crops does not depend on household access to resources (income, draught power or land), but rather on whether the crop is cultivated at all and whether the household gives priority to the characteristics of the given variety.

Finger millet is a 'traditional' crop favoured by elder people (men) for brewing beer. A gender conflict exists over the cultivation of finger millet, as women prefer to cultivate maize for beer brewing as it demands much less labour. The same conflict exists in the case of pearl millet, which has been given up by most households because of the high labour demand for bird protection, weeding, harvesting and processing. Resource-poor households tend to cultivate more pearl millet, as it is drought tolerant and serves as a food security crop.

Brown Wankee, the bambaranut variety used, is in fact a mixture of several different varieties. Because of the droughts in the 1980s, seed has been in short supply, and the landrace used today is a mixture of the indigenous variety and seed from the market in Bulawayo. Most households cultivate bambaranut on a small scale for subsistence, intercropping it with the field crops. A few households have begun to sell bambaranuts dried at the market in Bulawayo at Z$10/20 litre tin.

All the households interviewed cultivated yellow pumpkin on a small scale for subsistence, intercropped with maize. The large green and striped variety is used as livestock feed only, and its use is confined to households with livestock.

Both erect and creeping varieties of cowpea are cultivated by women in Silobela communal area. The produce consists primarily of leaves used as local spinach and eaten with sadza. Households which did not cultivate cowpea gave lack of seed as the reason.

Sweet potato is cultivated by all households and used for subsistence. Three indigenous varieties exist, all selected and maintained by women. No information exists concerning any social differentiation in cultivation between these three varieties.

Patterns of seed adaptation by crop

This section discusses how the different varieties used in Silobela communal area are adapted to the farming system and the requirements of peasant society. As there is great variation between the different crops, the analysis will be made crop by crop. Again, quantitative data only exist for the four main crops of maize, sunflower, groundnuts and sorghum, and assessment of other corps will be based on qualitative information. For the quantitative analysis of adaptation of crop varieties, several agricultural tasks are selected as parameters of analysis. These are method of tillage, timing of planting, method of weeding and number of weedings. The size of the cultivated area for different farm management practices within each of these parameters is analysed according to crop and variety. Also, the average yield of each method of tillage is analysed.

Maize

Measured by simple adoption, the hybrid varieties have been highly successful, occupying 98% of the cultivated maize area. The bulk of hybrid maize seed planted are purchased annually. Some peasants may add second generation retained hybrid seeds, if the hybrid seed they purchased is insufficient, e.g. if some fields have to be replanted and there is no seed available.

The rate of adoption is insufficient as a measure for determining whether the hybrid seed varieties offered satisfy the requirements and needs of the peasants in Silobela communal area. The most obvious argument for this is that there are no open-pollinated, improved varieties available for comparison. The breeding objectives embedded in the hybrid varieties in use are moreover directed towards commercial agriculture rather than the resource constrained conditions of farming existing in Silobela communal area. In the following, farm management practices recorded in the survey are correlated with the maize varieties used.

Because of the short and unstable rainy season, it is crucial to plant as early as possible in order to take full advantage of the growing season and secure reasonable yields. Survey results show that only 25–39% of the maize was planted early. To plant early may potentially give the highest yield, but it also involves a risk of crop loss (with possible need for replanting), if the rains are delayed, or an early season dry spell occurs. Between 13% and 17% of the maize area was staggered planted. This represents a different planting strategy which maximizes security for at least some of the harvest, but clearly reduces the potential yield. According to the peasants interviewed, planting of maize was delayed on between 43–58% of the total maize area. There is no clear pattern with regard to whether the variety planted is early or late maturing. The medium season hybrid *R215*, scores highest with 58% of its area planted late, and a correspondingly high proportion of delayed ox-ploughing. The magnitude of the problem of delayed planting indicates that there is a need for earlier maturing varieties in Silobela communal area.

The vast majority of maize planted is weeded intensively, using a combination of the plough for inter-row weeding and hoe for intra-row weeding. On the other hand, more than half of the area was weeded only once, which is regarded by Agritex as insufficient for achieving reasonable yields. The major reason for insufficient late weeding is labour constraints during February and March, when many tasks compete and some households have reduced manpower available because of seasonal migrant labour. The insufficient weeding indicates a need for varieties which compete better with weeds, i.e. better tolerate sub-optimal weeding during the period of growth.

Survey results show that the medium maturing varieties *R215* and *SC501* are yielding 17% above average. This indicates that the medium season varieties have a role to play in a low and unstable rainfall area such as Silobela communal area. One notes that the average yield is lower on maize areas where tillage was done 'on time' with the first rain than for fields where the ox-ploughing was delayed. This can be explained by an early-season dry spell which occurred in Silobela communal area during November 1989.

During the household interviews, peasants noted a number of differences between the qualities of the different hybrid varieties. Few peasants cultivated *SC501*, but those who did, claimed that the rate of maturity for *SC501* was better than for *R201*. Peasants also stated that resistance to weevils was better for *SC501*, and that *R201* is therefore preferably sold, while *SC501* is kept in storage for home consumption. A minus with hybrid *SC501* is that the variety is regarded for some reason as unsuited for roasting.

Some peasants have recently adopted the Pannar hybrid maize *PNR473*. *PNR473* yields 2–3 cobs per plant, while *R201* only yields 1–2 cobs per plant. One peasant questioned what consequence this might have for performance during a drought year. He complained that the seed on the cobs of *PNR473* were very small. Other peasants claimed that because of its early maturity, it performed better than *R201* during the 1988–89 season. Taste and density are otherwise the same for the two varieties according to the peasants interviewed.

California was the only local landrace cultivated in the survey, but peasants interviewed knew of four other local landraces. *California* is an early maturing, local, open-pollinated landrace which is known to yield at least something if there is little and unstable rainfall. Because of its flinty nature, the seeds on the cob are very hard and the weevils have difficulty in entering. If the maize is stored without application of chemicals, only one-quarter of the corn will be lost because of weevil attacks. If *R201* maize seed is stored without use of chemicals, most of it would be lost. The other known local landraces are:

1. *Red Cob*, a sweet maize for roasting or popcorn. According to peasants interviewed, *Red Cob* is the shortest maturing maize available. When planted in mid-November, it will mature in April. *Red Cob* has a higher density than *California* (which again is more dense than the hybrids), and produces a heavier sadza, well-suited for hard manual labour in the fields.
2. *Bogwe*, an early maturing landrace, stems from the retained seed of an old DR&SS release (*Salisbury White*). It has a low yield potential and is used for eating green or for making rich tasting sadza on special occasions.
3. *Three Month*, a landrace of flint maize, is cultivated only on a small scale. It matures very early and is mainly eaten fresh from the field and is preferred for its taste. Peasants also claim that the *Three Month* variety, under a no-chemical-input scenario, is more tolerant to weevil attacks than the hybrids. Peasants compare the yield of *Three Month* with that of *R200*, when cultivated under the same low input conditions.
4. *Kenya* is an open-pollinated, sweet yellow maize variety.

Groundnuts

Less than one-fifth of the peasants cultivate groundnuts and the major reason given by peasants is the absence of access to quality seed. Retention of groundnut seed by peasants in Silobela communal area has been seriously disrupted by the recurrent droughts during the 1980s. For many peasants, the groundnut crop, and thereby their source of seed for retention, was destroyed by drought over the last decade. For those peasants who still retain groundnut seed, the drought spells have affected the physiological quality of the seed. Notably, the rate of germination for retained groundnut seed has declined.

As there is no organized production and distribution of improved groundnut seed, the only groundnut seed available from the rural retailers is confectionery nuts, which are both exorbitantly expensive and of doubtful quality as seed.

More than three-quarters of the groundnut planted in the survey was *Natal Common* seed (locally called *Kasawai*). *Natal Common* is a medium-season maturing, improved variety which originates from a pre-independence release by DR&SS, but has been maintained by peasants in Silobela communal area through retention. Peasants prefer *Natal Common* to the two other retained varieties available, *Valencia R2* and *Butter*, for two reasons:

1. Groundnuts are planted as early as possible and are mature and ready for harvesting in late January/early February. Because of labour constraints during this period, harvesting of groundnuts is often delayed for up to a month. Peasants interviewed claimed that if this is the case, *Natal Common* will be less affected than the two other groundnut varieties.
2. Planting density of groundnuts in Silobela communal area is only a fraction of the seed rate recommended by Agritex. Instead of 110 kg/ha, the seed rate used by peasants in Silobela communal area is in the range of 18–25 kg/ha. Peasants explain that the recommended seed rates are far too demanding for the resource-poor, no-input conditions under which groundnuts are cultivated in Silobela communal area.

Natal Common is judged by the peasants to be the highest yielding variety under these farm management conditions. *Valencia R2*, like *Natal Common*, is an old DR&SS release which has been retained locally over the years. *Butter* is a local landrace of groundnuts of unknown origin. It is used for processing peanut butter and chosen for its rich taste.

Sorghum

Cheda is a local landrace of white sorghum, which is the dominant variety used in the survey. It has good palatability and is used for household consumption and beer brewing. *Cheda* is very drought tolerant and as such well-suited for the low rainfall regime of NR IV. *Cheda* is popular among the peasants, who claim it to be the highest yielding of the landraces under rotational application of manure. As is common for sorghum in general, losses caused by birds are the major problem for cultivation of *Cheda*, and women and children have to guard the sorghum fields from early morning until sundown during the period (March/April) when the seeds are still soft and vulnerable. Only one peasant in the survey cultivates *Segalani*, a medium season hybrid sorghum variety. Because of its early maturity, Cheda sorghum may be planted towards the end of the planting season, while the *Sengalani* was planted with the first rain.

Five other varieties, two landraces and three improved varieties, were known to the peasants, but not represented in the survey. *Long and Short White*, are two local sorghum landraces. Their potential yield is low and they are prone to bird attacks. *Red Swazi*, is an improved open-pollinated variety. It is early maturing and relatively drought tolerant. Because of its higher tannin content, *Red Swazi* is less prone to bird attacks. For the same reason its taste is too bitter for human consumption and its end use is beer brewing.

Peasants interviewed had heard about a new improved, white open-pollinated sorghum (*SV2*), but it had not been accessible in Silobela communal area. Peasants expressed interest in buying it to compare its performance with that of *Cheda*.

The white hybrid sorghum *DC75*, has been tried out by some peasants, who found its performance inferior to *Cheda* under farm management conditions where rotational application of manure is the only external input used. Peasants also noted that beer brewed from *DC75* was less tasty.

Sunflower

Peridovic was introduced in 1957 and has since been retained by peasants with occasional purchase of improved seed in town. Peasants complain that the quality of *Peridovic* seed sold from shops in town has been low during recent years. Retention dominates as source of seed. There is some confusion among the peasants over the difference between *Peridovic* and *Local Black*, and there is considerable overlapping between the two varieties because of cross pollination. Both varieties are early maturing and must be harvested by March, if planted in December. If harvest is delayed, the moisture content of the sunflower seed will dry out and the density will be reduced. *Peridovic* has a fairly high oil content on the research station, but the quality planted in Silobela is probably quite low as retention and cross pollination have been carried out for several consecutive years.

Local Stripped is the most popular variety. Like *Peridovic*, it is early maturing and must be harvested in March to retain its moisture content. The stripped variety has a very low oil content and thus low density, but harvest in terms of volume is, according to peasants interviewed, usually higher than for *Peridovic*. Oil from the sunflower seed is not extracted locally and all sunflower is sold to GMB, where it is not graded for oil content. For this reason, peasants judge the yielding ability rather than oil extracting capacity when judging the value of a sunflower variety, and the stripped variety is for this reason only popular among the peasants.

Peasants agreed that if cultivated according to common farm management standards and with no external inputs, the *Masasa* hybrid sunflower would not yield higher than the local retained varieties. A few peasants cultivated the hybrid *Masasa*; these are peasants where farm management is above standard, because the extra cost of buying hybrid seed would otherwise not pay off.

There is a marked difference in level of farm management between the hybrid *Masasa* varieties and the retained varieties. While fields planted with *Masasa* hybrid seed are winter-ploughed and planted early with the first rains, a large proportion of the fields with retained sunflower varieties is ploughed and planted late. This indicates that the requirements for higher management standards demanded by *Masasa* seed is honoured by those peasants using it. The local sunflower varieties are well adapted to late planting. The fields planted with *Masasa* seed are usually weeded three times using combined hoe and cultivator, while a high proportion of the fields with retained varieties is weeded only once and only part of these fields by using combined hoe and cultivator.

Peasants are generally content with the retained varieties used and for a new improved variety to be successfully adopted, it must be superior to the local varieties in terms of drought tolerance and yield under resource-constrained, no-external-input conditions.

Other crops

As already mentioned, seed supply for these crops is entirely based on indigenous plant breeding. In the following, the selection criteria and plant breeding objectives applied are discussed, on crop—and to the extent possible—on variety basis.

Three varieties of pearl millet are cultivated, all of which have been cultivated for centuries, and they are well adapted in terms of palatability. A change of taste can be detected in peasant society after it has been exposed to maize. Palatability—what tastes good—may well have changed considerably over the last 20–30 years. While pearl millet was once a predominant crop and commonly used for sadza, most people today prefer the taste of sadza made from maize.

Bird guarding for white sorghum and pearl millet is a very demanding labour task. Quelea birds seriously damage the crops if the fields are not constantly guarded while the grains are still soft in January and February. The problem of bird damage has increased over the last decade as the cultivated fields have become more scattered. If the small grains are dry-planted well before the first rains in October, the plants can be more mature when the Quelea birds arrive. Two so-called bird-proof varieties are cultivated in Silobela communal area. These are adapted to preventing birds from eating the soft grains by developing stiff straws which annoy the birds.

Chindundu is the only variety of finger millet cultivated in Silobela communal area. It is well adapted to beer brewing and its taste is preferred by elder people. To an even greater extent than pearl millet, its cultivation has declined as it cannot meet the competition in terms of labour input, yield and palatability.

For the *Idumba* landrace of cowpea, emphasis is placed on the ability to yield leaves over an extended period of time. It is a creeping type of cowpea, grown as much for its leaves as for grain. The leaves are eaten from ultimo-January to primo-March. Part of the leaves are eaten fresh as spinach, while the rest is harvested, cooked, dried and stored for the dry season. Although cultivation of cowpea is often limited to a few lines intercropped with maize, it is an important crop for the household diet and may be eaten three times a week during the rainy season. It is also an excellent cover crop which improves water infiltration in the soil and prevents soil erosion.

The recurrent droughts in the early 1980s caused considerable genetic erosion in bambaranut varieties, and many households today plant seeds obtained from different sources, including markets in town. The 'pure' landraces which existed a decade ago are replaced by a mixed landrace. The result has been that some plants mature before others and, as the crop is harvested at the same time, part of the crop may not yet be ripe when harvested.

Three sweet potato varieties exist in Silobela communal area. An early maturing yellow variety (4-month), a medium maturing red variety (6-month) and a late maturing white variety (7-month). The women cultivate all three varieties, as they satisfy different objectives. The yellow variety is fast maturing and secures the supply of sweet potato for household consumption already in March, when planted at the start of the rainy season. The red variety has the best palatability, while the late maturing white variety has the highest yield potential.

Economy of seed use

Maize

The fact that 98% of the area planted with maize recorded in the survey was sowed with hybrid seed is a clear indication that it is economically viable to buy hybrid seed annually. There is no doubt that this makes economic sense; hybrid maize yield is significantly higher than any of the five landraces of maize existing in Silobela communal area, and use of retained second-generation hybrid seeds can reduce yield by approximately 30%. One cannot conclude from this comparison, however, that hybrid maize is the optimal seed for all categories of farmers.

One outstanding feature of the Zimbabwean seed industry is the deliberate ban on the sale of open-pollinated maize. Open-pollinated maize varieties have been discouraged since 1960 and no breeding effort has been made to develop high yielding composites. The only composite available in Zimbabwe is a South African variety, *Kalahari Early Pearl* (KEP), which for a number of years has been produced by seed companies for export only.

One seed company began to market *KEP* in marginal areas during the 1988/89 season. This has caused heated condemnations from DR&SS, and the seed distributors have in 1990 received direct instructions from DR&SS that they are not allowed to sell *KEP* in Zimbabwe. DR&SS argues that trial results show that hybrid maize significantly out-yields *KEP*, and that from a national food security point of view, the highest yielding variety should be preferred.

To directly forbid composite maize to be sold is a very patronizing approach, which exhibits little or no trust in the peasants' ability to judge for themselves as to which variety suits them best. It is in fact possible that an improved composite maize would be the best choice for some poor farmers. The peasants can retain *KEP* seed, which saves them the trouble of getting hold of seed every year. Late access to seed results in late planting, while retained seed can be planted on time. Although hybrid maize seed is relatively cheap, the difference in price between hybrid seed and retained seed is Z$20–30 for the 25 kg required to plant one hectare. The money saved by using retained seed would buy from 100–200 kg maize, depending on the local price. In marginal areas and under low-input conditions, the yield for hybrid maize is lower than one ton/ha. The hybrid thus has to out-yield the retained seed by 10–20% before it is economically viable for the farmer to buy hybrid seed annually.

Sunflower

The hybrid sunflower seed *Masasa* is more than four times more expensive than retained seed (the producer price). The retail price for *Msasa* seed in 1989 was Z$95/50 kg, while 50 kg local seed cost Z$22.5 or Z$450/ton. The reason behind the high seed cost is that it is expensive to produce male sterile inbred lines for the hybrid.

Masasa seed is also demanding in terms of water and management, if high yields are to be achieved. Under the existing conditions of cultivation, with low spacing and no fertilizer application, the peasants interviewed during the survey unanimously claimed that no significant yield improvements are achieved by using hybrid sunflower. No scientific proof for this exists, as no evaluation trials have ever been carried out under realistic farming conditions.

