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The Impact of Investments in Maize Research and Dissemination in Zambia. Part I: Main Report

by

Julie A. Howard
with George M. Chitalu and Sylvester M. Kalonge

MSU International Development Working Paper No. 39/1 1993

Department of Agricultural Economics
Department of Economics
MICHIGAN STATE UNIVERSITY
East Lansing, Michigan 48824

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Department of Agricultural Economics
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Michigan State University
East Lansing, Michigan 48824-1039
U.S.A.

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PART ONE: MAIN REPORT

By

Julie A. Howard[*],

with George M. Chitalu[**] and Sylvester M. Kalonge[***]

Department of Agricultural Economics
Michigan State University

October, 1993

Funding for this research was provided by the United States Agency for International Development (USAID), Africa Bureau, through the Food Security in Africa Cooperative Agreement (No. DAN-1190-A-00-4092-00) and the Food Security II Cooperative Agreement (No. AEP-5459-A-00-2041-00) with the Department of Agricultural Economics, Michigan State University.

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[*] Research Associate, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824-1039.

[**] Research Assistant, Rural Development Studies Bureau, University of Zambia, Lusaka, Zambia.

[***] Research-Extension Liaison Officer, Adaptive Research Planning Team, Western Province, Zambia.

ISSN 0731-3438

Published by the Department of Agricultural Economics and the Department of Economics, Michigan State University, East Lansing, Michigan 48824-1039, U.S.A.

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ACRONYMS

ARMB	Agricultural Rural Marketing Board
ARPT	Adaptive Research Planning Team
ARR	Average rate of return
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CSO	Central Statistical Office
CSRT	Commodity and Specialist Research Team
CUSA	Credit Union and Savings Association
DAO	District Agricultural Officer
DRC	Domestic resource cost
FAO	Food and Agriculture Organization of the United Nations
GMB	Grain Marketing Board
GRZ	Government of the Republic of Zambia
IRR	Internal rate of return
MAFF	Ministry of Agriculture, Food and Fisheries
MRR	Marginal rate of return
MSU	Michigan State University
NAMBOARD	National Agricultural Marketing Board
NCZ	Nitrogen Chemicals of Zambia
PAO	Provincial Agricultural Officer
PCU	Primary Cooperative Union
RDSB	Rural Development Studies Bureau, University of Zambia
ROR	Rate of return
SCCI	Seed Control and Certification Institute
SER	Shadow exchange rate
SIDA	Swedish International Development Authority
UNDP	United National Development Program
UNZA	University of Zambia
USAID	United States Agency for International Development
USD	United States dollar

ZAMARE	Zambia Agricultural Development, Research and Extension
ZAMSEED	Zambia Seed Company
ZCF/FS	Zambia Cooperative Federation/Financial Services
ZK	Zambian kwacha
ZNFU	Zambia National Farmers' Union
ZSPA	Zambia Seed Producers' Association

Acknowledgments

Funding for this research was provided by the United States Agency for International Development (USAID), Africa Bureau and Research and Development Bureau, through the Food Security in Africa Cooperative Agreement (No. DAN-1190-A-00-4092-00) and the Food Security II Cooperative Agreement (No. AEP-5459-A-00-2041-00) with the Department of Agricultural Economics, Michigan State University. Professor Eric Crawford, co-director of the MSU Agricultural Technology and Policy Assessment Study, and Professor Carl Eicher were sources of intellectual guidance and encouragement in all phases of the study. Professor James Oehmke made valuable suggestions that improved the quality of the paper.

The authors would also like to acknowledge the support provided by Mr. M.R. Mulele, Director, and Dr. K. Munyinda, Assistant Director (Research) of the Department of Agriculture, Ministry of Agriculture, Food and Fisheries; Dr. John Milimo, Director, Rural Development Studies Bureau, University of Zambia; and Dr. William Whelan, Agricultural Economist, USAID/Zambia.

A dedicated team of enumerators, Mr. Keegan Chikonka, Mr. Gilbert Nkamba, Mr. Clement Nsandula and Mr. Champion Tembo, and an excellent and tireless project driver, Mr. Mekamu Siwale, made the field work rewarding and pleasurable. We received generous assistance from the Provincial Agricultural Officers and their staffs in Northern, Eastern, Southern and Central Provinces. District agricultural staff and camp extension officers frequently accompanied the team to help locate and interview the sample farmers. We thank the village headmen, and the men and women farmers interviewed, who offered us their unfailing hospitality and sincere cooperation.

Mr. M. Davidson Simusonkwe and his staff at the Agricultural and Environmental Statistics Division, Central Statistical Office (CSO) spent late evenings and weekends helping to define the sample frame, drawing the sample, providing detailed maps of the sample areas and calculating weighting factors. Adaptive Research Planning Team (ARPT) members at Mt. Makulu, Misamfu, Msekera and Kabwe Research Stations, and Mr. Stuart Kean, former ARPT National Coordinator, helped the team understand the role of maize in Zambia's different farming systems. Dr. Dusan Ristanovic, Dr. Catherine Mungoma, Dr. Watson Mwale, Mr. Brian Chivunda, Dr. Ken McPhillips, and Dr. Paul Gibson recalled and interpreted the key events in the history of maize hybrid and variety development in Zambia.

Mr. Winter Chibasa, General Manager of Zamseed, shared essential insights to both maize variety development and the birth of the seed industry in Zambia. Mr. Chance Kabaghe and Mr. Philip Kabwe of Zamseed's Marketing Division excavated company archives to find data on Zamseed sales of individual varieties and hybrids between 1979-1992. The directors of Zambia National Farmers Union (ZNFU) and the Zambia Seed Producers Association (ZSPA) introduced us to key members of the farming community who gave continuing guidance and welcomed us into their homes. Finally, the authors would like to thank the staff of CIMMYT/Harare, Ms. Anthea Dickie, Monitoring and Evaluation Officer, ZAREP, and the

staffs of SIDA, FAO, NORAD and the Zambian Cooperative Federation (ZCF) who provided us with detailed information about projects and expenditures related to maize development and dissemination.

1.0. INTRODUCTION

Michigan State University (MSU) is currently assessing the impact of agricultural research on various commodities in seven African countries: Cameroon (maize, cowpea, sorghum), Kenya (maize, wheat), Malawi (maize), Mali (maize), Niger (sorghum, cowpea, millet), Uganda (oilseeds), and Zambia (maize). These countries were selected because they represent a variety of agro-ecological regions, and because their research systems have received significant levels of funding from USAID. The country studies undertaken by MSU are part of a series of research works recently commissioned to help USAID and the U.S. Congress analyze the effectiveness of aid given to strengthen national agricultural research systems in Africa.

In Zambia, MSU collaborated with the Ministry of Agriculture, Food and Fisheries (MAFF) and the University of Zambia's Rural Development Studies Bureau (RDSB) to assess the impact of investments in maize research and dissemination made during the late 1970s and early 1980s. This research resulted in the release of ten new hybrids and open-pollinated varieties between 1984-88. Major support for maize research and dissemination came from the Government of Zambia (GRZ), the Centro Internaciónal de Mejoramiento de Maiz y Trigo (CIMMYT), the Food and Agriculture Organization/United Nations Development Program (FAO/UNDP), the Swedish International Development Authority (SIDA) and the United States Agency for International Development (USAID).

1.1. Maize in Zambia

Maize is the preferred staple of urban and rural Zambians and is the country's most important crop. Seventy per cent of Zambia's crop area is planted to maize, almost exclusively white varieties. During the 1980s, marketed maize represented 70 per cent of the value of all marketed food production, and 60 per cent of the value of all crops. Per capita consumption of maize is estimated at 105 kilograms annually, most of which is ground into mealie meal and consumed as stiff porridge, or fermented for beer, with by-products used as livestock feed (GRZ 1990, Jansen 1988).