The sunflower crop is not graded for oil content when sold to the GMB, and the peasants have thus no incentive to adopt the improved varieties because of their higher oil content. The peasants in Silobela communal area harvest the retained varieties of sunflower when the seeds have the highest moisture content. Sunflower seed is stored while still on the husk and threshed when dry, in order to keep the moisture content as high as possible when it is to be sold.

Groundnuts

Groundnuts are grown primarily as a subsistence food crop. Surpluses above family requirements are sold on the local market. The parallel market prices are at least twice as high as the official GMB prices, which is obviously the reason why communal farmers prefer to sell their groundnuts to the local market. The nuts are either sold unshelled by the bucket (20 litre tin) or processed to peanut butter. The sales of industrially manufactured peanut butter have gone up 10 fold and it is clear that the farmers are not growing enough groundnuts to satisfy the local demand.

The factors limiting production and deliveries in the communal sector are the availability and distribution of seed, and the fact that groundnut is a labour intensive crop. The producer price offered by GMB is not high enough to ensure an adequate return. Even though the prices of groundnuts are much higher on the parallel market, the communal farmers cannot be sure to sell their products right away. On a vender type of market, it may take some time to sell the product, even only a few bags. Prices may be high, but the volume sold is limited.

There is no doubt that with the present parallel market prices, there is a great demand for cultivating a larger area of groundnut. The unavailability of seeds of improved varieties over the last decade, combined with the fact that the recurrent drought has seriously limited peasants' access to and quality of retained groundnut seed, is a major constraint for increasing groundnut production.

The actual demand for improved groundnut seeds in Silobela communal area depends on the price of seed. If prices on short season improved groundnut seeds can been kept reasonably low, there is no doubt that high demand exists in the community.

Sorghum and pearl millet

Communal farmers do not have any tradition for purchasing improved open-pollinated sorghum and millet seed, and an awareness of their existence and benefits has to be built up in the communal areas. Communal area trials conducted by DR&SS show 70% yield advantage for *SV1* and *SV2* over local varieties and a 25% advantage for *PMR1*. If these results are applicable under real conditions, the seed industry would have no problems in selling the seeds if they were made available to farmers in rural retail shops and if Agritex supported their use with information about their existence.

The role of seed in peasant agriculture

As discussed in chapter 1, there are significant differences in the production objectives of peasants and commercial farmers. This difference in production objectives has consequences for the respective role of seed in commercial and peasant farming. The study has identified two major differences between commercial farmers and peasants which have a bearing on the role of seed: degree of involvement in the market; and access to resources.

Because of the partial market involvement which characterizes peasant societies, they have different and often conflicting seed requirements. On the one hand, seed is required which satisfies subsistence and food security objectives, including such related objectives as risk minimizing, palatability, storability, and consumption specific end uses. On the other hand, seed is required with high yield potential which can secure surplus production for marketing.

Peasants are commonly faced with a range of resource constraints which have a bearing on farm management practices, and thus on the productivity of agricultural production. Such shortcomings in farm management could, for example, take the form of delayed planting, low soil fertility, inadequate weeding etc. These problems are solved agronomically on commercial farms which do not experience similar resource constraints. For example, here the problem of late planting would be solved by dry season tractor ploughing (or with draught oxen if sufficient were available); low fertility could be solved by application of mineral fertilizers (or sufficient amounts of organic manure) etc. But because of the level of poverty found in peasant societies, these constraints are persistent and there are no indications that this poverty will be alleviated in the near or even more distant future. The optimal seed requirement of peasant societies is discussed in the following.

Two different systems of seed supply exist: indigenous plant breeding, which is associated with community seed exchange systems; and scientific plant breeding, supported by organized seed production. High yield potential under optimal farm management conditions is the main benefit of seed from scientific plant breeding/organized seed production, while high adaptability to specific local requirements is the advantage of seeds from indigenous plant breeding. As discussed earlier, the choice of variety in peasant societies is in many cases not only made on the basis of yield performance. The indigenous plant breeding system plays an important role, as its landraces are well adapted to the local-specific, agro-ecological and socio-economic conditions, and thus provides the peasant household with a range of options to choose from. The performance of these two systems is discussed in chapter 12.

Two processes influence peasant seed use: 1) the process of commodification of agriculture is increasing the demand for surplus production for marketing; and 2) the process of agricultural intensification is increasing the pressure of production on resources. These processes are changing the peasant household production objectives and strategies, and thus also their seed requirements. Commodification and intensification of agricultural production takes place gradually, with great regional and social differences. The pace at which changes occur varies from area to area and within the individual village. Peasant seed requirements also vary greatly from crop to crop.

These two processes are influencing seed use towards increased reliance on improved varieties with higher potential yield. The use of improved seed varieties which are not well adapted to sub-optimal growing conditions has a number of adverse effects for the household's food security and resource utilization.

An example of such adverse effects is the adoption of late maturing improved varieties. The objective of minimizing risk commonly results in peasants' adoption of short-term varieties, even in agro-ecological areas where late maturing cultivars offer higher bio-mass and thus higher yields. There may be many rational arguments for such adoption strategies: labour constraints may prevent the peasant to take full advantage of the growing season; delay in access to draught oxen may be a constraint for early planting; or adoption of a late maturing improved variety may mean an unaffordable delay in the planting of another crop on the same plot in areas of bimodal rainfall. Scientific plant breeding emphasizes maximizing potential yield, which results in development of late-maturing cultivars because of the correlation between yield and period of photosynthetic intake. Peasants adopting these varieties will thus have the potential to increase productivity, but may at the same time increase the vulnerability of crop production.

Despite the obvious resource constraints in peasant agriculture, scientific plant breeding has continued to produce improved varieties, which demand a high level of management demands if their full potential is to be realized. The question that needs to be asked is whether varieties which are adapted to these sub-optimal production conditions are better suited to increase productivity of resource constrained peasants than conventional improved varieties which are developed under optimal farm management conditions. Improved varieties which are adapted to sub-optimal production conditions would probably not have the highest potential yield, but might have higher actual yield under sub-optimal conditions, or otherwise be better able to satisfy the production objectives of the peasant households. The perspectives for such a scenario are analysed in chapter 13.

Optimal seed requirements for peasant societies

Available from the formal system of scientific plant breeding are a *few uniform* and *stable* varieties with *general adaptability*. When new varieties are released, they often replace earlier released varieties which are subsequently withdrawn from the market. This system is suited to highly commercialized agriculture and has serious long-term consequences for the *in situ* bio-diversity of the production system.

Limitation to a few available varieties which are generally adaptable ensures an enhanced commercial market for the seed industry, but is not optimal for meeting the requirements of different groups of commercial farmers or, to an even lesser degree, peasant societies. It can be argued that limiting the number of available varieties minimizes production and marketing costs for the seed companies and thus contributes to lower seed prices for the peasant. Whether this is correct or not depends on how seed multiplication and processing is organized.[1] And even if increasing the number of varieties carries with it an element of higher seed production costs, such increases would be on a much smaller scale than the value of the benefits of securing peasants access to optimal varieties.

Uniformity and stability of varieties are only an advantage in societies in which production and processing are highly mechanized, e.g. combine harvesters require an even stand on the fields for optimal results or the food-processing industry may require standardized product quality. The seed requirements of peasant societies, however, are highly varied, and rather than a few generally adapted varieties, there is a need for a catalogue of varieties which are adapted to local environmental and socio-economic conditions.

The seed industry today uses the concept of *potential seed demand*, when accessing the national seed requirement. The potential seed demand is calculated by multiplying the cultivated area of a given crop with the recommended sowing rate. This assessment is purely quantitative, but still a widely used method to determine the potential seed demand. It is implicit in this assessment that the demand can be satisfied by producing sufficient quantities of a limited number of improved varieties of physiological quality. Moreover, the assessment of potential seed demand does not differentiate between seed requirements of commercial farmers and peasants.

There is a need to develop a qualitative concept for understanding the optimal seed requirement of peasant societies. As discussed in chapter 1, peasants deviated from commercial farmers in at least four ways: 1) the existence of imperfect markets for land, labour, capital and products; 2) the partial participation in the market; 3) resource constrained sub-optimal production conditions; and 4) an early stage in the processes of agricultural intensification and commodification.

An analysis of the optimal seed requirements of peasant society should be based on an understanding of the peasant farming systems as a whole. This includes the following elements:

- adaptation to local agro-ecological conditions
- adaptation to specific local sub-optimal production conditions
- choice between high performance but expensive hybrid seed and improved non-hybrid, cheaper seed
- choice between late and early maturing varieties

Moreover, the concept of optimal seed requirements for peasants must acknowledge the diversity of seed requirements of different groups of peasant households, rather than focusing narrowly on potential yield as the only objective. This study has chosen household access to resources (land, livestock and income) as the parameter for differentiating between three

[1]For a comprehensive analysis of decentralized farmer-based methods of seed multiplication and processing, see Friis-Hansen et al. (1991).

different groups of peasants within the community. The analysis of seed use in Silobela communal area clearly showed that these groups of farmers used different seed varieties and had different production constraints.

Chapter 9
Agricultural Research in Zimbabwe

History of the seed industry

Formal research with the purpose of variety improvement started already in 1909 at the Botanical Experimental Station. Modern plant breeding started on a private basis in 1933 and was brought under government control in 1948 with the establishment of Department of Research and Specialist Services.

During the 1950s and 1960s, Zimbabwe had one of the most advanced agricultural research set-ups in the developing countries. Rhodesia had been one of the leading countries in the world for maize and tobacco breeding. With the implementation of international sanctions against Rhodesia in 1965, the large-scale commercial sector was forced to diversify its production. This was made possible by comprehensive and flexible support from the national agricultural research, which transferred the experience gained in the maize breeding programme within pest management, fertilizer agronomy and weed control to other crops such as wheat and soyabeans.

This period was characterized by the establishment of close cooperation between government plant breeding and private seed associations, consisting of (European) white commercial farmers involved in seed multiplication.

During the 1950s and 1960s, an informal but also extensive cooperation developed between government plant breeding and the seed associations. The government developed and released new varieties and distributed them to the seed organizations which multiplied and distributed them. An important part of the philosophy behind this cooperation was to build up the seed associations in order to make them capable of producing high quality seed under certification schemes.

The Zimbabwe Seed Maize Association (ZSMA) was the first association of that kind in Zimbabwe and was formed in 1940 with the task of multiplying open-pollinated maize seed. The Seed Co-op of Zimbabwe was born on 1 April 1983 from the merger of the two largest seed houses, ZSMA and the Zimbabwe Horticultural Crop Seed Association. Agricultural activity of large-scale commercial farmers increased fairly rapidly after World War II. The farmers had used open-pollinated varieties, and on-farm retention of seed was the most common seed supply. In 1940, a group of large-scale commercial farmers formed the Seed Maize Association in order to secure a sufficient supply of quality maize seed. In 1957, the Crop Seed Association was formed, covering soyabeans, wheat and groundnut seeds. More recently, the Crop Seed Association included sunflower, sorghum and bean seed crops. A number of other crop specific seed associations were formed in the following years, covering cotton, tobacco, Irish potatoes, pasture and horticultural seeds.

The seed associations and Seed Co-op are made up of large-scale commercial farmers who wish to produce certified seed as part of their enterprises and are prepared to comply with the regulations and standards laid down in the Seed Certification Scheme Notice of 1971. The majority of the farmers who are members of the seed associations or the Seed Co-op own well-established farms and have higher than average management skills. The number of commercial farmers involved in formal seed production is limited to approximately 1% of the total.

Before independence, improved seed was almost entirely sold to large-scale commercial farmers.[1] Seed associations were geared to satisfy the demand for seed from the large-scale commercial sector only, while retained seed were predominantly used in the communal sector (at that time known as Tribal Trust Lands). Seeds were distributed through private wholesalers located in provincial and district towns. The major channel of seed distribution was the farmers' co-op, which all commercial farmers belonged to. A price control system was set up under which a maximum pan-territorial price for seed was determined by MLARR in negotiation with the seed associations, based on production costs rather than on demand and supply.

The international sanctions against Rhodesia after the Unilateral Declaration of Independence in 1967 caused a drop in tobacco exports. This forced the adoption of an agricultural diversification policy. To establish an alternative for the tobacco farmers, a short season, three-way cross hybrid maize was developed and marketed. This was intended only for the large-scale commercial farmers, but there was also interest in the high yielding maize in communal areas. To exploit this market segment, the Maize Seed Co-op started packing three-way hybrids in small packs for small farmers in the early 1970s. Sales of hybrid maize in small packs to small farmers expanded rapidly until 1976, whereafter expansion of agricultural activities all but ceased due to the effects of the liberation struggle.

The cooperation between government agricultural research stations and the seed associations was formalized in 1967 by the establishment of the tripartite agreement (for maize), and at a later stage bipartite agreements (for sunflower, wheat, barley, soyabeans, groundnut and sorghum), between the government, the Commercial Farmers Union and the seed associations. These agreements included a number of clauses aimed at further strengthening the previous informal cooperation. The three central conditions laid out in the agreements are:

1. The government agrees to release to the seed associations all new varieties which are developed and released from government breeding pro-

[1]For an analysis of seed sales in Zimbabwe, see Friis-Hansen (1992a).

grammes. The government retains plant breeders rights over the released varieties, but licenses them free of charge to the seed associations for production.

2. A production schedule is developed annually and agreed to by the government, the Commercial Farmers' Union and the seed associations. This is to ensure that the country's demand for seed is secured, including the right proportions of the different varieties.
3. The seed associations are required to produce sufficient seed to meet the demand. In addition, in order to ensure that the nation will have sufficient seed should a bad season occur, a 20% buffer stock is kept.

These agreements are unique to Zimbabwe and originate from the state capitalist policy of the Unilateral Declaration of Independence government of the 1970s, the aim being to create a politically controlled monopoly to serve the large-scale commercial farmers while securing its efficiency by leaving production in private hands. As the seed industry did function efficiently, the agreements were renewed after independence and the latest bipartite agreement was signed in 1982.

The division of labour between the state and private seed industry in Zimbabwe leaves in broad terms seed multiplication, processing and distribution in private hands, while the state has taken charge of research, certification, quality and price control.

This division of labour has by and large been allowed to continue intact since independence. While the Seed Co-op is still by far the dominant seed producer in Zimbabwe, other private and public seed organizations have emerged. Savanna Seed and other private companies have challenged the Seed Co-op on the domestic and export markets, even though the Seed Co-op has maintained its monopoly status. Meanwhile, parastatals such as GMB and ARDA have been involved in seed production and NGOs such as ENDA have also initiated seed programmes. The scale and scope of parastatal and NGO activities are very limited compared with that of private seed companies. GMB has since independence been responsible for groundnut seed, but its practical involvement with seed production has been limited.

The tripartite and bipartite agreements state that the parties should hold annual meetings to review the performance of the agreement. Memoranda from such meetings, held after independence, give the impression that the main content has been the issue of setting prices. In the second half of the 1980s, the Seed Co-op tried several times to use the review meetings to stop the entry of Savanna Seed to the market, with reference to the agreement. One argument used by Seed Co-op was that the agreements impose a number of constraints on the company which foreign seed companies do not have, such as the obligation to store a minimum 20% of the annual seed sales.

It is characteristic that all initiatives have come from the Seed Co-op, while the MLARR has taken a passive and suspicious position. The impression from interviewing persons in the MLARR is that the ministry does not have any clear policy towards the seed industry. The actual performance of the industry in terms of supplying all farmers (including the communal sector) with the demanded seed has been regarded as a technical matter and left to DR&SS.

Two institutions within DR&SS are involved with the agreements, the Crop Breeding Institute and the Seed Services. Because of the agreement, the breeding programmes of Seed Co-op and Crop Breeding Institute are deeply interlinked, to such an extent that they are difficult to view separately. More than half of the DR&SS trials are actually run on the Seed Co-op research farm, Rattray Arnold. The Seed Services is the other cooperating institution, in charge of testing and controlling seed quality. Seed Services also has a close technical cooperation with the Seed Co-op, which acts as seed certifying agency for maize.

Good cooperation between agricultural extension, research, credit and marketing institutions has clearly been very important in contributing to the successful growth of maize production in Zimbabwe, including to the exceptionally high rates of adoption of hybrid maize seed. There are various reasons for this. First, these institutions were already operating relatively efficiently at the time of independence, so the re-orientation of their focus to include the needs of small-scale farmers has been implemented successfully. Other contributing elements are that the agricultural marketing system was already well set up to handle maize, well-adapted hybrid varieties were available, and appropriate crop husbandry advice and suitable credit packages existed. But a similar level of successful cooperation has not been achieved for other less important crops.