Unlike elsewhere in sub-Saharan Africa, agriculture has been relatively unimportant in Zambia's economy, contributing only about 14 per cent of Gross Domestic Product (GDP) (Table 1)[1]. Former President Kaunda often said, "We Zambians were born with a copper spoon in our mouths" (Pagni 1990:38). Zambia has been one of the world's major exporters of copper since before independence in 1964. Its economy grew at a rate of 12 per cent annually until it was dealt a double blow in the mid-70s, when world copper prices declined by 40 per cent while imported fuel costs skyrocketed (Jansen 1988:5). Since then, Zambian copper production has declined by 30 per cent because of low price levels, declining reserves and falling ore quality. A

[1] Agriculture remains an important employer and source of income for most Zambians. Two-thirds of the labor force are employed in the sector and about 60 per cent of the population depends on agriculture for subsistence (World Bank 1992).

major structural shift took place between 1970 and 1985, when the mining sector portion of GDP dropped from 36 to 16 per cent while service and manufacturing sectors shares rose (Table 1).

Table 1: Percentage of Gross Domestic Product by sector of origin, 1965-88

(current prices)

	1965	1970	1975	1980	1985	1988
Agriculture, forestry and fishing	14	11	13	16	13	14
Mining, quarrying	41	36	14	14	16	15
Manufacturing	7	10	16	18	23	25
Construction, other industry	6	8	12	5	4	3
Services, other	32	35	45	47	44	43
GDP	100	100	100	100	100	100

Source: World Bank, 1992

Significantly, copper and later other industries attracted many to urban areas in the Copperbelt region of north-central Zambia and the capital, Lusaka. Zambia is one of sub-Saharan Africa's most highly urbanized countries. Over 50 per cent of the total population of nine million lives in cities (World Bank 1992). The need to provide the urban population with a dependable source of cheap food, and the government's concomitant desire to improve smallholder incomes, were the *raisons d'etr*e behind heavy government involvement in all phases of maize production and marketing from independence until 1992. Interventions included the promotion of maize production through a series of investments in research, extension and the seed industry, and the implementation of pricing policies that dramatically affected the pattern of maize production and consumption.

The investments and policies began to bear fruit in the mid 1970s, when maize area, production and marketing rose markedly (Figures 1,2, Table 2). Maize area grew from less than 250,000 hectares in the mid-1970s to nearly 800,000 hectares in 1988-89. Production more than tripled in the same period, from 600,000 to 1,997,000 tons.

Beginning in 1988-9, however, fertilizer price subsidies were substantially reduced. Higher fertilizer prices, combined with GRZ's increasing inability to manage the logistics

Figure 1: Maize area and production

Figure 2: Official maize purchases 1963-92

Table 2: Maize area, production and sales, 1963-92

Year	Area (ml. ha)	Production (ml. tons)	Off. Purch. (ml. tons)	Yield (tons/ha)
1963-64	na	na	.189	na
1964-65	na	na	.252	na
1965-66	na	na	.378	na
1966-67	na	na	.369	na
1967-68	na	na	.243	na
1968-69	na	na	.252	na
1969-70	.267	.268	.126	1.01
1970-71	na	na	.396	na
1971-72	na	na	.589	na
1972-73	na	na	.4	na
1973-74	na	na	.589	na
1974-75	.212	.6	.56	2.83
1975-76	na	na	.751	na
1976-77	na	na	.697	na
1977-78	na	na	.582	na
1978-79	na	na	.467	na
1979-80	.540	.636	.49	1.18
1980-81	na	na	.693	na
1981-82	na	na	.511	na
1982-83	.434	.867	.452	1.99
1983-84	.564	.93	.607	1.65
1984-85	.576	1.214	.65	2.11
1985-86	.532	1.427	.955	2.68
1986-87	.659	1.003	.657	1.52
1987-88	.692	1.834	1.349	2.65
1988-89	.797	1.997	1.36	2.5
1989-90	.668	1.464	.893	2.19
1990-91	.579	1.448	.81	2.5
1991-92	.477	.515	.295	1.08

Sources: Wood 1990 (1964-69, 1971-74, 1976-1979, 1981-82). World Bank 1992 (1970, 1975, 1980) Central Statistical Office Crop Forecasting Survey Results (1992, 1982-92).

and cost of timely credit provision, physical input delivery, and collection and payment for produce, contributed to farmers' disenchantment with maize production. These factors led to a significant decline in maize area and production in the late 1980s, worsened by the disastrous region-wide drought of 1991-92 (Figure 1, Table 2).

1.2. What is the impact of maize research?

Maize was chosen as the focus for this study because of its importance to Zambian food security, and because of the major role that research played in increasing maize production during the 1980s. Also, a USAID-funded project, Zambia Agricultural Development, Research and Extension (ZAMARE), provided significant support for developing and disseminating the new maize varieties.

Research impact is usually recognized when varieties (as here) or new agronomic techniques that have the potential to increase yields are adopted by farmers, resulting in increased production and/or lower costs (Oehmke et al. 1992). Identifying this straightforward cause-and-effect process is complicated in Zambia by questions of who deserves credit (1) for technology development when several donor agencies besides government researchers are involved, and (2) for adoption of technology when farmers are influenced not only by the existence of new varieties, but by their accessibility, information about their use, availability and prices of complementary inputs, and product price and marketability.

2.0. OBJECTIVES AND METHODS

A review of evaluations of research impacts (Oehmke et al. 1992) shows that the benefits of farmer adoption of technology are commonly ascribed to research investments alone, with the implicit assumption that investments in related organizations are held constant. Evaluators (and funders) of programs want to show the return to their particular investment. Available econometric methods for disaggregating the impacts of highly complementary investments require high-quality time-series data, and therefore are not usually feasible in data-poor developing countries. Unfortunately, research program evaluations that do not provide information about the role and sequencing of investments in critical complementary organizations can overestimate the impact of particular investments.

2.1. Objectives

The objectives of this paper are:

(1) to describe maize production in Zambia since independence, and the physical, organizational and policy environment surrounding it;

(2) to describe the investments made in Zambian maize research by the Government of the Republic of Zambia (GRZ) and donor organizations since 1978; and

(3) to evaluate the actual impacts of those research investments, within the context of concurrent policy implementation and investments in extension, marketing, and the seed industry, all of which affected farmer adoption of technology.

2.2. Methods

The underlying hypothesis of this study is that investments in extension, the seed industry, marketing and price policies critically influenced farmer decisions about adoption of new maize varieties. A combination of quantitative and qualitative methods was used to estimate the impacts of maize research expenditures in the context of these related investments. These methods are detailed in sections 2.2.1.-2.2.3.

2.2.1. Rate of return as a measure of program worth

An index number/benefit-cost approach was used to calculate an average rate of return (ARR) to the set of investments in maize research, extension, the seed industry and marketing organizations during the 1978-91 period, and a projected ARR for 1978-2001. The rate of return (ROR) (or internal rate of return) is a discounted evaluation measure for a single or a set of projects. It is

> "(the) discount rate that just makes the net present worth of the incremental net benefit stream, or incremental cash flow, equal zero. (The ROR represents) the maximum interest that a project can pay for the resources used if the project is to recover its investment and operating expenses and still just break even...."(Gittinger 1982: 480-1).

A project or program is generally considered to be economically successful if the ROR exceeds the opportunity cost of capital.

There are two ways to calculate the rate of return to a set of investments, either as an average or a marginal rate. An average rate of return (ARR) takes the whole expenditure as given and calculates a rate of return to the global set of expenditures. The ARR indicates whether or not the **entire** investment package was successful, but not whether the allocation of resources between investment components (e.g., research, extension, seed) was optimal (Oehmke et al. 1992).

Economic theory tells us that resources are allocated optimally between program components when the last dollar spent on each component yields the same return. The marginal rate of return (MRR) calculates the return to the last dollar invested in each component, through econometric estimation of the relationship between the supply function and program expenditures. This entails estimation of an aggregate production function that includes research and complementary investments as separate variables. The results of the analysis indicate the effect that individual investment components such as research and extension have on increasing the supply of agricultural products and in theory could guide the policymaker toward optimal resource allocation, by indicating where to invest or subtract resources until the marginal dollars spent on alternative investments are equal. However, estimation of the MRR requires good quality time series data that is not usually available in developing countries (Oehmke et al. 1992).

The index number/benefit-cost, for the ARR, and the production function method, for the MRR, are the two most important approaches used in the ex-post evaluation of returns to agricultural research. The index number/benefit-cost approach has been most commonly used to calculate the rate of return from investments in the improvement of single crops or the development of single technologies. Production functions, on the other hand, are used to determine the rate of return from research and complementary investments in multiple crops or for an entire sector.
(Oehmke et al. 1992).

2.2.1.1. The index number/benefit-cost method

Griliches (1958) developed the index number method to estimate the impact of increased hybrid corn yields on the net social surplus of the U.S.. Working from Marshall's economic surplus paradigm, Griliches hypothesized that the essential impact of agricultural research was to raise productivity, causing the aggregate supply function to shift outward, from S to S' (Figure 3). If the market is in equilibrium and there are no commodity imports, the benefits from the supply shift are represented by the area AB0. The price elasticities of demand and supply determine the relative benefits gained by producers and consumers. In Figure 3, the

change in consumer surplus = P_nBCP_0, and the change in producer surplus = $A0C - P_nBCP_0$.

The additional social surplus created by the outward shift in the supply curve represents the gross benefits arising from investments in research and related investments. To estimate the ARR, net benefits for each year (or other relevant time period) are calculated by subtracting program expenditures from the gross benefits for that year.

Figure 3: Supply shift and calculation of economic surplus from research and related investments

Akino and Hayami (1975) developed formulas that enabled them to quantify the area of the change in social surplus (A0C) resulting from investments in Japanese rice breeding research. The Akino-Hayami method has moderate data requirements and has been widely applied in subsequent developing country studies, including this one.

The index number and benefit-cost methods of estimating the ARR are similar, differing primarily in their treatment of supply and demand elasticities. The index number tableau explicitly incorporates the elasticities in the ARR estimate, but the benefit-cost method does not. For the benefit-cost estimate, this is equivalent to assuming perfectly inelastic supply and perfectly elastic demand. These assumptions are valid in cases where the country is clearly a "price-taker," where the intervention being evaluated is not expected to change the country's status from net importer to net exporter of the commodity. An assumption of highly inelastic supply is valid when fixed inputs such as labor or land resources are almost fully employed, and when the commodity being evaluated is the principal user of these resources.

In the Zambian case, recent estimates indicate that consumer demand for maize is actually highly inelastic, and supply is somewhat elastic (Harber 1992, Nakaponda 1992)[2]. Assumptions about elasticities are critical for calculating the distribution of benefits between consumers and producers, but less so for determining the overall societal economic surplus, as in this paper. Here, calculations of the ARR using both the Akino-Hayami index number approach and a benefit-cost tableau will be presented. The advantage of the Akino-Hayami approach is its explicit incorporation of supply and demand elasticities, while the benefit-cost tableau offers a more transparent view of the data and assumptions used in the analysis.

In both methods, quantitative assessments of the costs and benefits of the program are made by estimating the value of the increased production resulting from the investment (benefit) and the cost of carrying out the program. The financial (market) values of these benefits and costs are then adjusted in the economic analysis, using shadow prices, to reflect the true costs of the factors of production to society. These adjustments are necessary because there are

[2] Price elasticity of demand is estimated at .12 and -0.04, and price elasticity of supply is estimated at .8 and .51 by Harber (1992) and Nakaponda (1992), respectively. The inelasticity of demand may result from the highly controlled consumer price structure from 1964-92, which left mealie meal the cheapest staple food, as well as the worsening economic climate, reflected in the declining per capita GDP since the 1970s (Nakaponda 1992:122). Maize supply by farmers is somewhat elastic, probably because in Zambia, unlike other African countries, availability of arable land is not a constraint. Only about 2 million of the estimated 9 million hectares of arable land in Zambia have been cultivated.

significant distortions in market prices, through subsidies and taxes imposed by the government and artificially imposed official exchange rates that do not reflect the true scarcity of local versus other convertible currencies.

2.2.2. Maize adoption survey

The rate and extent of adoption are critical impact indicators for technology-related investments, and are pivotal inputs to the rate of return analysis. To find the adoption rate of the improved maize varieties, and key factors influencing farmer adoption decisions, a survey of 462 small (less than five hectares) and medium-scale (5-20 hectares) farmers located in the principal maize-growing areas of Zambia's three agro-ecological regions was carried out between April and July 1992. The sample used was derived from the sample frame developed by the Central Statistical Office (CSO) for its 1992 Census of Agriculture. The location of sample areas is shown in Figure 4. Farmers interviewed were a stratified random subsample of those participating in the Census of Agriculture. Details on survey design, sample selection, questionnaire development and interviewing procedures can be found in Appendices 1 and 4.

No existing sample frame was available for large-scale maize growers, defined as farmers usually growing 15 or more hectares of maize each season. Instead, a questionnaire was mailed to all of the large maize farmers who could be identified through the membership roster of the Zambia National Farmers' Union (ZNFU) (Appendix 5). In addition, blank questionnaires were sent to the chairperson of every ZNFU affiliate with the request that they be forwarded to large maize growers in that area. Sixty responses were received from the several hundred questionnaires distributed.

2.2.3. Analysis of policies and organizations

This paper draws upon the conclusions of a forthcoming paper that will focus exclusively on policy and organizational issues relating to maize variety development and dissemination in Zambia (Howard, Kalonge, and Chitalu, forthcoming). The method used for the analysis was a modified version of the Agricultural Technology Management Systems (ATMS) framework developed by Elliot et al. (1985). Its components include:

(1) Sector Analysis. Assessment of the performance of the maize sector in general and identification of key organizations and policies affecting maize technology generation and transfer. Instrument: literature search.

(2) Functional Analysis. Description of the key policies and organizations affecting maize and analysis of their key functions and interactions. Instruments: literature search, interviews with key informants.

(3) Events Analysis. Identification of key events in the chronology of maize technology development and diffusion and documentation of the role of

Figure 4: Location of enumeration areas for small and medium farmer survey

organizations and policies in these events. Instruments: literature search, interviews with key informants.

(4) Policy Analysis. Description and analysis of the key macroeconomic, intersectoral, and agriculture sector policies that have had an impact on maize technology dissemination. Instruments: literature search, interviews with key informants.

3.0. MAIZE PRODUCTION IN ZAMBIA: PEOPLE AND ENVIRONMENT

Maize has been grown in southern Africa since the 16th century, when it was introduced by Portuguese traders. Small cultivators traditionally grew maize in a mixture of crops that also included sorghum, millet, pumpkins and groundnuts, and it did not become dominant in most systems until the arrival of European colonizers in the 1900s. In much of southern Africa, including Zambia, colonization introduced commercial large-scale modern farming systems which evolved alongside the traditional small-scale systems (Blackie).