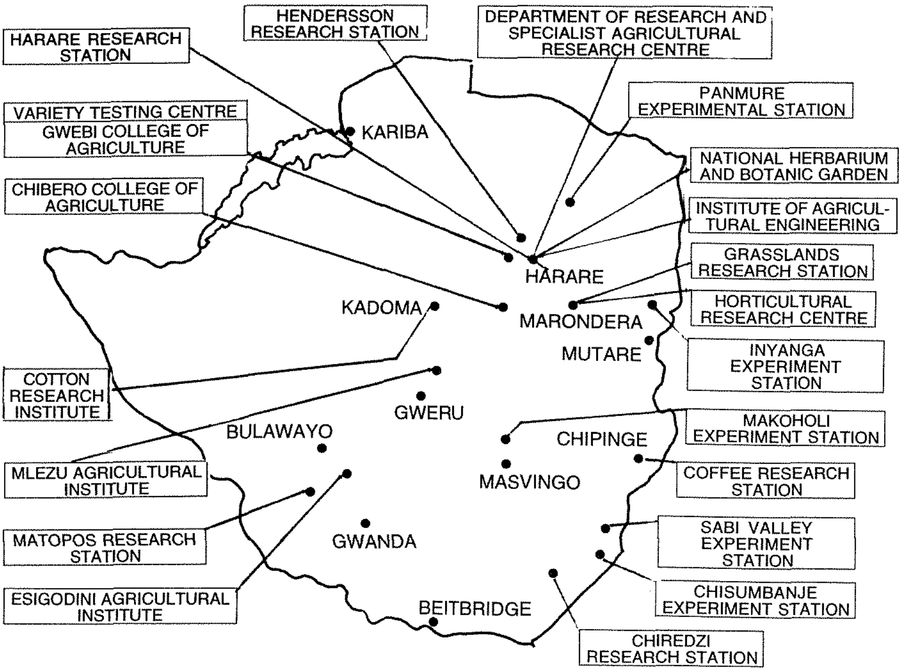
In agricultural research in general and in plant breeding in particular, there have traditionally been very strong links between DR&SS, Seed Co-op and CFU, and this close relationship continued after independence. With the decline in government funding of research in relative terms, private research bodies financed by the large-scale commercial sector, such as Agricultural Research Trust, have in recent years increased in importance.

However, the links between communal farmers and formal agricultural research have remained weak or non-existent, even though the post-independence government is strongly committed to serving small farmers. The practical influence of small farmers on issues such as plant breeding objectives and the direction of formal agricultural research programmes has been minimal and only indirect. And compared with the CFU, NFAZ remains a weak organization which has severe problems communicating with its grassroots members.

Plant breeding institutions in Zimbabwe

The institutions of the seed sector and the links between the various stages of the seed chain are illustrated in figure 2. This section will concentrate on

Map 11. *Location of agricultural research stations in Zimbabwe*



the institutions indicated by the three boxes at the upper left of the figure: agricultural research, seed services and seed legislation.

Ministry of Lands, Agriculture and Rural Resettlement (MLARR) is responsible for conducting agricultural research in Zimbabwe. It is divided into three departments: Department of Research and Specialist Services (DR&SS), Department of Agricultural, Technical and Extension Services (Agritex),[1] Department of Veterinary Science and Crop and Livestock Production.

DR&SS is responsible for plant breeding and has a staff of more than 158 professionals. It is the largest research organization in Zimbabwe with an annual budget in 1990 of Z$19.5 million, of which Z$250,000 is allocated to Crop Breeding Institute (Ministry of Agriculture 1989). The research budget of DR&SS, and therefore also Crop Breeding Institute, has decreased in real terms during the 1980s. The research budget of Seed Co-op has in the same period increased substantially and is now more than Z$1 million annually (or four times that of Crop Breeding Institute).

[1]Agritex is primarily an extension body though it does engage in research, e.g. in soil erosion and agricultural engineering.

Table 27. *Zimbabwe breeding programmes* (May 1990)

Crop species	Year begun	Parent organization	Headquarters
Maize	1932	DR&SS	Crop Breeding Institute
	1974	Seed co-op	Rattray Arnold Research Station
	1986	Savanna Seed Company	ART Farm
	1988	Pioneer International	ART Farm
Wheat	1954	DR&SS	Crop Breeding Institute
	1983	Seed Co-op	Rattray Arnold Research Station
	1985	CIMMYT	University of Zimbabwe
Sorghum	1969	DR&SS	Crop Breeding Institute
	1985	ICRISAT	Matopos Research Station
	1987	ENDA	On-farm communal trials
Pearl millet	1977	DR&SS	Crop Breeding Institute
	1985	ICRISAT	Matopos Research Station
	1987	ENDA	On-farm communal trials
Finger millet	1988	DR&SS	Crop Breeding Institute
	1985	ICRISAT	Matopos Research Station
	1987	ENDA	On-farm communal trials
Groundnut	1970	DR&SS	Crop Breeding Institute
Sunflower	1975	DR&SS	Crop Breeding Institute
	1988	Pioneer International	ART Farm
Soyabean	1963	DR&SS	Crop Breeding Institute
	1982	Seed Co-op	Rattray Arnold Research Station
Beans	1984	DR&SS	Crop Breeding Institute
Cowpea	1989	DR&SS	Crop Breeding Institute
Bambaranut	1990	DR&SS	Crop Breeding Institute
Potato	1957	DR&SS	Crop Breeding Institute
		UZ	Crop Science Institute
Cotton	1925	DR&SS	Kadoma Research Station
Tobacco	1953	Tobacco Research Board	Kutsanga Research Station
Sweet potato		UZ	Crop Science Institute
Cassava		UZ	Crop Science Institute
Vegetables		DR&SS	Marondera Research Station
Grasses		DR&SS	Marondera Research Station

Source: Interview with plant breeders at DR&SS, Seed Co-op, Savanna Seed Company and UZ.

DR&SS breeding programmes are undertaken at the Harare Research Station and the Seed Co-op's Rattray Arnold Research Station, while test trials are carried out on research stations throughout the country (see Map 11). The results are published in Crop Breeding Institute's Annual Report, the publication of which is seriously delayed; the latest issue covers the 1984–85 season.

Table 27 lists the current plant breeding programmes being undertaken in Zimbabwe. As shown, all major food and industrial crops are served by breeding programmes, including open-pollinated cultivars and hybrids. A number of crops, including sugar cane, fruit and horticultural crops, coffee and tea, pastoral crops and various minor crops are still dependent on importation of exotic cultivars.

The breeding programmes are based on exotic germplasm and, where relevant, local indigenous material. Importation of exotic germplasm and testing of crop species under local conditions have been carried out for a number of years. Moreover, local indigenous germplasm has been collected in Zimbabwe, most recently with the assistance of IPGRI (International Plant Genetic Resources Institute).

Most of the initial trials of food crops in the plant breeding programmes are carried out at Crop Breeding Institute in Harare, at the Gwebi Variety Testing Center and at the privately owned Rattray Arnold Research Station. Other government research stations together with commercial and communal farm land are used for advanced variety testing and evaluation.

Close cooperation exists between Crop Breeding Institute and other institutes within DR&SS. Statistical processing of trial results is carried out by Biometrics Bureau; germination tests are conducted by Seed Services; while screening of germplasm is carried out by Plant Protection Division etc.

Private agricultural research organizations and seed companies

The Agricultural Research Trust, ART, is an independent research, demonstration and training organization established in 1982 by commercial farmers and agricultural trade organizations. The trust has a 580 ha research farm in Triviotdale, outside Harare, and conducts a number of research projects.

In order to develop its own breeding and variety testing programme and thereby be less dependent on the government, the Seed Co-op acquired the Rattray Arnold Research Station in 1973. The station has 400 ha located outside Harare and is funded and staffed entirely by the Seed Co-op. It provides facilities for testing hybrids and other varieties developed by DR&SS under the tripartite and bipartite agreements. More than 4000 trials are conducted annually at the Rattray Arnold Research Station, including approximately half of all DR&SS trials.

A number of trans-national seed companies have been allowed to establish themselves in Zimbabwe in recent years: Cargill (England), Asgrow Seeds Ltd. (England), Savanna Seed Ltd. (Pannar of South Africa), Ciba-Geigy (Switzerland), Pioneer International (US), Shell Development Zimbabwe (Netherlands), Windmill (US), Agricure (Spain) have all at one time or another since independence established demonstration trial plots for their products, which include seeds and herbicides, pesticides and fertilizers.

Of these trans-national seed companies, only Savana Seed has started marketing products. Most of the varieties marketed by Savanna Seed are developed in South Africa and only screened in Zimbabwe before they are released. Very little research and development work is done by Savanna Seed in terms of adapting the varieties to Zimbabwean conditions.

Pioneer International is a trans-national company based in USA. It is the largest seed company in the world and has access to an extremely large germplasm bank. In comparison to Savanna Seed, it has followed a much more cautious strategy. It has many varieties, but has not yet released any on the market. Instead of screening their varieties and marketing the best, Pioneer International has become engaged in a 10-year research programme which aims at developing the most promising varieties for adaptation to the Zimbabwean environment.

International research organizations operating in Zimbabwe

The International Crop Research Institute for the Semi-Arid Tropics, ICRISAT, is in cooperation with the Southern Africa Development and Co-ordination Conference, SADCC, undertaking a research programme for sorghum, pearl millet and finger millet. ICRISAT is the focal point for research in these crops for Southern Africa. Its main research farm is situated at the Matopos research station, 30 km south of Bulawayo.

Centro Internacional de Mejoramiento de Maiz y Trigo, CIMMYT, the international agricultural research organization responsible for maize and wheat, is affiliated with the University of Zimbabwe and carries out its programmes on the University of Zimbabwe farm. CIMMYT also conducts an on-farm research programme.

University of Zimbabwe

The University of Zimbabwe has established a research farm close to Harare, where the Department for Crop Science conducts agronomic trials. Cassava and sweet potato are among the crops on which the Department of Crop Science has concentrated this work.

Non-governmental organizations

ENDA-Zimbabwe initiated in 1985 an "In-field Indigenous Seed Programme" to collect, test and distribute local composite varieties of maize, sorghum and millet. It is currently undertaking agronomic trials of 64 local composites in six communal areas and comparing their performance with hybrid varieties.

Seed services

In Zimbabwe, the seed certifying authority is the Seed Services Unit in the Department of Research and Specialist Services. The unit comprises a seed testing laboratory and a number of seed inspectors. The laboratory is divided into several sections to cater for the various aspects of testing: purity analysis, germination testing and seed pathology as well as a library and administrative offices. The laboratory is headed by a senior seed analyst, assisted by two seed analysts and 13 seed technicians. It has equipment and facilities to test up to 5,000 samples a year. Currently, there are 8 qualified and experienced inspectors at the Seed Services. The primary objectives of conducting field inspections are to confirm that the produced seed is of the designated variety, and that the produced seed has not been contaminated genetically or physically beyond certain specific limits specified in the field standards for each crop in the Seed Certification Scheme Notice of 1971. The seed notice also outlines the number and timing of inspections for each crop.

In addition to the seed testing authority, there also exist seed testing agencies. This status is granted to seed associations which have adequate equipment and experience. The largest is the Seed Co-op, which tests seed quality for wheat, barley, sorghum, sunflower and soyabeans. The Seed Co-op has a laboratory staffed with one seed analyst, assisted by two technicians and two assistants and can handle up to 5,500 samples per year (i.e. more than the Seed Services). Other seed testing agencies are the Cotton Marketing Board and the Forestry Commission.

The Seed Services Unit functions as a controlling body, but its effectiveness has been constrained by inadequate resources, particularly lack of transport. In 1990, the eight seed inspectors from the Seed Services shared three cars and private seed companies sometimes had to provide transport for the inspection of their seed crops. Three types of license are issued by the Seed Services to the seed industry: an A-license allows operating a seed laboratory; a B-license allows packing seed; and a C-license allows retailing seed.

Chapter 10
Review of Plant Breeding Programmes

This chapter reviews, crop by crop, the history and objectives of plant breeding at Department of Research and Specialist Services (DR&SS) in relation to the production conditions for crops in the communal areas.

Maize—a success story

In Zimbabwe, plant breeding and agronomic research for maize has had a long and successful history. The combination of hybrid maize varieties and use of fertilizers dramatically changed the productivity of maize production. Average maize yields in the large-scale commercial sector were around 0.5 tons/ha until around 1950; they increased to 1.44 tons/ha in 1950–56, 2.89 tons/ha in 1960–65 and further to 4.35 tons/ha in 1981–85. It has been estimated (Tattersfield 1982) that of the 325% increase in average maize yields (from 1946–1950 to 1976–1980), variety improvement contributed 45%, while increased use of fertilizer contributed 200% and improved agronomy and use of pesticides contributed 60%.

Table 28 compares the average maize yields in the large-scale commercial sector and the communal areas. One notes that the communal areas' mean yields are less than one-fourth of the yields in the large-scale commercial sector. This difference is mainly a result of differences in use of fertilizer and in agro-ecological zone (rainfall).

At the time of colonization of Rhodesia, maize was an established crop among the indigenous population. The local, open-pollinated landraces were low yielding and of round flint which stored well. With the urbanization of the rural population at the time of colonization, demand for maize grew. In order to be able to meet the demand, the farmers were forced to increase the area under cultivation or the yield per unit area.

Between 1900 and 1905, the Department of Agriculture imported seed of a number of high yielding American varieties such as *Golden Mine*, *Silver Mine*, *Golden Ball*, *Seaming*, *Bone County* and *Hickory King*, for distribution to farmers. When these varieties were introduced, yields of 3.25 tons/ha were recorded, which was a remarkable increase from the indigenous flint type landraces.

Table 28. *Maize yields 1970–88* (kg/ha)

Harvest year	Large- and small-scale commercial sector	Communal areas	Communal areas as % of total
1970	2,875	402	14.0
1971	4,607	677	14.7
1972	5,213	835	16.0
1973	2,570	305	11.9
1974	5,254	648	12.3
1975	4,774	600	12.6
1976	5,005	724	14.5
1977	4,590	667	14.5
1978	4,314	643	14.9
1979	3,699	700	18.9
1080	4,066	667	16.4
1081	5,044	1,000	19.8
1982	3,835	595	15.5
1983	2,201	271	12.3
1984	3,021	400	13.2
1985	4,844	1,394	28.7
1986	4,990	1,200	24.0
1987 (est)	3,167	400	12.6
1988 (est)	5,244	1,150	21.9

Source: Data for 1970–85: CSO (1987); AMA (1985); AMA (1986). The AMA reports provide estimates of small-scale commercial production missing from the CSO data. Data for 1986-88: CSO (various years).
Note: Totals do not include resettlement area production.

The maize breeding programme started in 1932. Some of the objectives for the maize breeding programme were:

- high yielding varieties (compared with the potential yield of today's hybrids (12 ton/ha), the potential yield of maize was low when the programme was established: 3 ton/ha)
- resistance to lodging (most varieties were susceptible to lodging, which was one major cause of low yields)
- resistance to pests and diseases (the most common diseases were cob rot, diplopia, and fusarium, which reduced yields, sometimes even to total crop loss)
- plant height
- short and long season varieties

Already in the 1950s the maize breeding programme had a strong bias towards the development of hybrid varieties, and it was gradually phased out. A major breakthrough for the hybrid maize breeding programme came in 1960, with the release of SR52, a single cross hybrid maize which significantly out-yielded the existing open-pollinated varieties.[1]

[1]In a series of 1983 variety trials carried out at different sites from 1960/61 to 1968/69, the mean yield of *SR52* was 46% greater than *Southern Cross*, which was widely grown before 1950 (Tattersfield 1982).

The hybrids available from DR&SS and the Seed Co-op, listed in order of late to early maturity, are *SR52, ZS233, ZS107, R215, SC501, R201, R200* and *ZS225* for white grain and *ZS206* and ZS202 for yellow grain. Most of the improved varieties were developed for higher potential production zones and are characterized by long growing cycles and poor resistance to drought (Kunjeku and Waddington 1988). To date, only two improved varieties suitable for semi-arid areas, *R201* and *R200* (both three-way cross hybrids), have been developed. Both hybrids reach maturity some 120 days after planting—25 days less than the most common hybrid in Zimbabwe, *SR52*. The two hybrids are more drought resistant than *SR52* and demand some 800 millimetres of rainfall for optimal performance (Harahwa and Whingwiri 1985). A short-season replacement for the 16-year old *R201* has not been forthcoming. DR&SS and the Seed Co-op have developed a number of promising hybrids, but they must be evaluated in on-farm communal area trials for a minimum of 3 years before they can be released. Results from preliminary screening trials indicate that some varieties may gain up to 10% in average yield over *R201*. The last release, *SC501*, a replacement of the medium-term maturing *R215*, is especially suitable for NR IIa, IIb and III.

R201, R215 and *SC501* all have good pollen to silk synchronization, which reduces the susceptibility to drought conditions at flowering. *R201* is heat stress tolerant and has satisfactory resistance to leaf blight and cob rot. *R215* has good resistance to leaf blight and to lodging. *SC501* has characteristics similar to *R215*, but is more responsive to good management and is likely to yield more in medium to high potential areas. The physiological quality of hybrid maize seed in Zimbabwe is very high and comparable with European standards.

The objective of the maize breeding programme is to develop varieties which are high yielding, resistant to lodging, pests and diseases, and of appropriate height and season length. With the intensification of cropping areas, monocropping of maize and lack of crop rotation in the communal areas, two major problems have emerged: a viral disease, maize streak virus, and a damaging pest, the maize stalk borer. The breeding programme has re-oriented its efforts toward combating these problems.

The maize varieties marketed by Savanna Seed are *PNR473, PSR6549* and *PNR6557* for white grain and *PNR482* and *PNR6514* for yellow grain. Savanna Seed claims to have a comparative advantage over the Seed Co-op in terms of the best short-season drought resistant hybrid maize variety, the top-cross hybrid *PNR473*.[1] Whether this claim is correct and *PNR473* is competitive with *R201* in the marginal areas is subject to strong and conflicting views. The commercial farmers union has published some inconclusive data comparing the varieties (Table 29). The ART farm has followed up

[1]A modified, single-cross hybrid is a cross between a single-cross hybrid and one of its composite parent lines (also called a modified single-cross hybrid, AxB=AB, ABxB=ABB). Because of the back cross with a composite, the *PNR473* is more unstable than a three-way hybrid and has greater genetic variance.