During the 1970s and 1980s, two important and related changes occurred in Zambian maize production. First, production shifted gradually from the large commercial to the small- and medium-scale sectors. Between the early 1970s and the late 1980s, the small- and medium-scale share rose from 60 to 80 per cent of total maize production (GRZ 1990:34). Second, the geographical and agro-ecological pattern of maize production changed during the last decade.

In the 1980s, the national market share of Central Province decreased, while market shares of Copperbelt, and the more remote provinces of Northern, Luapula and Northwestern all increased their shares (Figure 5, Table 3). These data show a partial migration of maize production from agro-ecological Region II, the locus of commercial maize production and considered the best area for maize production, to the more remote, high-rainfall Region III, dominated by small farmers. The shift is significant

Table 3: Provincial shares of the national maize market, 1982-92

(per cent)

Year	Central	Copper-belt	Eastern	Luapula	Lusaka	Northern	North-western	Southern	Western
1982-83	37.9	1.5	27.1	0.7	3.7	11.1	0.9	16.3	0.9
1983-84	33.4	2.1	29.1	1.1	3.0	11.8	1.1	16.9	1.4
1984-85	31.6	3.4	25.2	0.8	3.8	10.4	1.1	22.4	1.3
1985-86	30.7	3.7	22.4	1.0	5.3	6.4	0.8	28.4	1.5
1986-87	29.0	7.1	27.6	2.1	5.1	12.7	1.6	13.6	1.3
1987-88	27.9	4.0	24.6	1.6	5.1	10.6	1.6	22.9	2.1
1988-89	26.3	3.7	27.3	3.0	3.9	10.2	2.1	21.1	2.4
1989-90	25.6	5.9	19.2	3.3	4.8	15.2	1.4	22.1	2.6
1990-91	30.4	7.8	18.5	4.0	4.7	16.1	1.1	12.6	4.8
1991-92	30.7	11.7	7.1	5.5	1.3	36.2	2.9	2.1	2.5

Sources: GRZ, 1990; Central Statistical Office Crop Forecasting Survey data, 1990-92.

because efforts to improve maize varieties and disseminate improved technology beginning in the late 1970s focused on extending the range of high-yielding maize production beyond the boundaries of the best-suited agro-ecological region and larger farms.

3.1. Types of farmers

There are three major categories of farmers in Zambia, defined in terms of the area of land cropped by each farmer. **Small-scale or traditional** farmers cultivate less than five hectares of land and consume most of their produce, occasionally entering the market to sell any surplus. Small-scale farmers cultivate an average of two to three hectares, using few or no external inputs on their farms. The hand hoe is the predominant means of cultivation. Seventy-five per cent of Zambia's 600,000 farm households are small-scale, cultivating about 61 per cent of the total cropped area (World Bank 1992:8; GRZ 1991a:19).

Medium-scale or emergent farmers cultivate between five and twenty hectares. They use improved seeds and fertilizers and sell most of their production. Farmers commonly use a combination of hand hoe and animal draft power, and sometimes tractors, although they may rent rather than own animals and machinery. Medium-scale farm households

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Figure 5: Map of Zambia

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make up about 21 per cent of total farms, and cultivate an estimated 17 per cent of total cropped area. (World Bank 1992:8; GRZ 1991a:19).

Large-scale commercial farmers plant over twenty hectares of land annually. These farmers apply high levels of purchased inputs and use oxen or machinery for all farm operations. They produce almost exclusively for direct market sale or feed commercial animals kept on the farm. Large-scale farmers make up only four per cent of farm households, but cultivate 22 per cent of all cropped land (World Bank 1992:8; GRZ, 1991:19).

3.2. Agro-ecological regions

Zambia is divided into three major agro-ecological regions (Figure 6), which are primarily based on rainfall characteristics but also incorporate soils and other climatic data.

3.2.1. Region I

3.2.1.1. Location and climate

Semi-arid Region I includes areas of southern, eastern and western Zambia: specifically, the Gwembe and Lunsemfwa Valleys, central and southern Luangwa Valley, and the southern parts of Western and Southern Provinces. These valleys are the lowest-lying areas of Zambia, with elevations of 300-900 meters above sea level. The remainder of Region 1, like most of Zambia, lies at elevations between 900 and 1,300 meters (GRZ 1991a:32).

Mean annual rainfall in Region I ranges from 600 to 800 mm. The growing season[3] is relatively short (80-120 days) and perilous as poorly distributed rains mean that crops endure frequent dry spells.

Region I contains a variety of soil types, ranging from slightly acidic loamy and clayey soils with loam topsoil, to acidic sandy soils, to Rift Valley soils of variable texture and acidity. Characteristics of these soils that present problems for cultivation include: erosion, limited soil depth in hill and escarpment areas, difficulty of working cracking clay soils, crusting, low water-holding capacities in sandy soils and wetness in valley dambos and swamp areas (GRZ 1991a:90-91, 33).

[3] The growing season is defined as the number of days in which rainfall exceeds half of the potential evapotranspiration.

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Figure 6: Agro-ecological regions

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3.2.1.2. Farming systems

Farmers in Region I are predominantly small-scale. There are three main farming systems, Luangwa Valley (Eastern and Lusaka Provinces), Senanga West and Sesheke (Western Province) and Gwembe Valley (Southern Province).

In the Luangwa Valley, sorghum, finger millet and maize are the major starchy food crops, while groundnuts, cowpeas and pumpkins are the principal food relish crops. Cotton, sunflower and rice are also grown. Cotton, sunflower, and maize, to a lesser extent, are the most important cash crops. Farmers use hand hoes for cultivation. Goats and chickens are commonly kept by farm households, and some farmers have a few cattle. The main source of income in Luangwa Valley is the sale of mats and other items made from reeds, and sales of fish, game meat, chicken and beer (GRZ 1991a:33-34).

The major starchy food crops in Senanga West and Sesheke are bulrush millet, sorghum, cassava, and, to a smaller extent, maize. Pumpkins, beans, groundnuts and cassava leaves are the principal relish crops. Cattle provide draft power, milk and meat, and families also keep goats and chickens. Sales of baskets, fish, milk, cattle, goats and maize are the most important sources of income (GRZ 1991a:34).

In the Gwembe Valley, sorghum, maize and bulrush millet are the main starchy food crops, and relish crops include groundnuts, cowpeas and beans. Vegetables such as cucumbers, pumpkin, rape, tomatoes, onions and melons are also grown. Households commonly keep cattle, goats and chickens (GRZ 1991a:34).

The main crop production constraints in Region I are the short growing season and accompanying risk of drought, low soil fertility, prevalence of pests and diseases, and the lack of animal draft power and equipment. Tsetse fly and other livestock diseases limit the number of cattle, sheep and goats (GRZ 1991a:35).

3.2.2. Region II

3.2.2.1. Location and climate

Region II includes much of central Zambia, including most of Central, Southern, Eastern and Lusaka Provinces. It contains the most fertile soils and most of the country's commercial farms. Annual rainfall in Region II averages 800-1000 mm, and the growing season is 100-140 days long. Distribution of rainfall is not as erratic as in Region I, but dry spells are common and reduce crop yields, especially on sandier soils. Average mean daily temperatures range from 23-26^{o}C in the hottest month, October, to 16-20^{o}C in the coldest months of June and July (GRZ 1991a:37).

The most common soils in Region II are red to brown clayey to loamy types that are moderately to strongly leached. Physical characteristics of the soils that affect production include low water

holding capacity, shallow rooting depth, and topsoils prone to rapid deterioration and erosion. These soils also have low nutrient reserves and retention capacity, are acid, have low organic matter and nitrogen content, and are phosphorus-deficient (GRZ 1991a:38).