Table 29. *Comparison between competing maize varieties in Zimbabwe*

Seed Co-op	Variety	50% silk	Days to mature	Tons/ha
1. White	R 200	65	137	0–4
	R 201	65	140	2–7
	R 215	67	142	2–7
	ZS 107	70	153	4–9
	ZS 225	65	135	5–9
	SR 52	73	158	7–12
	ZS 233	73	161	7–12
2. Yellow	ZS 202	66	143	2–6
	ZS 206	70	156	4–12
Savanna Seed	**Variety**	**50% silk**	**Days to mature**	**Tons/ha**
1. White	PNR 473	60	135	0–7
	PNR 6540	65	140	3–8
	PNR 6557	70	150	5–9
2. Yellow	PNR 481	65	150	4–10
	PNR 6541	70	150	6–9

Source: Friis-Hansen 1990.

on this comparison, but the results are not yet available. It does appear, however, that Savanna Seed varieties have a role to play—especially *PNR473*—for communal farmers in the marginal areas.

Commercial maize production took place within the large-scale commercial sector which purchased 95% of the total sale of hybrid seed during the 1960s. Within 10 years of its release, two-thirds of the commercial farm area was cultivated with *SR52*. The sale of hybrid seeds to peasants was insignificant until 1969, when the market share consumed by this sector jumped to 10%.[1]

Zimbabwe has over time developed a number of hybrid maize varieties suited for a wide range of agro-ecological zones. The first single hybrid maize variety *SR52* was released in 1960. It is a long season (157 days to maturity) single hybrid suited for NR II and is today primarily grown by large-scale commercial farmers.

The two most used varieties, *R201* and *R215*, are short-season (138 and 135 days respectfully). These varieties (together with their predecessor *R200*) were released in the mid-1970s to enable large-scale commercial farmers situated in marginal areas to diversify production. *R201* and *R215* are examples of successful transfer of technology, as they are well suited for growing conditions in communal areas; in 1989, they accounted for 46% and 39% respectively of total hybrid maize seed sales from Seed Co-op.

It is remarkable that no replacement has been developed for *R201*, released 17 years ago. A new three-way hybrid, short-season variety, *SC501*, was released be Seed Co-op in 1989, intended to replace *R215*.

[1]Personal communication with M. Caufield, 1988, maize plant breeder at the Seed Co-op.

The share of seed bought by communal and small-scale commercial farmers has gone up since independence from 60% to 90% of total sales. The market share of small packs has remained stable at around one-third of total sales, suggesting that packing seeds in small packs is useful for reaching the poorest small farmers.

The vast majority of communal farmers buy hybrid seed annually and more than 90% of the maize planted is hybrid seed. Seed sales have approximately been at their present level since the early 1980s and the market for hybrid maize seed is saturated and at a level close to the potential demand (Friis-Hansen 1992).

These hybrids are less susceptible to poor pollination at flowering under drought stress, because of improved ability to synchronize silk emergence with long pollen shed period. They are therefore better adapted to the harsh conditions in some parts of the communal areas, and are recommended for use in medium to low yielding areas.[1] Marketing improvements, both in terms of seed supply and grain marketing facilities, have also increased the use of hybrid maize seed in the communal areas. The introduction of small plastic bags containing 1, 2, 5 and 10 kg of hybrid seeds have enabled small farmers to buy hybrid seed; today, they comprise more than half of seed sales.

Since independence, maize cultivation has expanded rapidly in the semi-dry communal areas of Zimbabwe and replaced sorghum as the most preferred food. A similar change in choice of crop has taken place since the mid-1970s in the semi-arid areas of Zambia, Malawi, Mozambique, Tanzania, Swaziland and to a lesser extent Botswana (where sorghum is still the predominant food crop).

In Mangwende communal area (NR II) the adoption rate of hybrid maize was 35% in 1974, 70% in 1980 and 90% in 1982. In contrast, Chibi communal area (NR IV) is cited as having adopted hybrid seed 100% already in 1970.

> In Chibi, farmers particularly noted the fact that unfertilized hybrids provided higher yields than the old, open-pollinated varieties, even in years of poor rainfall. Once tried, hybrid seed was consistently employed. (Rohrback 1988:203)

The more rapid adoption of short-season hybrid maize in the dry parts of the communal areas is more likely to reflect the absence of short-season improved and indigenous varieties of open-pollinated maize. The open-pollinated landraces of maize cultivated by communal farmers before the introduction of three-way hybrids are likely to be influenced by the earlier open-pollinated releases from DR&SS in the 1950s and 1960s, which were all medium to late maturing.

Not all maize planted today is hybrid seed. Local composite maize varieties do exist and are maintained through farmers' mass selection, but they are cultivated on a very small scale only. These so-called local varieties

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[1]Personal communication with Enos Shumba, Head of Agronomy Institute, DR&SS, 1988.

derive primarily from earlier releases by DR&SS. In addition, farmers do not always buy sufficient hybrid seed, and they may add retained second generation hybrid seed to their bought seed. This is typically done for maize cultivated in gardens near the house, but can also be the case for some of the fields. The potential yield of the F2 generation is reduced by 61% in the case of *R201* (Ashworth 1990).

One exceptional feature of Zimbabwean seed industry is the deliberate ban on the sale of open-pollinated maize. Open-pollinated maize varieties have been discouraged since 1960 and no breeding effort has gone into developing high yielding composites.

Directly to forbid composite maize seed sales is a very authoritarian approach, as it is not unlikely that an improved composite maize would be the best choice for some poor farmers. First, they could retain seed, saving themselves the trouble of getting hold of seed every year and allowing timely planting using retained seed, where late access to purchased maize seed in some marginal areas results in late planting. Second, although hybrid maize seed is cheap, the difference in price between hybrid seed and retained seed is between Z$20 and Z$30 for the 25 kg required to plant one hectare. The money saved by using retained seed buys from 100–200 kg maize, depending on the local price. In marginal areas and under low-input conditions, the yield for hybrid maize is lower than one ton/ha. The hybrid thus has to out-yield the retained seed by 10–20 per cent before it becomes economically viable for the farmer to buy hybrid seed annually.

The price sensitivity of hybrid maize seed is low for most communal farmers, as competitive open-pollinated varieties are not available and the opportunity cost of using the F2 generation is very high, as mentioned earlier.

The development of short-season hybrid maize varieties is DR&SS's the biggest success. The usefulness of these varieties for peasants in NR III, IV and V operating under severe resource constraints is questionable. A recent farm management survey by MLARR (1990) recorded an average yield of 1.8 tons/ha in the 1988/89 season. The average maize yield for communal areas located in NR II was more than 3 tons/ha, while the average maize yield for communal areas located in NR III and NR IV were from one to less than one-half ton/ha. The input level for the communal areas varies widely. The MLARR farm management data show that the average cost input in communal areas was Z$83/ha, ranging from an average application of 232 kg/ha of ammonium nitrate and 268 kg/ha of 'component D' in the best communal areas to practically no other seasonal input than hybrid seed in low rainfall areas.

> Farmers are not willing to risk expenditure of fertilizers in a very uncertain climate. This unfortunately means that they will inevitably produce a very small yield even in a year when climatic circumstances are relatively favourable. (MLARR 1991:ix)

This cycle of low input, poor yields and very poor returns per hour of family labour from production of maize in NR IV and V gives rise to a reappraisal of whether the focus of the maize breeding programme is appropriate.

Oil seed—an untapped potential

This section reviews plant breeding for the three major food legumes: groundnut, soyabean and cowpea. Food legume seed is an untapped potential. Well-adapted improved varieties and technologies to improve yields exist, but have not been applied in the communal areas.

Groundnut—absence of short-season improved seed

A survey of the production of groundnut in the communal areas (Shumba 1983) found that the major constraints were low profitability, high labour needs, lack of high quality seed, shortage of money to purchase inputs and greater importance attached to other crops. The planting practices which cause low yields include late planting, low plant population (less than a quarter of the optimal), low soil fertility and widespread incidence of rosette and cereospora disease (Hardy 1984).

The majority of communal farmers use retained seed only. The most usual variety used is *Natal Common*, an out-dated, open-pollinated variety originally released by DR&SS in the early 1960s and retained since then by communal farmers. *Natal Common* has short season maturity (110–130 days) and is well suited to low rainfall and sandy soils. Seed Services Unit conducted a major cleaning exercise and re-released it in 1986, however, seed is not multiplied and distributed to communal farmers at present, as there is no differentiation in the producer price. Growing short-season varieties suitable for small farmers is less profitable for seed growers than producing long-season varieties which are used only by large-scale commercial farmers.

Valencia R2 is another common retained variety in the communal areas. It was released by DR&SS in the 1970s and has short season maturity (100–110 days). Like *Natal Common*, it is no longer available from the seed industry. *Valencia R2* has red skinned kernels.

The most common non-retained groundnut seed in the communal areas is named *Spanish* and purchased from GMB. *Spanish* is not strictly speaking a variety but the common name of the type of groundnut used by communal farmers. The *Spanish* seed sold by GMB is not improved seed but a mixture of all groundnut bought from the communal areas, that is cleaned, processed and resold to the same farming sector.

Plover, a short season maturity (110–130 days) replacement for *Natal Common* was released in 1982 by DR&SS. It has higher yield potential than *Natal Common* and is less prone to leaf spot. Also, it has better quality kernels. However, *Plover* has never been multiplied and distributed to communal farmers.

Retained seed is generally tolerant to insect attack, although problems with pests (web blot, leaf spot and rosette) occur in some seasons. No pesticides or sprayers are available or used.

The local varieties of groundnut are medium-season maturity and have to be planted early to achieve a reasonable yield. If the farmers plant late because of labour or draught-power bottlenecks, groundnut production becomes a high risk venture because of mid-season dry spells. DR&SS trials have shown that planting two weeks after the first rains can reduce the yield by 150–200%. The incremental yield obtained from using improved seed with timely weeding and with two weeks delay in weeding is 84% and 55%, respectively. In addition, harvesting takes place in February/March which is during the peak labour period, but delaying harvesting because of this may cause rot.

Mineral fertilizer is not usually applied to groundnut, nor is it required to obtain reasonable yields. Groundnut are frequently cultivated in rotation with maize. The seed rate is commonly not more than 50 kg seed/ha, half the rate recommended by DR&SS and Agritex.

Groundnut have a remarkable ability to adapt to all types of soil, but a pH level of between 5.0 and 5.5 is required. The pH level of many soils in the communal areas (depleted) and Agritex recommends application of 200–400 kg of gypsum/ha at early flowering. Due to transport constraints, lime is not available in the communal areas and very few communal farmers apply gypsum. Low soil pH leads to calcium deficiency and results in development of pods without kernels, known as 'pops'.

While the availability of seed of the long season groundnut varieties demanded by the large-scale commercial farmers presents no problems, the availability of good quality, short season groundnut seed has been a serious problem for the past decade. Various schemes for groundnut seed multiplication and distribution have been tried with little success (Friis-Hansen 1992).

From the discussions above, one could conclude that short season, improved varieties and technologies have been developed at DR&SS which could go a long way in solving the production constraints in the communal areas. Problems of late planting could partly be solved by using short season varieties such as plover. Low plant density is partly a result of the unavailability of improved seeds, partly an effect of the low soil fertility, which could be alleviated without use of mineral fertilizers if *rhizobium inoculum* were made available and applied when sowing groundnut seed. DR&SS found that inoculation of groundnut with *rhisobium inoculum* significantly increased both grain and stover yields. The problem with groundnut diseases could be alleviated without use of fungicides by the use of improved varieties and wide crop rotation (once every four years).

Soyabean—potential for expansion

99% of soyabean production has taken place in the large-scale commercial sector (AMA 1990). The crop is believed to have considerable potential in the communal areas located in NR II and III for peasants with better than average management resources (Shumba 1983). Soyabean is in fact more drought tolerant than maize during all stages of growth (Tattersfield 1987). It will produce a satisfactory yield of up to 3 tons/ha on light textured soils with a total seasonal rainfall of over 600 mm.

The soyabean breeding programme started as early as 1963. The objectives of the programme were to breed for:[1]

- resistance to lodging
- higher and stable yields
- suitable to local day lengths and temperatures
- maturity in 130–136 days
- resistance to pod shattering for at least 3 weeks after maturity
- good pod clearance height over soil level of the lowest pod
- resistance to diseases, mainly red leaf blight

Soyabeans were never indigenous in Zimbabwe. The crop was introduced in 1916 and some years later the first local variety was released, but it was mainly for fodder. In order to improve the local varieties, a collection programme was initiated which collected exotic material from Europe; however, the varieties were too short season for the sub-tropical climate. Material was also imported from countries like South Africa, Brazil, Taiwan and Nigeria (IITA). Usually, tropical lines grow more pods than temperate ones.

The soyabean breeding programme has developed a number of varieties, namely Duiker, Roan, Sable, Gazele and Buffalo. The first four varieties are grown for grain, since they have satisfactory oil levels and protein content, while Buffalo is a good fodder variety. A significant part of the breeding work is carried out by Seed Co-op at the Rattray Arnold Research Station and is coordinated and complementary to the work done at DR&SS.

Soyabean seed can easily be retained for subsequent croppings without any significant change in yield, thus lowering production costs. Most seed is sold to commercial farmers and the level of seed sales is directly dependent on the price differential between maize and soyabeans. Approximately half of the area planted by commercial farmers is retained seed; seed is purchased for the other half.

In 1986, a major effort was made by DR&S, in cooperation with the Seed Co-op, to promote cultivation of soyabeans in the communal areas. The area chosen was Hurungwe communal area, and the campaign was relatively successful in encouraging soyabean cultivation among small farmers; however, the then head of the DR&SS Agronomy Institute was the driving force behind the campaign and since his departure from the DR&SS, the

[1]Interview with DR&SS soyabean breeder, Mr. Tichagwa.

Table 30. *Soyabean responses to liming and seed inoculation*

Inoculation status	Seed yield g/plant	
	Lime 0	Lime 1,130 kg/ha
No inoculation	2.9	24.29
With inoculation	8.8	39.86

Source: Metelerkamp 1987 (from Corby 1959).

campaign has come to an end. Nonetheless, the Hurungwe experience showed that it is possible to grow soyabeans in the communal areas, but it requires serious support and extension advice to expand the cultivation of soyabeans to small farmers. Soyabeans are not an easy crop to grow and they are more suited to large-scale production, which can be combine harvested, because the harvesting period is very limited. In addition, a lot of the communal area soils are unsuitable because they are too sandy.

A precondition for achieving full potential of soyabeans is to apply *rhizobium*.[1] *Rhizobium* inoculant exists in farmers' co-op sales outlets and is produced in sufficient quantities at Marondera research station, but at present it is seldom used in the communal areas. *Rhizobium* can be applied to the soyabean seed by mixing bottle of the bacteria and adding sugar to the liquid to make it stick to the seed. The seed then has to stay in the shade and needs to be planted the same day. Little research has been done on the use of *rhizobium* in communal areas and it is questionable whether the *rhizobium* bacteria can work in communal area soils, which are predominantly sandy and at times very hot. Preliminary results from DR&SS indicate that it might be possible if simple precautions are taken, for example application while the weather is overcast. The principle reasons why *rhizobium* inoculant is not used in the communal areas is the absence of distributors and lack of knowledge about it in these areas, as there is little extension advice available about it.

The inoculation of seed with suitable strains of *Rhizobium aponicum* has been shown to increase yields markedly. Corby (1959) reported the results with liming and inoculation as shown in table 30.

Sunflower—neglected marketing

Sunflower can adapt to a wide range of soils and climatic conditions as it is insensitive to variations in day length. Sunflower is drought tolerant, but yields are significantly reduced if there is moisture stress immediately before or during flowering. As it is resistant to the parasitic witch weed, it is a good crop to rotate with maize.

Two local varieties are dominant in the communal areas. The most common variety used is an open-pollinated black landrace, originating from the improved variety *Peridovic* which was first introduced in the communal

[1]Rhizobium bacteria act as an inoculant in the soil and significantly increase the fixation of nitrogen by the crop.

area in the early 1960s. It is a medium maturity variety (85–105 days to maturity). The *Peridovic* variety originally had 40% oil content which, in the present day landrace, has been reduced to below 20%. The second popular variety is a white striped landrace, of the type used as bird feed in Europe and North America. Its volume yields are higher, but its density is lower and the oil content below 10%.

Most farmers retain seed from previous harvests through mass selection. However, farmers have no way of isolating the crop to ensure the purity of the seed, as pollination can occur over distances of up to two kilometres. Selection of seed takes place after harvest but before threshing. Selection criteria are: the heaviest seeds with large shells chosen from mature plants.

The breeding programme started in 1975 and experienced considerable disturbances. Not less than 6 different breeders have been in charge of the programme since independence. The entire focus of the programme has been developing hybrid varieties. Hybridization of sunflower is a process of some 10 years, from the inbreeding stage to the release of new hybrid varieties. At present, varieties exist at all stages.

DR&SS have released two improved hybrid sunflower varieties since independence, *Msasa* in 1986 and *Mupane* in 1990. Increased oil content has been a major objective behind the development of hybrid sunflower varieties and these new varieties yield 45% and 44% oil.

Hybrid varieties are easier to handle for the farmers than the locally retained seed which is most commonly used. The hybrids mature at the same time, are uniform in height and have a single large flower. The locally retained, open-pollinated varieties are of mixed origin and therefore can vary in maturity by up to several weeks. In addition, they have two or more smaller flowers at different locations on the stem and they differ in height. This makes harvesting more laborious.

Msasa is demanding in terms of water and management inputs if high yields are to be achieved. Under the prevailing conditions of cultivation in the communal areas, viz. low spacing and no fertilizer application, communal farmers interviewed in Silobela and Chiduku in 1990 unanimously claimed that no significant yield improvements are achieved from using the hybrid sunflower. No scientific proof for this exists, as no evaluation trials have ever been carried out under realistic small farming conditions.

Since the present sunflower breeder took over the programme in 1988, the emphasis has been changed to include the development of high yielding open-pollinated varieties. At present, only exotic open-pollinated varieties have been released as standard seed: *Peridovik* (USSR), *Modern* (Canada). The changes in the breeding programme were necessitated by the fact that the former breeding objectives were for uniformity in maturity, which is primarily an advantage for large-scale commercial farmers who practice mechanized harvesting, whereas the communal farmers can utilize the broader gene frequency of open-pollinated varieties. No problems have been noted for open-pollinated varieties; therefore, hybridization should not be a priority.

For good reason, little effort has been made to collect local germplasm in Zimbabwe, and only some 40 local samples are present at DR&SS. These have been characterized as low yielding, poor in oil content and susceptible to leaf spot. The open-pollinated programme is based on back crossing of the collected lines with exotic material. As no international germplasm bank exists for sunflower, DR&SS has not been able to access all the exotic material it would have liked to. The objectives of the open-pollinated programme are:

- to increase seed yields
- to increase oil content
- to develop leaf spot resistance
- to develop high yield, open-pollinated varieties
- to reduce plant height

Developing new open-pollinated varieties will take at least another three years. The lines are crossed and 'selfed' during the winter season (irrigation) and evaluated during the summer season. Preliminary trials were carried out during the 1989/90 season. Intermediate trials were to take place during the 1990/91/92 seasons, and the final trials to be carried out during the 1992/93 season.

It is very positive that DR&SS in 1988 initiated an open-pollinated plant breeding programme for sunflower. The uniformity of hybrid sunflower varieties has been of little relevance for communal farmers. The popularity of *Msasa* can be attributed to its high yielding ability and drought tolerance. There is a clear need for a replacement for the old Russian open-pollinated variety, *Peridovik*, which is prone to leaf diseases and may lodge.

Using a planting rate of 7 kg/ha, the potential demand for sunflower seed for the communal areas is about 620 tons, using 1988 crop data; current sales of 125 tons therefore account for only about 20% of this.

The marketing of sunflower seed is unsatisfactory to the extent that sunflower seed sales to the communal areas are more or less neglected by wholesalers and retailers. Improved sunflower seed is seldom found in rural retail shops, and communal farmers who want to buy it have to go to town to get it. The Seed Co-op distributors do not take sunflower seed seriously and advertising and marketing activity is limited. Wholesalers and retailers claim that demand is low and it is therefore not worth their effort to sell sunflower seed.

Hybrid sunflower seed is more than four times more expensive than retained seed (valued at the producer price). In 1989, the retail price for *Msasa* seed was Z$95/50 kg, while 50 kg local seed cost Z$22.50 or Z$450/ton. The reason behind the high seed cost is the expense of producing the male sterile inbreed lines needed for the hybrid.

There is no grading of sunflower for oil content at GMB depots, so communal farmers have no incentive to adopt the improved varieties to benefit from their higher oil content. Communal farmers harvest sunflower when it has the highest moisture content. It is stored on the husk and threshed when dry in order to keep the moisture content as high as possible when it is sold.

Small grains—neglected food security crops

Sorghum—a crop on the wane

Despite the fact that sorghum has a shorter growing season than maize, better tolerance to heat and drought during the season (House 1987), its cultivation has been waning during the past 40 years. One reason for this is that maize often yields better than sorghum and millet, even in drought years (Rohrback 1990). When the season is favourable, maize yields substantially better than sorghum and millet. Tattersfield (1982) found that the comparatively low yield level of sorghum was the result of low research efforts in the past. A contributing factor to the decline in cultivated area of sorghum is the high labour requirement for bird guiding and dehulling when compared to maize.

The sorghum breeding programme was started in 1969. The high yielding varieties developed and released before independence were entirely focused on the needs of large-scale commercial farms and on the needs of the opaque beer industry. These varieties were consequently badly suited as staple food for peasant families in the communal areas.

The programme bred for high, stable yields, with maturity ranging from 100–130 days, and adaptability to different natural regions. Short-statured types were selected for combined harvesting in the large-scale commercial areas, and taller ones for the communal areas where the stalks are used for building (Danagro 1988).

The objectives of the present breeding programme are: [1]

- reduce plant height, thus reducing the overall management demands of the crop (making it easier to scare birds because they can be seen) and making the plants more resistant to lodging and better suited for combine harvesting practised by commercial farmers
- reduce the period of maturity to 15–20 days and thus increase the drought tolerance of the plants
- maintain palatability of crop in order to satisfy the demand of rural consumers for porridge
- transfer the high grain quality of some indigenous landraces to high yielding cultivars

[1]Interview with Mr. J.N. Mushonga, DR&SS sorghum breeder, December 1989.

- select for leaf blight, leaf spots and ergot and screen material for stem-borer resistance

The following cultivars have been released by DR&SS and are in principle available from Seed Co-op:

Red sorghum	Red Swazi A	bred in Zimbabwe
	DC75 (hybrid)	from South Africa
White sorghum	Serena	from Botswana
	Segaolane	from Botswana
	SV1	from ICRISAT
	SV2	from ICRISAT

Among these improved sorghum varieties, *SV2* is the most relevant for communal farmers. The most important advantage of *SV2* compared with landraces is its earlier maturity. The *SV2* takes an average of 70 days to 50% flowering, compared with an average of 90 days for landrace varieties. This shorter time to maturity may be crucial for food security in natural regions 4 and 5.

A cross-country communal area household survey of the 1992/93 cropping season showed that *SV2* offered an average 50% yield gain compared with seed of landrace varieties (Friis-Hansen and Rohrback 1993). *SV2* has been released by DR&SS based on germplasm originating from West Africa and enhanced by ICRISAT headquarters in India.

Birds, especially Quela, are still a major unsolved problem. Plant breeders have sought to solve it genetically by investigating the few indigenous white-grained varieties collected where no bird damage was found, but with poor results. The brown-red types of sorghum are resistant to birds, because of the presence of tannin in the sub-coat. For this reason, these varieties are also too bitter for human consumption and are used for opaque beer brewing.

An agronomic solution to the problem of post-harvest losses is for the farmers to process all their grain immediately after harvest. There is also considerable scope for improving the pest protection of traditional storage, which is very deficient at present.

Sorghum plant breeding at R&SS and Seed Co-op has successfully re-oriented its objectives to serve the needs of communal farmers. Plant breeding of sorghum during the pre-independence era aimed at the needs of the large-scale commercial sector only, as a fodder crop and raw material for the opaque beer brewing industry. Two white sorghum varieties now exist, one of which was developed in Zimbabwe and is adapted to marginal rainfall areas and suitable for human consumption. The present breeding objectives of drought tolerance, palatability and bird resistance are all highly relevant for communal farmers.

The improved white sorghum varieties *SV1* and *SV2* were released by the breeder at DR&SS in 1985. Due to production problems, *SV2* was not available in any substantial quantities before the 1989 season, and *SV1* is still not commercially available (Friis-Hansen 1992). SV2 was for the first time made widely available in Zimbabwe as part of the 1992 emergency drought relief following the devastating 1991/92 drought.

Savanna Seed has marketed three South African bred sorghum varieties in Zimbabwe after only a short period of screening trials. No independent data exist on their performance:

White sorghum	PNR8544	only white hybrid sorghum in Zimbabwe and highly drought tolerant
Red sorghum	PNR8369	open-pollinated with good malting qualities
Forage sorghum	PNR841	only forage sorghum available in Zimbabwe

Potential demand for small grain seed is considerable higher than the present seed sales to the communal areas. Using 1988 data for cultivated area in the communal areas and a planting rate of 12 kg/ha, the potential demand for improved sorghum seed is 2,550 tons compared with Seed Co-op sales of 200 tons.

Pearl millet (mhunga)—unavailability of improved seeds

A breeding program for pearl millet has been carried out since 1977. In 1982, an estimated 120,000 ha were cultivated by communal farmers. Pearl millet plays a crucial role during droughts because of its ability to produce some grain even under very dry conditions. Despite its importance in the communal areas, very little breeding effort has taken place until recently. The first improved pearl millet variety in Zimbabwe was released in 1987 (Mentelerkamp 1987).

Only two varieties have been released, *PMV1* and a 'local land variety'. *PMV1* is short (1.5 meter) and early maturing compared with the local landraces cultivated by communal farmers. If planted by mid-December, *PMV1* will mature by the end of March. *PMV1* is also resistant to ergot and rust.

Communal farmers can improve their productivity by 25% by adopting *PMV1* instead of their local composite variety.[1] The pearl millet variety *PMV2* gave a 30% yield loss compared to landrace varieties during the 1992/1993 season. This can largely be explained by late delivery of seed from the emergency drought relief and subsequent late planting by the farmers. Many farmers in the survey indicated that the *PMV2* harvest contributed a significant net addition to their household food supplies despite the late planting, because of its shorter time to maturity compared with landrace varieties.

ICRISAT is responsible for supporting the development of national breeding programmes for pearl millet in Southern Africa and is engaged in breeding for early (80–100 days), medium (110–130 days) and late (over 130 days) maturing varieties. Grain quality must meet the demands for palatability, and pearly grey to white grains are selected and purple gloomed

[1]Estimate by Dr. Obliana, ICRISAT sorghum breeder.

types are avoided. Breeding for resistance to ergot, the most common disease, is practised.

The potential yield of improved pearl millet varieties is significant higher than the yields currently obtained in the communal areas, which are in the range of 400 kg/ha. The improved open-pollinated pearl millet variety, *PMV1*, was released by DR&SS in 1987, with a yield potential of 2–3 tons/ha in dry years. The *PMV1* variety is earlier maturing and more drought tolerant than traditional varieties, and it is shorter in height as well as having a higher potential yield.

Potential demand for pearl millet seed is 2,800 tons and for finger millet 1,430 tons. But in the case of both types of millet, no organized seed production has taken place so far.

Finger millet (rapoko)—a new plant breeding programme

Breeding of finger millet was initiated in 1988, but no varieties have yet been released. The goal is to produce a range of different period maturing varieties which are palatable and high yielding. Resistance to blast-and-kill leaves is also an objective. The finger millet plant is compact and has no bird problem, but its production is labour intensive. DR&SS has taken a long time to initiate a plant breeding programme for finger millet, and there will not be any release of improved varieties for several years. The breeding objectives of blast-and-kill leaf resistance for short, medium and long maturing varieties, are very relevant for communal farmers. ICRISAT supports development of the Zimbabwean finger millet programme.

Finger millet is grown for brewing beer and in the form of beer an important source of income for poor households (Rohrbach 1990). It is also a standby food crop which can be stored for a number of years without weevil attack (World Bank 1991).

Food legumes—undeveloped potential

Field beans

Bean production in Zimbabwe is mostly concentrated in the small-scale farmer sector. Before independence, there was no breeding programme for beans, but soon thereafter it was realized that agricultural research should address some of the constraints faced by small-scale farmers. One of the identified constraints was the lack of a bean improvement programme, since beans are a major household food staple in the majority of the communal areas.

The bean breeding programme commenced in 1984. Most of the indigenous seeds were judged to be susceptible to weevil, disease, and post-harvest loss due to poor shattering. Introductions of exotic germplasm were made, mainly from Central International de Agricura Tropical (CIAT). The introduced materials were tested over three seasons and were found to be adaptive to the Zimbabwean environment.

The objectives of the Bean Breeding Programme are to breed:[1]

- high yielding varieties
- disease resistance
- resistance to shattering
- resistance to lodging
- resistance to weevil attack

In addition to breeding for these characteristics, farmers preferences were also taken into account as beans play a major role as a household food crop. Most farmers prefer the red brown, kidney shaped sugar bean type. Bean intercropping is prevalent in the communal areas, so farmers prefer a bean type with growth habits suited to intercropping. The exotic types have different growth habits than the indigenous bean varieties, being more erect and less bushy and thus appropriate for intercropping.

Another objective of the breeding programme is to breed for drought and heat stress tolerance. Germplasm was collected from Ethiopia and CIAT's East Africa Division and tested at Makoholi Research Station without irrigation. Unfortunately, the material died due to drought, and the programme has thus not yet been successful in identifying drought and heat stress tolerant material suited for the Zimbabwean environment.

Breeding for resistance to weevil attack is done by increasing the acce lyine content. CIAT runs a trial programme correlating high accelyine content with nutrition. If promising lines with a negative correlation can be identified, they will be released to the national breeding programmes. Such material can go a long way toward solving the weevil problem.

The bean breeding programme is close to release of a variety which is adapted to the Zimbabwean environment and has good resistance to most damaging pests. Seed born diseases are still a major problem for seed multiplication.

Cowpea

The cowpea breeding programme was started by the DR&SS bean breeders in 1986. Germplasm was acquired from IITA and tested for characterization on-station. By 1989, a total of 120 varieties from IITA has been evaluated at DR&SS in Harare, Matopos, Makoholi and Gwiri for adaptation to the Zimbabwe environment.

The evaluation has shown that the exotic material is susceptible to fungus and virus diseases, e.g. ascochyta, scrab and septoria were common in the trials. The Gwiri trials also showed post-harvest losses of more than 50%, e.g. from aphids and bruchids. Most of the IITA material described as early maturing, tended toward medium maturity at trials in Harare. In

[1]Interview with DR&SS bean breeder, Mrs. Mkoko.

Zimbabwe, the following maturity periods apply: early maturity: 50–60 days; medium maturity: 60–90 days.

The indigenous varieties are mostly the runner type and late maturing. The leaves can thus be harvested gradually over a long period, as needed for household consumption. The result of the questionnaire survey among the Agritex workers indicates that the indigenous varieties are low to medium yielding in terms of seed.[1] One exception is *Vita 4*, collected by DR&SS many years ago and later purified, which gave yields up to 1.3 tons/ha in on-station trials.

Two different sub-programmes for development of open-pollinated varieties are undertaken, back-crossing local material with exotic varieties: the first is for pure-stand cultivation for the seed export market; the second is for intercropping for communal areas in Zimbabwe.

The objectives for breeding cowpea for use in intercropping with other crops are:

- shorten the maturity period
- develop high yielding bush types suitable for intercropping
- develop resistance to diseases and pests
- in the long term, increase the N-fixation capacity

The Marandera Research Station produces *rhizobium* bacteria for soyabean, but has not yet produced any for cowpea. The programme aims to produce stable geno-types with high yields across the country and does not attempt to develop area-specific types. Heat stress in not a problem for cowpea.

In terms of seed retention, cowpea belongs to the same group as soyabean, groundnut and wheat. Under good management, the farmer buys new seed every fourth year or less. Under bad management, with for example seed mixing, new seed has to be purchased every second year. Seed mixing is commonly practised in the communal areas to guard against risks. Cowpea stems and leaves have a high nitrogen and protein content and are suitable as forage and green manure.

The plant breeding programme has only been fully in effect for cowpea for one year but has already taken shape. It must be appreciated that an intercropping sub-programme has been established which is tailored to meet the conditions of land pressure in the communal areas. A shorter period to maturity and resistance to pests and diseases seem reasonable breeding objectives. By emphasizing development of bush types of cowpea, the period during which farmers will be able to harvest leaves will be shortened considerably. This may become a serious constraint for its diffusion. The plant breeding programme should seriously reconsider including a runner type in the cowpea programme.

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[1] Interview with Mr. Nyoka, DR&SS cowpea breeder, November 1989.

Bambaranut

Bambaranuts are commonly cultivated in most communal areas of Zimbabwe. They are boiled green and unshelled soon after maturity (nyimo) or boiled dry together with maize (matakura). Bambaranut releases gasses in the stomach which can cause pain. Since people in the communal areas are used to eating bambaranuts, this is not regarded as a problem. Only local varieties are used today.

Objectives of the programme have not been established and the programme is still in the planing stage. Some work has been done to collect indigenous germplasm from bambaranuts at Gwebi College of Agriculture and IPGRI prior to the establishment of a formal breeding programme. Only 10 samples of bambaranut were available to the DR&SS breeder in May 1990, and these are now being evaluated and characterized. One characteristic that gives bambaranut a potential is that weevil attack is less of a problem than for cowpea.

Tubers

Irish potato

Irish potatoes are grown by large-scale commercial farmers and sold primarily as a vegetable, though there is a limited market in the food processing industry. To secure a continuous supply, Irish potatoes are grown three seasons per year under full or supplementary irrigation. Times of planting are November, March and July.

Maintenance of a collection of virus-free Irish potatoes is essential for breeding work and for the capacity to release virus-free material into the seed multiplication system. Since 1964, such work has been successfully undertaken at the Nyanga Experimental Station, where cool, high altitude conditions are not conducive to spread of virus.

Four varieties have been released:

Mountclare	bred in Zimbabwe
Amethyst	bred in Zimbabwe
BPI	from South Africa
Pimpernel	from Holland

The first three varieties are for household consumption; they are bred for attractive appearance with white skin and flesh, no internal defects and good cooking quality. The *Pimpernel* variety is bred specifically for chips manufacture and has a high dry matter content.

Sweet potato and cassava

Sweet potato and cassava are grown by communal farmers as subsistence crops. They have until now been neglected by DR&SS, but some breeding work has recently been done by Department of Crop Science, University of Zimbabwe.

Sweet potatoes are widely used by communal farmers. The crop plays an important role for household food security and as a staple. At least four local retained varieties are used by communal farmers. Yields are seldom above 10 tons/ha. Imported exotic material has been screened and high yielding varieties selected by the Department of Crop Science. Yields of 40 tons/ha have been achieved at the university trials.

Cassava is not widely cultivated in Zimbabwe; its use is limited to the eastern parts of the country. Cassava has a high potential in Zimbabwe as both a food and fodder crop. High yielding varieties have been developed at the Department of Crop Science which have yielded more than 40 tons/ha.