3.2.2.2. Farming systems

Zambia's large commercial farmers are concentrated in Region II. Their farming systems are mechanized and highly diverse, including maize, soybeans, wheat, cotton, tobacco, coffee, vegetables, flowers and livestock. Besides the large-scale systems, there are four main farming systems used by small- and medium-scale farmers (GRZ 1991a:38).

Maize is the main staple of the hand hoe system in Central and Eastern Provinces. Beans, groundnuts, pumpkins, sindambi and cassava leaves are grown for relish, and other crops include cotton, sorghum, soybeans and sunflower. Cattle, chickens, goats, pigs and sheep are common. Sales of maize, sunflower, cotton, chickens and goats provide the main sources of income (GRZ 1991a:38).

Crops and livestock in the maize-cattle mixed farming system of Central, Eastern and Southern provinces, and Kaoma District, Western Province, are almost identical to the hand hoe system above. Farmers also grow tobacco, and cattle are important for traction, meat, milk and manure. Oxen and rented tractors are the main sources of draft power in this system. Hybrid maize, sunflower, cotton, soybeans and tobacco are major cash crops, and sales of goats and chickens are also important income sources (GRZ 1991a:39).

The major crops in the hand hoe system of Western Province are cassava, sorghum, bulrush millet and maize. Cassava leaves, cowpeas, pumpkin leaves, sweet potato leaves, sindambi, beans, bambara nuts and groundnuts are common relishes. Farmers in this system commonly keep cattle, chickens, ducks and goats for meat, milk, manure and trade. Maize, sorghum, millet, cassava and sweet potatoes are grown primarily for home consumption, but are often sold informally (GRZ 1991a:39).

In the central Zambezi floodplain farming system, sorghum, maize, bulrush millet and cassava are the principal starchy food crops. The major relishes are cassava leaves, sindambi, local beans and vegetables, supplemented by beef, milk, poultry and fish. Oxen are the main source of draft power. Household income comes from the sale of fish, cattle, milk, rice, bulrush millet and cassava (GRZ 1991a:39).

The major constraints to increased crop production in Region II are the lack of low-cost controls for pests and diseases, soil degradation and depletion of fertility, lack of open-pollinated varieties, unreliable rainfall distribution, poor storage characteristics of improved cash crop varieties, shortage of labor and lack of draft oxen. For livestock, the main problems are poor nutrition during the dry season, disease, lack of breeding stock, poor husbandry practices and inadequate water supplies (GRZ 1991a:40).

3.2.3. Region III

3.2.3.1. Location and climate

Region III, the high-rainfall area, lies in a band across northern Zambia, including the provinces of Northern, Luapula, Copperbelt, Northwestern and some parts of Central Province. This region receives over 1000 mm of precipitation each year, and the growing season ranges from 120-150 days. The mean monthly temperatures during the growing season are 19-27°C, and 16°C in June and July (GRZ 1991a:42).

Soils in Region III are highly weathered and leached, characterized by extreme acidity. Consequently, the soils have few nutrients available for plant growth, and are high in exchangeable aluminum and manganese, both of which are toxic to most crops (GRZ 1991a:43).

3.2.3.2. Farming systems

Small-scale farming predominates in Region III. The rural areas of this region have the lowest population density in Zambia, and farmers use very low-input shifting and semi-permanent cultivation techniques. Chitemene and fundakila are two widely used, traditional methods of cultivation. In chitemene, trees are cut at chest height, their branches are heaped in piles and burned, with crops later planted in the ash. Fundakila is used on already cleared fields. Grass is cut and buried at the end of the rainy season, then allowed to decompose. The composted material is spread before the next planting season onto frequently mounded fields.

There are four main farming systems. Principal crops in the hand hoe system of Northern, Luapula and Northwestern Provinces are cassava, local maize, sweet potatoes, pumpkin, finger millet and beans. Cowpeas, groundnuts, onions and leafy vegetables such as rape are grown as relishes. Most farmers have chickens and a few goats, but other livestock are uncommon. The existence of tsetse in some areas keeps the cattle population low. Households earn income through the sale of fish, beans, maize, cassava, beer and chicken (GRZ 1991a:43).

Sorghum is the most important cereal in the hand hoe system of Northwestern and Copperbelt Provinces, followed by finger millet. Sweet potatoes and maize are minor crops. Cassava is the most important starch, and relishes include cassava and sweet potato leaves, beans and game meat. Fish are also important in areas close to rivers. Chicken and goats are common in many households, and a few cattle are found in Solwezi and parts of the Copperbelt, although not in tsetse-infested Kasempa. Households obtain income through the sale of sorghum, finger millet, beans, sweet potatoes, the brewing and sale of sorghum/millet beer, and sales of game meat, chicken and honey (GRZ 1991a:44).

Cassava, finger millet and maize are the staples of the fundakila farming system of Isoka and Mbala Districts, in Northern Province. Beans and groundnuts are important relish crops. Cattle, chickens and goats are also kept by farm households. Farmers mainly use hand hoes for

cultivation, but oxen are sometimes used for draft power. Maize and beans are the most important cash crops and sources of income (GRZ 1991a:44).

In the chitemene farming system of Northern, Luapula and northern Central Province, finger millet, cassava and maize are the main crops, with beans and groundnuts the most important relishes. Goats, chickens and some cattle are kept, all primarily for meat. The main source of income for farm households is the sale of beans, maize, groundnuts and beer (GRZ 1991a:45).

The main constraints to production in Region III are high soil acidity, low soil fertility, lack of animal power, poor storage characteristics of improved maize hybrids, pests and diseases in food crops, and a shortage of labor. Livestock production is limited by a shortage of breeding stock, disease, poor markets and deficient husbandry (GRZ 1991a:46).

4.0. MAIZE RESEARCH

4.1. Structure and evolution of the National Agricultural Research System

Agricultural research during the colonial period met the needs of the expatriate commercial farmers, focusing on the production of maize to feed the mine workers, export crops such as coffee and tobacco, and fruit and vegetables for the resident European population. Beginning in the 1920s, a network of research stations and trial sites was developed which covered the principal agro-ecological zones. A research branch was created within the Department of Agriculture around 1950. The first permanent station, Mount Makulu Central Research Station, opened in 1953, with sections for soil survey, plant pathology and entomology, pastures, irrigation, chemistry, plant breeding and tobacco. Agronomy, seed services, stored products and livestock sections were added later (Eylands and Patel 1990:309-10).

In the period immediately following independence, the research focus remained much the same because of the continued importance of mining and the large urban population, and the need to produce cheap food. A few research programs were initiated to meet the needs of small-scale farmers, including sunflower research and farm management research. It was not until the mid-70s, with the collapse of copper prices, that the unexplored potential of the small-scale farming sector came to the attention of policymakers, and the GRZ began to develop major programs for the sector (Eylands and Patel 1990:310-11).

As a result, in 1975-76, the Research Branch underwent a major reorganization to address four perceived weaknesses in the research program. First, the Research Branch had previously been organized by single disciplines which were slow to develop new technologies. To address this, sixteen multidisciplinary Commodity and Specialist Research Teams (CSRTs) were formed, bringing together specialists of different disciplines to form a "critical mass" of scientists to address all aspects of technologies under development. Second, these CSRTs began to work on traditional crops such as cassava, millet, sorghum, beans, groundnuts, and problems such as soil productivity in the high rainfall area. Third, the Research Branch began to actively recruit and

train agricultural graduates from the University of Zambia to reduce the proportion of expatriate scientists (Eylands and Patel 1990).