Chapter 11
Post-independence Re-orientation of Plant Breeding

Government of Zimbabwe agricultural research policy

The pre-independence objectives of national agricultural research were closely linked with the requirements and problems of the commercial farmers. Crop research concentrated its efforts in NR I and II, where most of the arable large-scale commercial farms were situated. Agricultural research conducted in the low potential NR III, IV and V, where most communal areas are located, was oriented towards extensive cattle ranging or irrigation.

In line with its general agricultural policy, the government adapted a very cautious approach to changing the focus of agricultural research from large-scale commercial farming to small-scale communal farming. It has been of prime concern that these policy changes should not disturb or lower the standards of the existing research and thus affect the productivity of the large-scale commercial sector. The re-orientation of agricultural research was, during the first decade of independence, by no means radical. It was aimed at extending the focus to all farming sectors while maintaining and consolidating the high research standards inherited from the pre-independence era. This approach has been received positively by the international agricultural research systems (CGIAR).

> The most important change in the post-independence period for the research organization has been the re-orientation towards the peasant sector. This re-direction exercise has been careful throughout and there has been no sudden discontinuance of research programmes that could be considered to be only suitable for the commercial sector. (Billing 1985:47)

The adoption of these technologies by peasants in the communal areas is based on the principle of transfer of technology. The communal farmers have benefitted from the agricultural research programmes to the extent that the results have been appropriate for them. As the objectives of all the agricultural research programmes before independence meant improvements for the large-scale commercial farmers, far from all the experiences have been applicable for resource-poor peasants.

The development of short-season hybrid maize varieties *R200* and *R201* is an example of a relatively successful transfer of technology. These varieties were developed for the large-scale tobacco farmers who in the early

1970s diversified their production from tobacco to maize. Many of these large-scale farms were situated in NR III with sandy soil and limited rainfall, conditions similar to those of large parts of the communal areas. As shown elsewhere, these short-season varieties are still the dominant maize varieties grown in the communal areas.

Agricultural research has since independence undergone a significant re-orientation toward the small farm sector. The spirit of reconciliation has helped the government to maintain and consolidate the high research standard inherited from the colonial era. The re-orientation has resulted in the initiation of a number of new research programmes and the establishment of a farming systems research unit.

No documents or other written material exist, to my knowledge, which discuss or reflect the discussions within DR&SS concerning how the changed focus of research should affect the content of the research programmes and the specific plant breeding programmes. Decisions to start a plant breeding programme for a new crop, or to choose a hybrid or open-pollinated variety as objective, are in principle made by the director and management of DR&SS. The actual content of each specific plant breeding programme is in practice decided in an on-going dialogue between the plant breeder conducting the programme, DR&SS management and interest groups. This dialogue is far from always formalized, but nevertheless of great importance for the choice of method and breeding objectives of the individual plant breeding programme.

The strong influence of the seed industry on the focus of the research at DR&SS has continued to exist and may in fact have grown stronger since independence. As defined in the tripartite and bipartite agreements, Seed Co-op is a direct and close partner to DR&SS in regard to agricultural research. According to these agreements, Seed Co-op has exclusive rights to use the research results of DR&SS (i.e. multiplication of the released varieties). In fact, more than half of the DR&SS trials are today conducted at the Seed Co-op owned Rattray Arnold Research Station, due to a real decline in the government research budget. As discussed elsewhere (Friis-Hansen 1992), Seed Co-op contributes greatly to maintaining high standards of research at DR&SS. Seed Co-op also participates actively in research for crops of high commercial value such as maize, wheat and soyabean. It is difficult to pinpoint exactly how and where Seed Co-op influences the focus of research at DR&SS, but it is of fundamental interest to Seed Co-op to ensure that the seed varieties developed and released by DR&SS are economically viable to produce. Three DR&SS research policies which are especially important to ensure economic viability of seed production for Seed Co-op are all practised in Zimbabwe at present:

1. Maintenance of monopoly status for use of the varieties released by DR&SS. The advantage for Seed Co-op is obvious in that it makes its products semi-official and secures the support of the extension service (Agritex).

2. Bias towards developing hybrid varieties where possible. Hybrid seeds must be purchased annually and are clearly much more economically viable to produce as seed than open-pollinated varieties, which can be retained by the farmer.
3. Bias towards breeding for cross-country yield stability. This breeding strategy ensures that the market for a single variety is as broad as possible thus enhancing the size of its market.

The Commercial Farmers Union (CFU) is perhaps the strongest interest group in Zimbabwe today. It is a well organized and funded organization which pursues the interests of the large-scale commercial sector quite efficiently. CFU is organized into producer associations for each of the major crops, which closely monitor production development and are thus in a good position to define the research needs of their members and convey them to DR&SS. Since independence as well as before, CFU has been strongly critical towards the research efforts of DR&SS. This criticism has been directed towards the fact that the research at DR&SS is under-funded rather than towards the focus of the research.

National Farmers Association of Zimbabwe (NFAZ) and Zimbabwe National Farmers Union (ZNFU) represent the communal and small-scale commercial farming sector. Compared with CFU, both these interest groups are weak, and neither of them have been able to produce an in-depth analysis of the production conditions of their sector and define the research requirements of their members.

In 1984, the government established, with the assistance of CIMMYT, a farming systems research unit and an on-farm research programme at DR&SS. These initiatives have been the visible result of the re-orientation process. The aim of the farming systems research unit and on-farm research is to generate knowledge about the production conditions and constraints in communal areas, in order to improve the relevance of research and extension recommendations for these farmers.

What has perhaps influenced the focus of agricultural research most of all is the research budget, which increasingly sets the limits for what is possible. While budget for DR&SS has increased in absolute terms, it has gradually declined in real terms. This has seriously limited the activities possible, especially the initiation of new activities which involve frequent visits and transportation to distant communal areas.

Like the rest of the state bureaucracy, the real wages of the professional staff have been eroded by inflation and make it difficult to keep or attract qualified staff. The turnover of professional staff is thus high, and in 1987, 60% of the staff had less than 5 years of working experience.[1]

[1]Personal communication with Dr. Whinwiri, at that time head of Agronomy Institute, DR&SS.

Re-orientation of plant breeding method and objectives at DR&SS

There exists a large bulk of knowledge within the agricultural research institutions in the Southern African region about the "technological requirements to produce sustainable, rather high grain yields of rain-fed cereal crops in semi-arid[1] areas" (Metelerkamp 1987). Still, only few of these technologies have been adopted, or, if so, fully used by the peasants in semi-arid communal areas of Zimbabwe.

Experience from a number of Third World countries has shown in recent years that the conventional breeding approach has a number of shortcomings in adapting improved varieties to small farmers' production conditions. Breeding in Southern Africa has been concentrated on developing material for the wetter, input-intensive, mechanized and high potential areas, and little has been done to breed cereal crops for drier environments (Kunjeku and Waddington 1988). To achieve food security on a national level, a basic rule of national breeding programmes has been to give priority to what pays best in terms of increased marketed production. The majority of plant breeding in the past has therefore been directed towards satisfying the needs of resource-rich farmers in the large-scale commercial sector, in high potential areas. High yield capability has been of prime importance in the breeding programmes (Danagro 1989) and the prevailing idea has been that what is best under optimal conditions is also best under marginal conditions.

Trials at the Crop Breeding Institute are usually conducted under optimal management conditions to achieve potential yields. This entails early planting, adequate plant population, high levels of fertilization etc. The fundamental criteria used for evaluation of varietal performance are:

- crop establishment
- yield level
- stability of yield over space and time.

Trials conducted on-station are designed and replicated to facilitate quantitative statistical analysis. Statistical verification of significantly improved performance of a specific variety demands both a long time and considerable resources.

Since Zimbabwe's independence in 1980 and due to serious periods of drought in 1981–83 and 1986–87, the emphasis for breeding has changed to some degree. It was recognized that large numbers of poor families in the communal areas depend on food produced under rain-fed conditions in the semi-dry areas.

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[1]Semi-arid areas can be defined as areas with less than 700 mm rainfall per annum. In Southern Africa the rainy season is relatively short, 90 to 130 days. Dry spells frequently occur during any part of the growing season. The soils are sand and sandy loams with low retention power, which further increases the vulnerability of crop production due to drought.

Box 22. Breeding methods

The conventional approach to varietal selection in plant breeding can be characterized as follows:

- Large numbers of varieties, both of local land races and from international germplasm banks, are critically evaluated at the research station.
- A few varieties are selected or developed on the basis of agronomic objectives. Grain yield is commonly the most important selection criterion. Other criteria often used are adaptability to a wide range of agro-ecological zones, physiological quality and pest resistance.
- A few varieties are officially released and certified for commercial multiplication and distribution. Certification of a variety can only take place if it performs significantly better under specified conditions than an earlier certified variety.

Stages of a hybrid breeding programme:

Stage 1	Plant crosses of open pollinated varieties to obtain variability
Stage 2	Minimum six generations (three years) of inbreeding for development of pure lines
Stage 3	Combination of pure lines Choice of promising lines
Stage 4	Minimum six generations (three years) of back-crossing to obtain 98% pure male sterile lines and pollen fertility restorable lines
Stage 5	Preliminary, intermediate and final testing trials

The on-farm trial programme was initiated in 1984 by CIMMYT and covers a range of activities of DR&SS, as shown in table 31. In the 1985/86 season, the Crop Breeding Institute had approximately 60 on-farm research trials. 80% of them were located in low-potential areas, NR III, IV and V. The programme thus provided a wide range of agro-ecological conditions for testing germplasm. Varieties and hybrids developed by Crop Breeding Institute, Seed Co-op or external sources have been evaluated by the on-farm trial programme. The evaluations are only based on the testing of yield stability under different agro-ecological conditions. Varieties and hybrids are not evaluated under different farm management conditions, as the trial design and management level does not in principle differ from on-station trials. The optimal package is determined for each site.

Until 1988/89, the programme conducted testing trials in 16 different communal areas located in different agro-ecological zones. The purpose of these trials was to obtain information on adaptability to different detrimental conditions such as susceptibility to different diseases, response to different soils and response to different climates.

The on-farm trials have provided the opportunity to evaluate yield stability of advanced variety trials over a wide range of environmental conditions representative of the communal areas. The on-farm trials have also been used to refine and adjust farm management recommendations. The design of the on-farm trials has been made by the researchers, and farm management practices far beyond those used by the peasants have been applied.

Table 31. *Key features of on-farm research programmes, 1987*

Description	Crop breeding institute	Agro-nomy institute	Cotton research institute	Lowveld research institute	FSRU[a]
On-farm research in communal areas started in:	1982	1980	1980	1982	1984
Total professional staff (person/years)	9	13	7	6	5
Average research experience of on-farm research staff (yrs)	9.3	5.1	13	11.1	6.2
No. of disciplines in on-farm research	1	1	3	1	4
No. of research areas	24	8	3	7	2
Average distance of areas from headquarters (km)	180	260	110	120	220
Surveys to date	0	5	1	0	8
Enterprises in trial program	6	9	1	4	9
Trial sites/research areas	2	10	26	3	54
Trial sites/professional staff	19	17	33	16	22
Trial sites/resident assistant	8	4	15	4	15
% sites researcher managed	100	100	75	100	65
Outposted field team[b]	none	AA,RH	RH	none	RT,AA,RH
Average staff cost/trial site (Z$)[c]	NA	1082	NA	NA	853
Average operational cost/trial site (Z$)	NA	275	NA	NA	262

Source: M. Avila, E. Whingwiri and B.G. Mombeshora 1989: Organization and Management of On-Farm Research in DR&SS.
[a]Farm Systems Research Unit
[b]RT = research technician; AA : agricultural assistant; RH = research hand.
[c]NA = not available.

The only participation of the small farmers, on whose land the on-farm trials are conducted, is during weeding and protection of trial sites. The land preparation, design and planting are done by the institute. Nor are farmers involved in the problem identification phase. No *ex ante* analysis is carried out to assess the appropriateness of the trials. Nor are farmers encouraged to improve the trials or to experiment on their own.

Crop Breeding Institute has been criticized for simply using the on-farm trials to test advanced varieties under different climatic and soil conditions, and not generating knowledge from these trials to develop the breeding programmes.

> On-farm research is not really given much credibility as a source of information for setting research priorities or directions in breeding work. Researchers are dedicated to varietal development under optimal conditions... . (Whingwiri 1989:115)

Breeders at DR&SS do not approve of breeding for specific areas and conditions of farming, as suggested by CIMMYT, among others. The Zimbabwean breeders interviewed insisted that the conventional breeding methods are appropriate, given the limited scope of the breeding programmes. Only varieties which perform well cross-country are selected for advanced trials.

The plant breeders at DR&SS have in fact been so "good" at creating optimal farm management conditions for the on-farm trials that the on-farm trials showed a range between varieties tested similar to the range obtained in on-station trials. The usefulness of this kind of on-farm trial has thus been limited. As the design demands frequent visits to ensure high farm management standards, the on-farm trials have also turned out to be quite expensive. This combined with budget limitations have resulted in a decision to terminate the on-farm research programme conducted by Crop Breeding Institute.

Even though the manner in which the Crop Breeding Institute has conducted the on-farm trial programme leaves much to be desired, it must be regarded as detrimental to end the programme completely.

While the Crop Breeding Institute is decreasing its activities in the communal areas, the Seed Co-op is expanding its communal area testing programme. Seed Co-op had on-farm trials in 10 communal areas in 1989/90 and planned to expand the programme.

Chapter 12
Plant Breeding in Zimbabwe

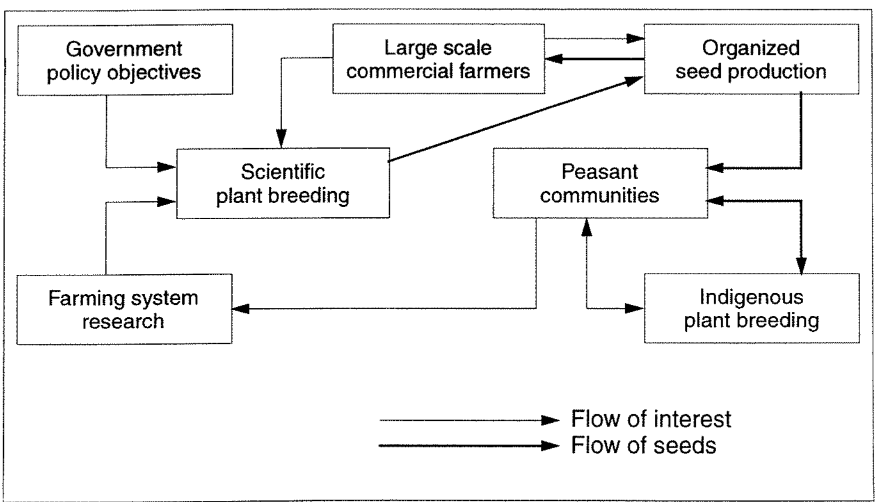
The political economy of plant breeding

Two parallel plant breeding and seed production systems exist from which peasants have access to seed: indigenous plant breeding and its related system of community informal seed exchange; and scientific plant breeding and organized seed production.

The scenario in which well-adapted improved seeds are available is seldom valid for peasant societies in Africa. This is even less so in economically and agro-ecologically marginal areas. A central aim of this study has been to analyse the plant breeding requirements of resource-poor peasants and review whether plant breeding (both scientific and indigenous plant breeding) satisfied these requirements. This is discussed in detail in the following two sections, but before proceeding, the flow of information and influence between farmers and plant breeding is examined.

As illustrated in Figure 8, peasant communities are supplied with seed from both indigenous and scientific plant breeding through organized seed

Figure 8. *Macro economic environments*



production. While there are direct and strong links between the peasant community and the indigenous plant breeding system, the links between peasants and scientific plant breeding are indirect and weak.

In Zimbabwe, the plant breeding interests of communal farmers are in principle brought to the attention of plant breeders through farming systems research and the on-farm trial programme. Only two in-depth farming system analyses have been undertaken by the farming system research unit of DR&SS (Shumba 1984), and these are of a general nature and do not discuss plant breeding requirements in particular. As discussed in chapter 11, the on-farm trial programme in the communal areas has been designed in such a way that it has been useful for adjusting extension recommendations only.

Moreover, Figure 8 indicates that both farming sectors influence the overall government policy objectives. These have been to re-orient agricultural research and plant breeding towards the communal sector, without lowering the standards of research into the problems important for the large-scale commercial farmers. The Commercial Farmers Union (CFU) is perhaps the most influential and well-organized interest group in Zimbabwe. On the practical level, CFU has exerted great influence on the direction of both scientific plant breeding and organized seed production. The government of Zimbabwe has been generally friendly with the Zimbabwe National Farmers Union and National Farmers Association of Zimbabwe, which represent the peasants interests, but these organizations have had little concrete impact on the development of the breeding programmes, as they are weak, both organizationally and analytically.

Organized seed production, which in Zimbabwe is dominated by the Seed Co-op, is very high in regard to the content of public plant breeding. The links between Seed Co-op and DR&SS are institutionalized through tripartite and bipartite agreements which cover six crops of commercial interest. There is thus a direct cooperation between the plant breeders at Seed Co-op and those at DR&SS, and some 60% of the DR&SS trials are conducted at the Seed Co-op research farm.

Indigenous plant breeding

The indigenous plant breeding system is traditional, which should not be understood as conservative or static over time; traditional in this sense means that it builds on well-developed traditions within the peasant household and community. Indigenous plant breeding is conducted within the peasant societies, and is the main supplier of agricultural seeds for peasants in Zimbabwe, as well as in the majority of other peasant communities in Africa. Indigenous plant breeding is closely linked with the way the peasant community operates as a whole, with its informal channels of information and exchange mechanisms. The landraces are thus commonly highly adapted to specific local household requirements, and although seed exchange may extend over wide geographical areas, the activities and use of indigenous plant breeding are primarily limited to the community itself.