Finally, Adaptive Research Planning Teams (ARPTs) were created to conduct farming systems research focused on the needs of subsistence and small-scale commercial farmers. ARPTs are organized by provinces, and are based at the regional research stations in each province. Each ARPT is supposed to have three professional staff members: a farming systems economist, a farming systems agronomist, and a research-extension liaison officer (Kean and Singogo 1988). By 1991, there were ARPTs in every province except Southern. Funding from donor agencies has been essential to the establishment and continued functioning of the ARPTs. Individual donor agencies, including USAID, SIDA, EEC and Netherlands Aid adopted ARPTs in different provinces, and also funded the costs of a central ARPT unit.

4.2. Maize research pre-independence

Before independence in 1964, Zambia, then Northern Rhodesia, relied on its Federation partner Southern Rhodesia (now Zimbabwe) for maize seed. Southern Rhodesia had a hybrid maize breeding program as early as 1932, which developed the SR52 and SR11 hybrids and a white version of the open-pollinated American Hickory King variety. SR52, released in 1960, has been widely used throughout Southern Africa and remains a major influence on maize germplasm in the region (Eicher 1986). It is a tall white dent[4] with large ears, and has a long season, taking 140-150 days to reach maturity.

In Northern Rhodesia, maize became the predominant food crop in many areas, both in European and African farming systems. Research and other services supported the production of crops grown by the European farming sector and promoted the development of large-scale farms producing cheap food for the mining community and some crops for export (Gibbon, 1981). These commercial farmers were the primary users of SR52, SR11 and Hickory King imported from Southern Rhodesia, while the small-scale farmers, who could not afford inputs or meet the higher management requirements, planted "local" maize varieties.

The "local" varieties are open pollinated, long-season varieties, requiring lower levels of management than the imported hybrids and open-pollinateds. They are flinty and have small grains as opposed to the large, denty hybrid grains. Over time, the distinction between "importeds" and "locals" has blurred as maize in small-scale farmers' fields became cross-

[4] The texture of the maize grain ranges from hard (flint) to soft (dent). "Dent" maize has a characteristic depression in the top of the kernel which comes from the proportion of hard or vitreous endosperm in the kernel to the soft or floury endosperm. The "dent" is formed because the soft endosperm collapses inwardly as the kernel dries. Local or unimproved maize in Zambia tends to be flinty, and improved hybrids are more denty. Flinty maize appears to store better than dent types, as the harder grain is more difficult for insects and microorganisms to penetrate (Blackie:5-6).

pollinated with improved maize from neighboring commercial farms, especially Hickory King. Small farmers also began to try SR52, often mixing the hybrid with local seed. In subsequent seasons, farmers commonly replanted advanced generations of the hybrids rather than purchasing new seed each year (McPhillips, personal communication, 1992; Gibson, personal communication, 1993).

4.3. Establishment of a Zambian maize breeding program

A succession of maize breeders worked in Zambia after independence in 1964, supported initially by British and Yugoslavian aid, and later by SIDA, USAID and FAO. Several varieties and hybrids were developed in the period from independence to the late 1970s, including Zambian Composite A (ZCA), Zambia Ukiringuru composite A (ZUCA), the first Zambian hybrid, ZH1, and two composites, Zambia Yellow Composite (ZYC) and Zambia Short Composite (ZSC). However, although these varieties were developed specifically for the small-scale farmer, they were never popular because their performance was inferior to SR52 (Chibasa, personal communication, 1992).

A Yugoslavian breeder, D. Ristanovic, began working in Zambia in 1977, initially directing work at the Yugoslavian Maize Research Institute's winter nursery in Mazabuka, and later seconded to the Zambian maize program, where he continues today. Also, in 1978, the first Zambian professionals joined the maize breeding program, both with Bachelor of Science degrees from the University of Zambia School of Agriculture.

Ristanovic discovered that the Zambian parents of SR52[5] had become contaminated to the extent that there was now a yield difference of about 15 per cent in the Zambian SR52 compared to the original Rhodesian/Zimbabwean version. The contamination was the result of improper maintenance of the breeder's seed, due perhaps to the lack of continuity between maize breeders since independence (Ristanovic et al. 1985). Efforts to obtain the original SR52 parents from Zimbabwe failed, so Ristanovic started cleaning both parents in the 1977-78 season. A newly purified SR52 showed a yield increase of 20 per cent over the old SR52, although this was not statistically significant. The new version was released in 1983-84 under the name Mount Makulu 752 (MM752). The seven is an FAO number indicating the time to maturity, while 52 was retained to show the connection with SR52 (Ristanovic et al. 1985).

4.4. Swedish aid to maize research and the seed industry

SIDA began funding maize breeding activities in 1980 as part of its Agricultural Sector Support Program (ASSP) for Zambia. The ASSP had four objectives: (1) improvement of agricultural research being carried out by the Ministry of Agriculture, Food and Fisheries (MAFF); (2) formation of a commercial seed company organized as a joint venture between the government

[5]After independence, breeders began producing a Zambian version of SR52 from the parent lines instead of importing SR52 from Southern Rhodesia.

and private entities; (3) establishment of the Seed Control and Certification Institute (SCCI); and (4) provision of training for research, extension, and the seed industry (Erikson et al. 1989:ii).

The commodity research program initially focused on the development of improved maize varieties, later expanding to include pasture species, vegetables, sorghum, millets, and root and tuber crops. Assistance to the maize research program included taking over the payment of Ristanovic's salary and operational support. Beyond the purification of Zambian SR52, Ristanovic and his counterparts sought to develop new hybrids and varieties that were earlier maturing, more drought tolerant and disease resistant than SR52. The breeders aimed for varieties that were better adapted to the needs of different categories of farmers in Regions I, II and III (Erikson et al. 1989:iv).

Perhaps the most serious problem confronting small farmers interested in planting commercial maize varieties was the long growing period that necessitated early planting. In reality, Zambian small farmers tend to plant commercial maize late, for several good reasons. If they are using hand hoes, it is extremely difficult to prepare the fields before the first rains, since the surface is very hard after seven to eight dry months. Also, if farmers hoe early in the season, the weeds return a second time. Farmers usually wait to plant commercial maize until after local maize and the other family subsistence crops have been planted. Late planting carries a high cost, however. Late planted maize is vulnerable to maize streak virus, especially in wetter areas such as Region III. Most important, researchers estimate that farmers lose 1-2 per cent of maize yield for each day of delay (Gibson, personal communication, 1993).

To meet these needs, seven shorter-season hybrids (tolerant of late planting) were developed and released between 1984-88: MM501, MM502, MM504, MM601, MM603, MM604, and MM612. The characteristics of these varieties are described in Table 4. Breeders have continued to advance in this area: in 1992, an extremely short-season hybrid, MM414, was released.

Concurrent with its support for maize breeding, SIDA was instrumental in providing extensive funding and technical assistance to the Zambian seed industry. A semi-commercial company, Zambia Seed Company (Zamseed), was organized in 1981 with GRZ, Zambia Seed Producers' Association (ZSPA), Zambia Cooperative Federation (ZCF), Svalöf (a Swedish seed company) and Swede Fund as the major shareholders. The general objectives of the seed company were to organize the multiplication of seed varieties developed by the Research Branch and to carry out their processing, storage and distribution to farmers. Zamseed produces and distributes a variety of seeds, including potatoes, sorghum, vegetables, pasture, wheat, soybeans, and sunflower, but sales of maize seed constitute most of the product volume (70 per cent in 1988-9) and the major source of revenue (60 per cent in 1988-9). SIDA also provided major funding, technical assistance and training for strengthening MAFF's SCCI, and for the central and provincial ARPTs (Erikson et al. 1989).