The indigenous plant breeding system has functioned satisfactorily over centuries and has managed to sustain an eight-doubling of the human population before industrialization and the discovery of fossil fuels (Norgaard 1985). But although landraces are highly adaptable, the peasants have in many situations not been able to cope with the productivity demand of recent decades because of the sub-optimal resource conditions under which they have to operate. There are three fundamental limitations to the efficiency of the indigenous plant breeding system:

1. Indigenous plant breeding as a breeding method

Mass selection is a simple breeding method compared to the techniques available from science today. It builds on selection from phenotypic characteristics (characteristics which are easily observed) instead of the genotypic characteristics used by scientific plant breeding. Mass selection as a method of plant breeding is only efficient for breeding characteristics with high inheritability.

2. Access to a diversity of germplasm for indigenous plant breeding

Access to germplasm from which indigenous plant breeding can select and recombine desired landraces is limited by the availability of diversity to choose from, and by the nature of this diversity, which varies greatly between different geographical areas and between different crops. Germplasm is very unevenly distributed. A 'centre of origin', where the diversity highest, is characterized by the existence of wild relatives of the crops and long traditions of domesticating them.

The diversity of germplasm available for indigenous plant breeding in a given area depends on the history of crop production. Many crops, including maize, sunflower, and groundnuts, have a short history of cultivation in Zimbabwe, and a major part of the germplasm which has been available for indigenous plant breeding consists of earlier released improved varieties. For crops such as sorghum and millet, which have been cultivated in the region for centuries, indigenous plant breeding has access to germplasm with much higher diversity.

3. Social organization of indigenous plant breeding

The efficiency of an indigenous plant breeding system depends on some degree of specialization within the peasant community. Moreover, it requires organizational structures which allow for and encourage indigenous plant breeding to take place.

The significance of the very turbulent history of settlement of the communal areas in Zimbabwe is that indigenous plant breeding in these areas has

Box 23. Enhancing farmers ability to exercise greater choice in adapting planting material and in rejecting poorly-adapted exotic varieties: the case of community genebanks in Ethiopia

In situ conservation of landraces on peasant farms provides a valuable option for conserving intra-species crop diversity. It increases the range of strategies for genetic resource conservation efforts, and provides a mechanism through which the evolutionary systems responsible for the generation of variability are sustained. In relation to pests and diseases this will allow continued host-parasite co-evolution. Within stressful environments, access to a wide range of local landraces may provide the best available planting strategies. The ability of landraces to survive under such stress is conditioned by an inherent broadly-adaptive genetic base. This is often not the case with more uniform improved varieties, which despite their high-yield potential are less stable and hardy under adverse growing conditions.

The Plant Genetic Resource Centre in Ethiopia has since the mid-1980s been engaged in a number of genetic resource conservation and development programmes in collaboration with peasant households and communities. This work will be greatly expanded in the 1990s, due to a major grant from the Global Environmental Facility.

Decentralized field genebanks play a central role in enhancing the flow of germplasm between farmers and scientists. Materials previously collected from surrounding areas and regions are given to farmers to plant and to carry out simple forms of mass selection to improve their characteristics. Farmers are assisted by breeders and other scientists who have access to the farmers' fields for the purposes of carrying out research. The long-established skills of the farmers are complemented by scientists from the Ethiopian genetic resource centre, who establish standard descriptor lists (such as ear length, ear width, number of tillers, disease and pest resistance, lodging resistance etc.) which they train farmers to follow, enhancing their selection skills.

commonly had less than 40 years to adapt landraces to their new environments. The struggle for independence during the 1970s and the following civil war from 1980–87 have further limited the efficiency of indigenous plant breeding.

Scientific plant breeding

Mike Collinson concludes in a recent article that scientific plant breeding in Africa

> ... seek[s] the optimal way to grow crops and expect[s] farmers to adjust to these requirements. When scientists' selections of new crop varieties are based solely on features of the natural environment (such as rainfall, soils and temperatures), farmers may reject the high-yielding varieties scientists most admire. (Haugerud and Collinson 1991:4)

Although this picture is still valid for much scientific plant breeding in Africa, there are clear indications of changes taking place, and there has been an attempt over the last decade to institutionalize a process in which scientists learn from farmers, and in which farmers are given the opportunity to participate in the research process. For an example see box 24.

Box 24. An example—farming systems research at IITA, Nigeria

The most obvious way for scientific plant breeding to assist the indigenous plant breeding system would be to improve landraces by performing some of the tasks which are not possible within the indigenous plant breeding system. One example of this is to screen for pathogens and insert resistance genes, such as the changes presently taking place in the cowpea breeding programme at IITA in Nigeria.

Until 1985, the breeding programme was entirely committed to developing the erect type of cowpea, which has the highest potential kernel yield and response to fertilizer. Meanwhile, peasants throughout Kano Province, which is in the centre of cowpea production in Nigeria if not in Africa, cultivate the 'creeping' type of cowpea. One of the advantages of this type under no-input conditions is that its production of leaves is high and it is available over a longer period of time than the erect type.

The cowpea programme has undergone radical changes and the breeder has devoted 80% of his time over the last two years to improving landraces collected from peasants in Kano Province. During this time, he has reached the F7 generation and has incorporated five vertical resistance genes into the local landraces, which are now ready for on-location trials for yield stability in Kano Province. It is expected that these two years of work will have improved the yield of the landraces of cowpea from 300–400 kg/ha to approximately 500 kg/ha.

Source: Personal communication from IITA cowpea breeder, Dr. Singh, Kano, November 1991.

The majority of plant breeding in Africa has in the past been concentrated on the most widely used crops, and especially on the crops of economic importance: 1) stable crops, such as wheat, rice and maize; 2) crops demanded by the food processing industry, such as red sorghum for industrial brewing of opaque beer in Zimbabwe; and 3) export crops, such as tobacco, cotton and coffee. Crops which are used for subsistence production in marginal areas are generally not served at all or are poorly served by plant breeding programmes, nor are they supported by formal organized seed production.

This trend is beginning to change, and plant breeding today in many African countries is undertaken for a range of crops, including open-pollinated maize, small grains etc. Table 32 compares characteristics of indigenous and scientific plant breeding.

Table 32. *Comparison of indigenous and scientific plant breeding*

Characterizations	Scientific Plant Breeding	Indigenous Plant Breeding
Bio-diversity in the production system	LOW	HIGH
Spatial genetic diversity	LOW	HIGH
Temporal genetic diversity	HIGH	LOW
Use of external inputs	HIGH	LOW
Response to mineral fertilizers	HIGH	LOW
Adaptation to local-specific agro-ecology	LOW	HIGH
Adaptation to local socio-economic conditions	LOW	HIGH
Horizontal resistance to pathogens	LOW	HIGH
Vertical resistance to pathogens	HIGH	LOW
Hybridization	HIGH	LOW

Plant breeding in Zimbabwe has experienced a process of re-orientation since independence in 1980. As discussed in chapter 11, this re-orientation process includes the establishment of a farming systems research unit, on-farm variety trials, re-orientation of plant breeding objectives for selected crops and finally the initiation of plant breeding programmes for a number of new crops.

Although this sounds rather impressive, the content and impact of the re-orientation is limited. The fundamental plant breeding methods have not been subject to change. These methods include: emphasis on breeding for yield stability over wide areas, as opposed to adapting the varieties to specific local agro-ecological conditions; emphasis on hybridization; and emphasis on developing vertical resistance to phatogens as opposed to development of horizontal resistance. It has not been possible to trace any impact of the work done by the farming systems unit on the plant breeding programmes, nor have on-farm trials been given credibility as a source of information for setting research priorities for plant breeding.

Chapter 13
Towards a Sustainable Poverty-oriented Plant Breeding

From the previous discussion, it is clear that the existing system of scientific plant breeding and commercial seed industry have a number of shortcomings with regard to meeting the requirements of peasant communities and ensuring a high level of *in situ* bio-diversity in the production system. The indigenous plant breeding system, meanwhile, is not geared to meet the demand for intensification of agricultural production which is required, as pressure of resources on production are increasing because of population growth and commodification of rural societies. But there is much untapped potential in indigenous plant breeding, which can come into life if properly assisted by scientific plant breeding. Scientific plant breeding has, for its part, much learn from peasants in the process of choosing plant breeding objectives and establishing and evaluating research trials.

Establishing a dialogue between scientific plant breeding and resource-poor peasants

> Fundamental changes in the organization of agricultural research, and in the attitudes of agricultural scientists, remain necessary... . In defining relevant breeding priorities, however, the essential starting point is for anthropologists, economists and breeders alike to give close attention to farmers' own detailed knowledge of existing crop varieties and to how they select, manage and use them. On-station trials to test improved cultivars should take farmers' cropping systems and husbandry practices explicitly into account. On-farm trials should incorporate farmers' own methods of informal experimentation, their standards of judgement, and their suggestions concerning experimental design. As scientists adjust their research priorities and experimental techniques to solve clients' problems, they will require the courage to depart from the textbook experimental design and disciplinary paradigms. (Haugerud and Collinson 1991:14)

In chapter 12 we concluded that an ideal scenario to satisfy the seed requirements for peasant communities would be a whole catalogue of different seed varieties which should be adapted to a range of local-specific, socio-economic and agro-ecological conditions. The argument for this is that the ideal seed requirement within peasant communities is differentiated, depending on household access to resources.

Neither of the two plant breeding and seed diffusion systems satisfy peasant communities' ideal seed requirements. Indigenous plant breeding produces varieties which are highly adaptable to peasants' production conditions, but are limited by access to germplasm and by simplicity of breeding methods. Scientific plant breeding is limited by professional conservatism and biased towards developing varieties which are commercially profitable for the seed industry.

The focus of this chapter is on possible options for narrowing the present gap between peasant seed requirements and existing plant breeding and seed supply. This can be done by exploring ways in which cooperation and dialogue can be established between the two systems of plant breeding in order to benefit peasant agricultural production and bio-diversity conservation. It is clear from the above that there is an urgent need for radical changes in the present system of plant breeding and seed production. It is argued in the following that the changes required go beyond those which are currently being undertaken at the international and national agricultural research institutes.

It is important to stress that the expansion of the range of seed available to peasant societies, from a limited and controlled number of certified varieties to a catalogue of seed varieties, has costs as well as benefits:

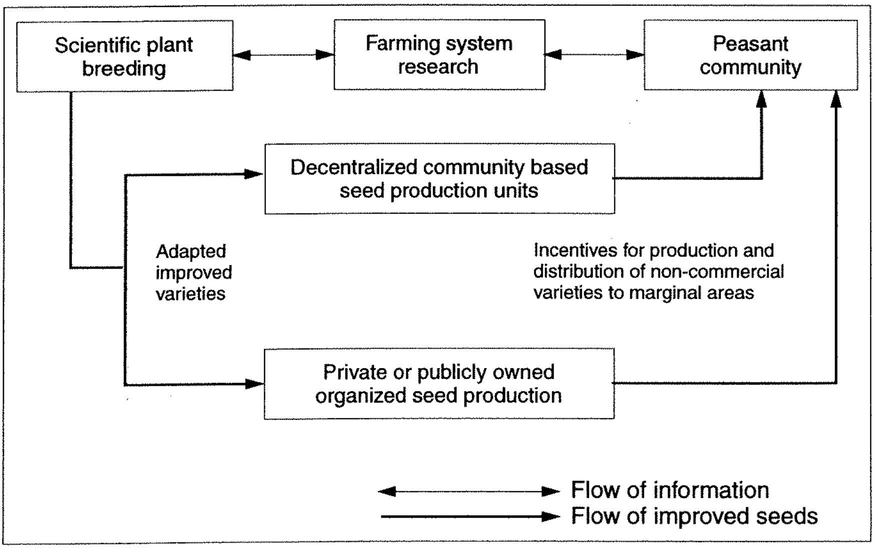
1. Adaptation of improved varieties by scientific plant breeding at national agricultural research institutes will not only demand a change in professional attitude, but also a considerable increase in manpower and funds. These changes will thus require firm political commitment and public sector support from the governments concerned.
2. The adaptation of improved seed varieties to specific local conditions, moreover, will atomize the market. The market share of the individual improved varieties will thus be smaller and costs will increase for the seed industry, as the economy of scale of producing varieties in bulk will be diminished.

It is not suggested here that the ideal peasant seed requirements should be satisfied by formal organized seed production at all costs, but that the balance between costs and benefits should not be determined by what is profitable for the seed industry only, but also by the potential benefits for peasant communities.

> Plant breeders cannot respond to every quirk of farmers' circumstances. Their task becomes more complicated, costs increase, and progress slows as the number of selection criteria increases. Breeders require general guidelines based on an accurate prior identification and ranking of cultivar traits that particular categories of producers' end-users find important, discarding less relevant screening criteria, and assessing farmers' capacities to change existing practices. Crop breeding is a long-term investment; decisions taken at the outset have implications for many years to come. (Haugerud and Collinson 1991:13)

As discussed in chapter 3, there has been a trend within parts of the scientific plant breeding community in Africa towards establishing some kind of dialogue between plant breeders and peasants. This has largely been accomplished through establishing small farming systems research units at the

Figure 9. *Integrated plant breeding system*



international and national research institutes. It is only seldom that direct dialogue between the plant breeders and peasants has been established, and the influence of the farming systems research units has at most tended to be limited to influencing the plant breeding programmes in such a way that they take into account the most basic resource constraints and preferences of the peasant farming systems. There is a strong need to support and encourage this process of change taking place within the national and international agricultural research institutes. Figure 9 illustrates how such a system could be organized.

There is scope for developing the farmers participatory research methodology within the area of plant breeding in such a way that plant breeders would become partners with peasants rather than with the seed companies. Many plant breeders would possibly feel more comfortable with such a partnership. One area requiring methodological development is ways by which scientific plant breeding can involve peasants in designing and evaluating on-farm trials. This is a difficult task because of the distance between the two worlds: one based on strict control of all factors and use of quantitative statistics; the other based on sequential decision making and holistic evaluation.

Science-supported indigenous plant breeding

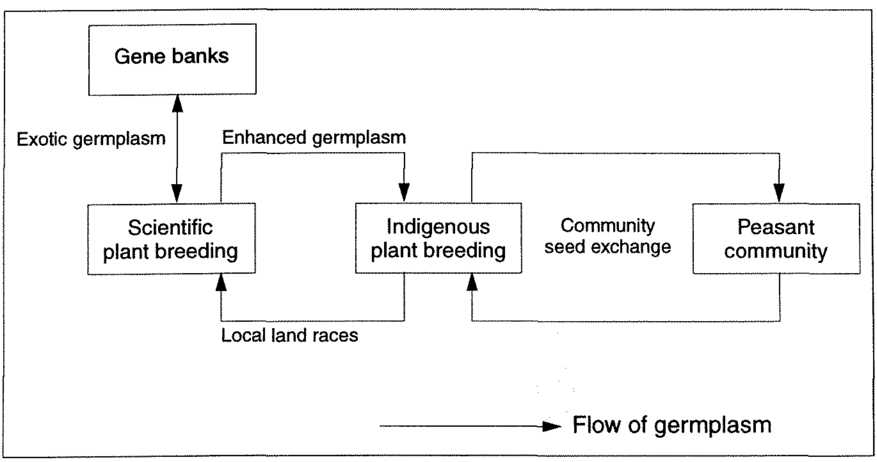
The consequences of such a re-orientation of plant breeding and the seed industry in Africa are certain to be costly and develop slowly, and the scope of this strategy is quite limited under the present economic crisis. In the following, therefore, options for the scientific plant breeding system to assist the indigenous plant breeding system in overcoming its limitations are examined. Such an integrated plant breeding system, illustrated in Figure 10, is discussed below.

As discussed in chapter 3, there are two major limitations to the indigenous plant breeding system: the relative simplicity of the selection method (mass selection) and the limited availability of germplasm. These limitations could be alleviated by scientific plant breeding through improving access to germplasm for the indigenous plant breeding system.

A comprehensive step would be for the scientific plant breeding system to supply the indigenous plant breeding system with enhanced germplasm to work with. This proposal is an elaboration of a similar line of thought presented in a recent report from Norwegian Centre for International Agricultural Development (NorAgric) (Berg et al. 1991), which focuses on conservation of bio-diversity. The central proposal is to redefine the role of scientific plant breeding as practised at national agricultural research institutes so that they become responsible for germplasm enhancement, rather than for developing final varieties.

Scientific plant breeding distinguishes between the breeding population and development of cultivars intended for commercial sale.

Figure 10. *Plant breeding redefined*



Box 25

Comparison of scientific and indigenous plant breeding and the scope for scientifically aided indigenous plant breeding

The difference between scientific and indigenous plant breeding cannot be defined in terms of technique and efficiency. The strategies of plant breeding activities are influenced by different aims and objectives. There are no formal links between scientific and indigenous plant breeding and the two systems are become associated with different seed supply systems and are involving independently. It is therefore important to analyze the characteristics, constraints and comparative advantages of both systems of plant breeding, and the types of linkages which would enhance indigenous plant breeding activities.

Components of plant breeding technologies and strategies

Plant breeding activity		Scientific breeding	Indigenous breeding
Breeding Technology	Genetic resource base	World geneticresources	Local genetic resources
	Crossings	Controlled	Random
	Selection Method	Efficient	Moderately efficient
Breeding Strategy	Adaptation	Broad adaptation	Specific adaptation
	Variation	Uniform varieties	Heterogeneous varieties

The strategies of scientific plant breeding has been conditioned by the requirements of the formal seed companies for broad, adaptive qualities and uniformity in improved varieties for mass dissemination. In contrast, the selection criteria of indigenous plant breeding are concerned with the performance of varieties in specific localities. A geographically-wide adaptive sphere is feasible when varieties are bred for standardized cultivation methods. In areas, which highly complex and varied farming systems it is much harder to achieve a site adaptation of breeding materials. In these areas local selection would be a more feasible solution and the scope of a scientific supported indigenous plant breeding include two aspects: supply of enhanced breeding material; and improvements of indigenous methods of seed selection.