Total SIDA expenditures on agricultural research and the seed industry between 1979-91 are estimated at USD 30.1 million. Of this total, expenditures related to maize research are

estimated at USD 6.9 million, and maize-related expenditures for the seed industry at USD 9.8 million. Complete information on maize research and seed expenditures by SIDA, and maize research expenditures by GRZ, is presented in Appendix 6.

4.5. USAID support for maize research

A USAID project, Zambia Agricultural Development, Research and Extension (ZAMARE), was carried out between 1982-88 at a total cost to USAID of USD 12.5 million, of which an estimated USD 3.1 million was spent on maize-related research (Appendix 6, Table 31). ZAMARE provided long-term technical assistance to three CSRTs: a maize breeder, a sunflower agronomist and a soybean breeder. An agronomist, economist and a research-extension liaison officer were also provided to help establish Zambia's first ARPT, in Central Province.

The SIDA-funded researchers and the ZAMARE maize team cooperated, informally agreeing that Dr. Ristanovic would continue to concentrate on hybrid breeding, while the principal maize breeder assigned to ZAMARE, Dr. P. Gibson, focused on open-pollinated maize. Gibson, with his counterparts, identified and released two open-pollinated maize varieties based on genetic material from CIMMYT and Tanzania, MMV400 and MMV600 (Table 4). MMV400 was developed as a fast-maturing, drought-tolerant variety suitable for low-rainfall areas. In other areas, it has grown in popularity as an early food source during the hungry period between January and April. MMV600 is a medium long maturing, streak virus-resistant variety suited for all regions, particularly Regions III and II (Gibson 1986). Unlike hybrids, the seed of open-pollinated varieties may be replanted in successive seasons without significant degeneration of varietal characteristics.

Dr. Gibson also established close links with the provincial ARPTs and was instrumental in ARPT testing of the new hybrids as well as the open-pollinated varieties, and in promotion of the new hybrids among commercial farmers. He and his counterparts developed a commercial farm maize variety demonstration plot and reactivated national variety trials throughout Zambia.

ZAMARE provided masters-level training for three of the principal Zambian breeders, besides short courses and in-country training for other staff conducted with CIMMYT, and on-site training by Dr. Gibson and the American maize breeders who succeeded him, Drs. Meyers and Harada (Gibson 1986). The ZAMARE breeders and their counterparts worked extensively in population improvement, toward the development of additional open-pollinated releases. However, although the project received a positive evaluation from USAID (USAID 1988), an anticipated Phase II of the project was unexpectedly canceled in 1988. Some linkages continued between the ZAMARE technical assistance staff and Zambian staff from 1988-90 under the program ZAMLINK, which provided limited funding for in-country workshops and exchange visits (USAID 1988,1991).

After ZAMARE ended, the open-pollinated maize breeding work was assumed by the FAO-managed project, but discontinuities in breeders and methodologies, combined with coordination

problems with the hybrid group, have hampered its progress. No new open-pollinated varieties have been released since 1984.

Table 4: Characteristics of Zambian maize hybrids and varieties

Type and year released	Days to maturity	Yield in tons/ha[a]	Target area	Characteristics
MM501 1984	130-135	6.0	Regions I, II	Single cross, white semi-dent; drought tolerant; mod. resistant maize streak virus (MSV), rust, blight, cob rot
MM502 1984	140-145	7.5	Regions II, III	Single cross, white semi-dent; multiple cobs; high resistance MSV; mod. resistance blight, cob rot
MM504 1984	135-140	6.5	Region I	Three-way cross, white dent; drought tolerance; good resistance lodging; mod. res. MSV, rust, blight, cob rot
MM601 1984	140-145	7.5	Regions, II, III	Single cross, white semi-dent; mod. drought tolerance; resistance blight, rust, MSV, cob rot
MM603/604 1984	145-150	7.0	Regions II, III	Three-way cross, white dent; multiple cobs; high resistance MSV, resistance blight, rust, cob rot
MM752 1984	160-165	8.0	Regions II, III	Single cross, white dent; susceptible lodging, MSV; mod. resistant rust, blight
MM612 1988	155-160	7.0	Regions II, III	Double cross, white dent; resistant MSV
MMV600 1984	150-160	4.0-5.0	Regions I, II, III	Open-pollinated, white flint; resistant lodging, rust, blight, MSV
MMV400 1984	120-125	2.5-3.5	Region I	Open pollinated, white flint; resistant blight

Sources: Zamseed Maize Production Guide; Ministry of Agriculture, Food and Fisheries Guide to Commercial Crop Production; D. Ristanovic, personal communication, 1992

[a] Research station yields under medium levels of management.

4.6. Food and Agriculture Organization (FAO)

FAO began providing technical assistance to the maize research program in 1978, with funding from the Norwegian Trust Fund and the UNDP. The initial focus of the work was plant protection. In Phase I, "Control of Maize Diseases," FAO provided technical assistance, including a long-term plant pathologist, Dr. K.N. Rao (who also assisted the sorghum pathology program), and several agronomists. They studied the epidemiology and biology of causal agents for two important maize problems, cob rots and maize streak virus, and developed screening methods to identify resistant germplasm. The project also provided long and short-term training for Zambian counterparts (FAO 1990).

Phase II, "Development of Pest and Disease Resistant Maize," began in 1983 and continued through 1988, after which maize research activities were continued through the FAO-administered UNDP Maize and Bean Research Project until 1992. After 1983, Rao and his counterparts began to get more directly involved in maize breeding. The FAO-funded researchers initially screened germplasm for disease resistance to feed into the hybrid and open-pollinated breeding program being supported cooperatively by SIDA and USAID, and three of the hybrids and one of the two open-pollinated cultivars released in 1984-88 had high resistance to maize streak virus (Table 4). However, the FAO project eventually evolved into a separate and somewhat competitive open-pollinated and hybrid breeding program, especially after the USAID-funded project ended in 1988 and an FAO-funded breeder was added to the team. Total expenditures by these FAO-funded agricultural research projects from 1978-92 are estimated at USD 2.6 million, of which USD 2.1 million were maize-related (Appendix 6, Table 33).

4.7. CIMMYT'S contribution to Zambian maize research

CIMMYT has promoted maize research in Zambia since 1980, providing assistance in several areas. First, the CIMMYT Maize Program was the most important source of germplasm for the open-pollinated development program. The two open-pollinated varieties released by the Zambian program in 1984, MMV400 and MMV600, were based on populations provided by CIMMYT, Pirsabak (2) 7930 and EV 8076. Improvement of these and other populations originating from CIMMYT continued under the ZAMARE and FAO/UNDP projects (Gelaw, personal communication, August 1991; Gelaw 1985:220; Meyers 1988).

Second, staff members from CIMMYT headquarters in Mexico and the regional program office in Harare have played an ongoing consultative and training role in the Zambian maize

program. ZAMARE maize breeders spent several days with researchers at CIMMYT headquarters in Mexico before starting work in Zambia. CIMMYT Maize Program staff members have visited Zambia 5-6 times per year for consultation, program planning and in-country training of Zambian maize scientists. Several regional maize workshops were organized by CIMMYT in the 1980s and attended by Zambian scientists. Ten Zambian researchers were sent to Mexico for a month of training at CIMMYT headquarters, and others were trained at the regional office in Harare.

Finally, CIMMYT Economics Program staff members were instrumental in helping the Research Branch carry out initial preparatory studies, and design and set up the ARPTs. CIMMYT staff continued to provide technical assistance and some funding for ARPT activities through the early 1990s. Total maize research-related expenditures by CIMMYT are estimated at USD 860,000 (Appendix 6, Table 34).