Local crop varieties, which have been maintained and used by farmers, have been systematically collected by scientists for utilization in breeding programmes. Indigenous plant breeding, however, remain confined to their traditional seeds. While the diffusion of varieties through informal networks of neighbourhood exchange may add new germplasm to local genetic resource bases, this does not allow indigenous breeders to explore the potential of knowledge emanating from scientific institutions and to carry out their work on equal terms with scientific breeders. The dissemination of genetic materials in the form of enhanced germplasm for local selection could be a way of compensating traditional seed selectors for the contributions to the genebanks of the world.

The scope for improvement of indigenous selection skills depends on: the degree to which seed selection is considered important; the people involved in breeding; time allocated for seed selection; and the methods through which knowledge of seed selection are transmitted to the next generation.

Source: Berg 1993.

> The purpose of the breeding populations is to preserve a 'sufficiently' wide variation, in which the average values of characters may be continually improved through selection, generation after generation. In a genetic sense such population improvement reflects increasing frequencies of desirable genes in the population. From this genotypes may be selected and tested for potential use as cultivars. (Berg et al. 1991:110)

It is therefore proposed that population improvement should continue to be done on-station by scientific plant breeding using both indigenous and exotic germplasm; then, the second stage of selecting and testing for potential use as cultivars should be done by the indigenous plant breeding system. In case of self-pollinated crops such as sorghum and grain legumes, the opportunities of selection within the indigenous plant breeding system could be improved, if scientific plant breeding provided enhanced segregating populations or line mixtures. Similar enhanced populations could be provided in the case of open-pollinated and vegetatively propagated crops, leaving the tasks of selection and evaluation to the peasants.

The implementation of such an integrated plant breeding system would require a strong element (and perhaps a re-defined role) of extension services, which could provide the link between scientific plant breeding and farm level selection. One task of extension services would be to identify peasants interested in and capable of indigenous plant breeding. Then, these peasants could possibly be trained in improved breeding techniques.

APPENDIX

Methodology

This appendix discusses the availability of information and choice of methodologies and field work techniques. Because of the complexity and interdisciplinary nature of the research objectives, a wide range of sources and academic traditions are drawn on.

Sources of literature for theoretical considerations

The theoretical considerations of the study combine at least five different academic traditions and debates.

The discussion of the concept of the peasant and the process of social differentiation and commodification of agricultural production in Africa make use of the many articles from the late 1970s and early 1980s which appeared in journals such as *African Study Review*, *Journal of Peasant Studies*, *Development and Change* and *Journal of Development Studies*.

The discussion of peasant household production strategies is based on a wide range of writers who all use the household as their unit of analysis and aim to explain its behaviour in reaction to changing circumstances. The theories are all to some extent based on the profit maximization theory presented by Upton (1976). The risk aversion theories have Ellis (1988) as a major source; the labour productivity maximizing theories are explained with point of departure in Harriss (1982), while the discussion of the new household theories is based on Low (1986).

The discussions of agricultural intensification and commodification of agricultural seeds draw on a substantial, but very varied, body of literature, primarily consisting of books published over the last 25 years. One can distinguish between three academic schools of thought: the modernists, the evolutionists, and newer social science and 'system' oriented writers. Boserup (1965) is a principal exponent for the evolutionist school of thought, which also includes major works on agricultural systems such as those by Allan (1965) and Ruthenberg (1974). Exponents of the newer social science orientation are Richards (1985) and Blaikie (1987).

The discussion of seed production is inspired by the poverty-oriented seed debate of the 1980s. This debate is an elaboration of the often heated discussion of the 1970s of the green revolution. Major contributors to this debate are Lipton (1989), Kloppenburg (1988), Juma (1989), Hobbelink (1987) and Mooney and Fowler (1990). This body of literature also questions the adequacy of conventional plant breeding methods and practice to satisfy the seed requirements of peasant societies.

The discussions of peasant seed requirements draw on two groups of literature: the farming systems research theories developed in the early 1980s, and the discussions of indigenous technological knowledge in the late 1980s and early 1990s.

As background literature on the technical principles of scientific plant breeding, the following three references have been used: Poehlman (1987), Berg et al. (1991) and Simmonds (1991).

Sources for analysis of the agrarian sector

The introduction to the analysis of the agrarian sector of Zimbabwe draws on a number of seminar and conference papers and articles, including seminars at Zimbabwe Institute for Development Studies and the annual Food Security Conferences organized by University of Zimbabwe/Michigan State University. The quality of data and level of information on agricultural development are high in Zimbabwe compared with the African continent in general. Despite this, it is difficult to gain access to more detailed and dis-aggregated data on key issues such as rural credit, input supply and marketing. This study has had exceptionally good access to detailed data, due to the participation of the author in the evaluation of two Danida development projects (Rural Credit from the Agricultural Finance Cooperation (AFC) and Education of Agricultural Extension Workers (Agritex)). The study has moreover had direct access to dis-aggregated data drawn from the central computer at the Grain Marketing Cooperation (GMB).

Methodology for review of plant breeding

The information about plant breeding activities is based on interviews with most plant breeders at the Department of Research and Specialist Services (DR&SS). This information is supplemented by descriptions and trial results from annual reports from the Crop Science Institute (CSI). Since the latest available CSI annual report covers the 1983/84 season, the data is mostly unpublished. The data was made available in connection with the author's consultant work as a team member of the Zimbabwe Agricultural Sector Memorandum for the World Bank (WB), in cooperation with the Ministry of Lands, Agriculture and Rural Resettlement (MLARR).

The actual review of the commodity breeding programmes during the first decade of independence draws on a collection of field work studies of agricultural development in communal areas. The information about the general conditions of cultivation in the communal areas is used as a framework for reviewing plant breeding efforts.

Organization of field work in communal areas

The field work for this study was carried out in two communal areas of Zimbabwe, Silobela and Chiduku. Silobela communal area is situated in a semi-arid area (Natural Region IV) in Gweru region, 80 km west of Kwekwe town. Chiduku communal area is situated in a high-potential rainfall area (Natural Region IIb) in Manicaland region, 25 km south of Rusape town (see Map 12).

The field work was conducted in three phases; farmers' participatory research; a formal household questionnaire survey; and an in-depth study based on qualitative interviews.

The farmers' participatory research was carried out in Kwekwe and Makoni districts during two weeks in August 1990, and two reports were produced and discussed immediately after the field work (Friis-Hansen 1989a, 1989b). Several field work techniques[1] were applied, including interviews with key informants, officials and traditional leaders, groups of peasants, and individual peasants of different social strata. 1:50,000 maps and 1:20,000 aerial photographs were also used extensively, for example to conduct trans-sector walks to determine land-use patterns. The interviews were qualitative and thematic in nature, based on check lists. The peasants interviewed in groups were asked to arrive at a consensus on averages and social differences concerning access to key resources such as cultivated area, livestock ownership and use of improved varieties. The farmers' participatory research focused moreover on peasant seed use, and some 56 different local and improved varieties were collected from the peasants interviewed.

The results of the farmers' participatory research in the two communal areas were used to choose enumeration areas for the formal survey. They were also instrumental in designing the household questionnaires and a code book including names of indigenous varieties etc.

A total of 70 households were interviewed during the formal household survey, 32 households in Silobela and 38 households in Chiduku. This book draws on the data from Silobela communal area only, since although the farming system and resource constraints facing peasants in Chiduku communal area are quite different from the situation in Silobela, no significant new knowledge about the seed requirements of peasant societies would be gained from analysing both sets of data.

The enumeration area in Silobela communal area consists of a circle of cultivated land where the peasants live, surrounded by grazing areas; this constitutes a farming system unit (an infield-outfield system). The households living at the rim of the cultivated circle constitute five kraals.[2] Household selection was based on stratified random sampling. The actual selection

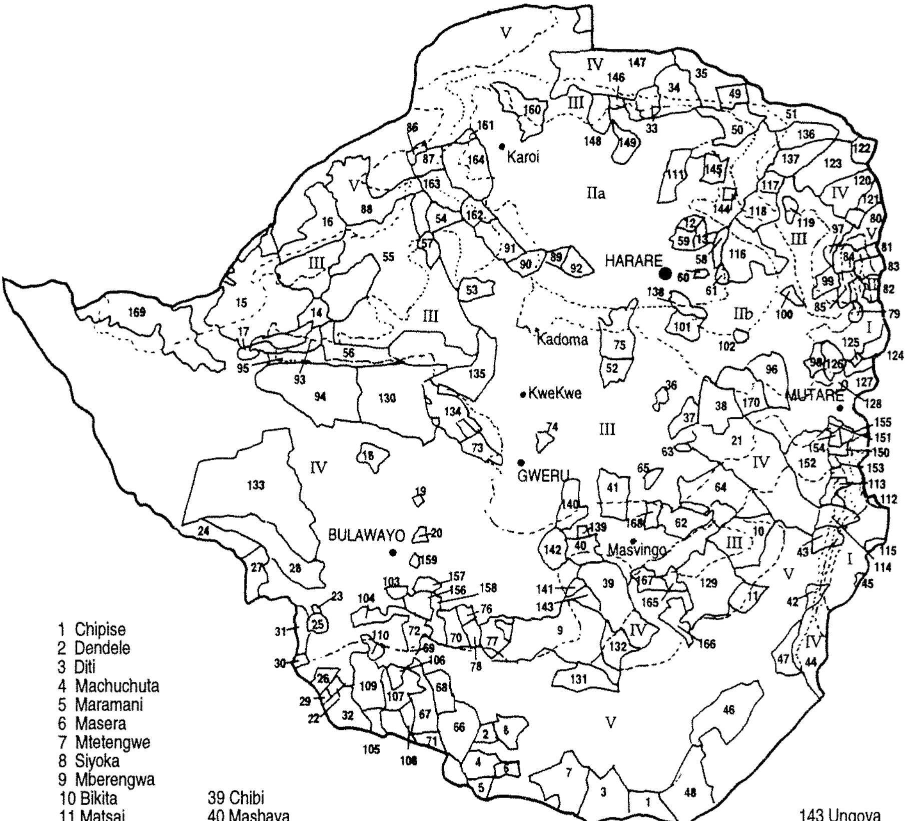
[1] The choice of field work techniques was inspired by publications from the Department for Rapid Rural Appraisal, at the International Institute for Environment and Development.

[2] A kraal is the smallest traditional administrative unit, commonly consisting of 30 to 50 households.

was made from inventory lists of all households in the enumeration area so that three kraals, Mali, Mbonjani and Kande, were represented. The official administrative system of village development committees (vidco) does not function in Silobela communal area, and the only existing list of households in the enumeration area was drawn up by the former headman, Lukuluba, in 1974. This list was updated by the kraal heads and used to make the random sample of households participating in the questionnaire survey.

The in-depth study was organized as three follow-up surveys in Silobela communal area. These were based on qualitative interviews of key informants, both within and outside the group of peasants participating in the questionnaire survey. The purpose of the in-depth study was, as the name suggests, to study selected issues in detail. Moreover, these follow-up visits provided the opportunity to fill out missing information from the previous surveys and to cross-check the collected data.

Map 12. *Zimbabwe natural regions and location of communal areas*



1 Chipise
2 Dendele
3 Diti
4 Machuchuta
5 Maramani
6 Masera
7 Mtetengwe
8 Siyoka
9 Mberengwa
10 Bikita
11 Matsai
12 Masembura
13 Musana
14 Busi
15 Manjola
16 Siabuwa
17 Lubumbi
18 Inkosikazi
19 Inyati
20 Ntabazinduna
21 Savi
22 Brunapeg
23 Ingwezi
24 Maitengwe
25 Mpande
26 Mphoengs
27 Mpimbila
28 Nata
29 Ngulube
30 Raditladi
31 Ramakwebana
32 Sansukwe
33 Gutsa
34 Muzarabani
35 Mukumbura
36 Manyeni
37 Nharira
38 Sabi North
39 Chibi
40 Mashava
41 Chirumanzu
42 Musikavanhu
43 Mutema
44 Ndowoyo
45 Tamandayi
46 Matibi
47 Sangwe
48 Sengwe
49 Chiswiti
50 Kandeya
51 Masoso
52 Ngezi
53 Sanyati
54 Gandavaroyi
55 Gokwe
56 Kana
57 Sebungwe
58 Chikwaka
59 Chinamora
60 Chinyika
61 Kunzwi
62 Chikwanda
63 Denhere
64 Gutu
65 Serima
66 Dibilishaba
67 Gwanda
68 Gwaranyemba
69 Makwe
70 Matshetshe
71 Shashi
72 Wenlock
73 Lower Gwera
74 Chiwundura
75 Mondoro
76 Glass Block
77 Godlwayo
78 Insiza
79 Nyanga
80 Nyanga North
81 Matizi
82 Nyamaropa
83 Sawunyama
84 St Swithins
85 Zimbiti
86 Gatshe Gatshe
87 Kanyati
88 Omay
89 Chirau
90 Magondi
91 Mupfure
92 Zvimba
93 Dandana
94 Lupane
95 Mzola
96 Chiduku
97 Chikore
98 Makoni
99 Tanda
100 Neya
101 Chihota
102 Svosve
103 Gulati
104 Kumalo
105 Mambali
106 Maribeha
107 Mbongolo
108 Seear Block
109 Semukwe
110 Tshatshani
111 Chiweshe
112 Chikukwa
113 Mutambara
114 Muwushu
115 Ngorima
116 Mangwende
117 Maramba
118 Uzumba
119 Mutoko
120 Mudzi
121 Chikwizo
122 Mukota
123 Ngarwe
124 Holdenby
125 Manga
126 Manyika
127 Mutasa North
128 Mutasa South
129 Ndanga
130 Nkayi
131 Maranda
132 Matiba North
133 Tsholotsho
134 Silobela
135 Zhombe
136 Chimanda
137 Pfungwe
138 Seke
139 Mashawa
140 Shurugwi
141 Mazvihwa
142 Runde
143 Ungova
144 Bushu
145 Madziwa
146 Bakasa
147 Dande
148 Kachuta
149 Guruve
150 Chinyawuhera
151 Dora
152 Marange
153 Muromo
154 Rowa
155 Zimunya
156 Matopo
157 Mzinyatino
158 Nswazi
159 Esiphezini
160 Mukwichi
161 Nyaodza
162 Piriwiri
163 Rengwe
164 Hurungwe
165 Mutirikwi
166 Nyajena
167 Masvingo
168 Zimuto
169 Hwange
170 Wedza

Methodological considerations regarding the social differentiation of peasant societies and their seed use and requirements

A central methodological issue related to the study of agricultural seeds in peasant societies is: How do we differentiate between the different social groups of peasant households, and how do we determine the seed requirements of these groups?

The ability to generate sufficient surplus from agricultural production to reproduce the household at a socially acceptable level has been used by some writers to distinguish between the poor and middle group of peasants. The group of rich peasant households has been defined as those in which agricultural production is higher than the labour capacity of the household and thus based on the use of hired labour (Kjærby 1989; Bernstein 1979).

Migrant labour is an important source of income in the rural areas of Southern Africa, and for this reason, the method of social differentiation referred to above is not applicable for this study. In Zimbabwe, income from migrant labour of household members and remittances from relatives living in town, plays a significant role for the household income. It would thus be inadequate to limit the analysis to the sphere of production.

Instead, the study uses the annual household income as a parameter for dividing the sample of peasant households into three social groups, because then both agricultural production and external income are taken into account. The data on annual household income used in this study is calculated from sale of surplus production and non-agricultural income. The value of subsistence is not calculated and thus the total household income is not arrived at, but a good measure of the spending power of the household is.

Great effort was made to collect reliable data on household income and expenditure patterns. Despite this, it has not been possible to establish the level of saving (or use of savings), nor has it been possible in all cases to obtain reliable data on remittances. When the recorded household expenditures are higher than the recorded household income (primarily for the low income group), the income has been adjusted under the category "estimated remittances and use of savings". When the recorded income has been higher than the recorded expenditures, the expenditures have been adjusted under the category "domestic spending and savings".

From an analysis of the standard deviation of household income, three income categories were chosen: <Z$250; Z$250–1000; >Z$1000. These income categories were found to correlate with access to the two key resources, land and livestock. There is a clear relationship between livestock and household income. Livestock is essential for agricultural production, both in terms of generating fertility and as draught power. The three household categories have been correlated with access to livestock. The criteria chosen for livestock is whether or not the individual household has access to one draught power equivalent (DPE). DPE is defined as ownership of either four draught oxen or eight donkeys. There is a clear correlation (on a 3% significant level in a chi-square test) between the three household income groups and access to draught power (categories used are 0–0.99 DPE and >1 DPE). There is also a relationship between income groups and land, although this is less clear (correlation on a 14% significant level). The land categories have been defined by using the area actively cultivated during the 1989/90 season. The following categories have been used: <4 acres, 4–10 acres, >10 acres. There is also a correlation between access to draught power and cultivated land (on a 3% significant level).

The household questionnaire includes a range of questions concerned with peasants' reasons for using crop varieties. Because the peasants had great difficulty in answering these questions, analysis was not possible. Instead, the study uses an indirect method of determining seed requirements. First, the farming system was analysed thoroughly to generate an understanding of the resource constraints facing the three social groups of peasants. The peasants' access to seed was then analysed to determine the options available (in terms of indigenous and improved varieties). In this context, the social differentiation in seed use was analysed to determine whether the pattern of seed use differed with household access to resources. Finally, the study analysed how well the crop varieties used by the peasants in the sample were adapted to existing farm management practices. This analysis was made on a field basis by crop.

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