5.0. POLICY AND ORGANIZATIONAL CONTEXT

The shift of maize production from large to smaller farmers, and from line-of-rail to more distant areas, was stimulated by a set of conscious government investment and pricing policies since independence that incorporated both production and equity objectives. These policies aimed, first, to increase domestic maize production in order to supply the densely-populated urban mining areas with cheap maize meal. A second objective was to reduce reliance on the European commercial farmers by increasing the participation of African farmers in commercial agriculture, raising rural incomes at the same time. A third objective was the improvement of regional equity by increasing the market involvement of farmers in less agriculturally advanced provinces (Wood 1990: 23).

5.1. Marketing and pricing policy

Marketing of the major crops (including maize, tobacco, cotton, wheat) and fertilizers has been managed by a parastatal monopoly in various manifestations since independence. At independence, the Grain Marketing Board (GMB) and the Agricultural Rural Marketing Board (ARMB) were established and charged with marketing agricultural produce and eventually agricultural inputs along the line of rail (GMB) and rural areas (ARMB). These were merged in 1969 to form the National Agricultural Marketing Board (NAMBOARD), which was given a monopoly in the purchase, sale, import, export and storage of maize and other controlled crops and fertilizers. NAMBOARD was also responsible for maintaining marketing outlets in surplus regions and ensuring supply in deficit regions.

For these major crops, producer prices have been kept below border-equivalent prices, while retail prices have been kept below production and marketing costs, resulting in an increasing subsidy bill for the government. Besides the controlled producer price, maintenance of a uniform price country-wide and through the whole season has contributed to the shift of maize production to more remote areas. Before 1971 there were regional differences in producer prices that reflected differences in transport cost. In 1972, pan-territorial and pan-seasonal pricing for maize was adopted, and uniform pricing of other controlled crops and fertilizer followed (Jansen 1988:47).

In 1972, the marketing of some crops, but not maize, was decontrolled so that the government established only a commodity floor price. Later, NAMBOARD took on more responsibilities, marketing additional crops and distributing inputs such as seeds, chemicals and implements. NAMBOARD's problems began to mount over time, as it was obligated to buy and sell at government-determined prices that did not cover its handling and transportation costs. The agency became more and more dependent on government subsidies to sustain its maize marketing services. Disbursement of these subsidies was frequently delayed, so that NAMBOARD was unable to meet its outside financial obligations to suppliers, and thus obtain and distribute inputs, or collect and pay for maize, on time (Nakaponda 1992:53).

Provincial Cooperative Unions (PCUs) were formed in 1981 and functioned as branches for NAMBOARD in an attempt to improve marketing services. Although the government shifted marketing responsibilities back and forth between the two organizations, the problems of dependency on subsidies, delayed payments, inefficient operations and financial mismanagement persisted. NAMBOARD was dissolved in 1989, and its inter-provincial grain marketing responsibilities were transferred to Zambia Cooperative Federation (ZCF), while PCUs continued to market maize intra-provincially, serve as buyers of last resort for other crops, and distribute seed and fertilizer (Nakaponda 1992:53-4).

The familiar problems reappeared despite the new arrangements. In 1991 the government liberalized maize marketing, permitting participation by private traders for the first time. However, since consumer meal prices were still heavily subsidized, the margin for potential private traders was not attractive and the state was left with its monopoly virtually intact. It was not until 1993 that the government began to withdraw from participation in maize marketing except as a buyer of last resort, and most consumer meal subsidies ended.

5.2. Fertilizer policy

While low controlled producer prices and inefficient marketing arrangements discouraged maize production, especially by line-of-rail commercial farmers, generous subsidies on fertilizer encouraged it. The subsidies began in 1971, when the government cut all fertilizer prices by an average of 30 per cent of landed cost. During the early 1970s, the distribution network was expanded so that fertilizer was more accessible to farmers in remote areas. A further incentive for use came in 1974 when pan-territorial pricing for fertilizer was introduced. The subsidy was reduced to 15 per cent of landed cost for the next four years, then increased again in 1975 and 1978. By 1982, the average subsidy was 60 per cent (Jansen 1988:71). Since 1988, GRZ has reduced the fertilizer subsidy substantially, and it is the policy of the current government to discontinue it completely.

The subsidies and wider availability of fertilizer after independence rapidly increased the use of chemical fertilizers. At independence, an estimated 30 metric tons of fertilizer were being used annually. By 1976, this had expanded to 150,000 tons and, by 1987, to 243,000 tons (GRZ 1989:5; McPhillips and Wood 1990:92-30).

5.3. Credit

Zambia's agricultural credit system has two components: one, operated by the private commercial banks, lends primarily to large-scale commercial farmers; the second is a publicly supported small-scale farmer credit system that is heavily reliant on government subsidies. Large-scale commercial farmers can secure short, medium, and long-term credit and use short-term credit for a variety of crops. However, maize is frequently the only crop for which small and medium-scale farmers can secure credit, except in some areas where credit for cotton and soybeans is available. About 90 per cent of credit to small-scale farmers is used for maize inputs (GRZ 1991b:15).

The three major sources of credit for small-scale farmers are the Credit Union and Savings Association (CUSA), Lima Bank and Zambia Cooperative Federation-Financial Services (ZCF/FS). Loanable funds for these agencies are provided by the government and donors. Groups of small-scale farmers receive credit as fertilizer and inputs and sign a note authorizing the local depot to deduct the repayment from the sale of the harvest. Abouut 25 per cent of the estimated 576,000 small and medium farm households receive loans each year (GRZ 1991b:21-26).

The small-scale credit system started to break down in the late 1980s. A drought in 1989-90 reduced loan recoveries from the previous two seasons' average of 91 per cent to 44 per cent.

At the same time, inflation increased to more than 100 per cent. The combination led to a gap of ZK 2.5 billion between funds required and funds recovered from previous loans and contributed to the decline in maize plantings by small-scale farmers. These credit problems snowballed through the whole production system; credit disbursements were delayed because of the slow pace of recoveries and fertilizer was released late to farmers, sometimes well after planting (GRZ 1991b:18-19).

5.4. Extension

Extension services in Zambia are primarily the responsibility of the Extension Branch of the Department of Agriculture, MAFF. The Department of Agriculture adopted the Training and Visit system as the principal extension methodology in 1978. The Extension Branch is headed by the Assistant Director of Agriculture/Extension, who is supported at the national level by seven senior Subject Matter Specialists (SMS). Provincial Agricultural Officers (PAOs) are responsible for all agricultural development activities at the provincial level. Below the provincial level, District Agricultural Officers (DAOs) supervise district-level agricultural activities, supported by Subject Matter Specialists. These officers oversee the Block Supervisors and Camp Extension Workers, who are in day-to-day contact with farmers. Six to eight camps make up a block, with 5-8 blocks per district. By 1984, there were 1500 extension workers at 1100 blocks across the country Regular farmer contacts with extension agents are supplemented with training offered at a network of provincial farm institutes and district farmer training centers developed beginning in the 1960s and 1970s (Lof and Mulele 1990:346).

Table 2 shows that the acceleration of maize area and production began in the late 1970s, before the release of improved Zambian varieties, and continued through the 1980s. The Department of Agriculture's Lima Program, starting in 1980, played an important role in introducing small farmers to commercial maize production and more efficient use of purchased inputs, especially fertilizer. Although fertilizer use among small farmers increased dramatically during the 1970s, researchers and extensionists were concerned that farmers were using it inefficiently, without using the recommended application rates. The introduction of the metric system in the late 1970s and the changes in recommendation units to hectares and kilograms caused further confusion.

The Lima (meaning to hoe or cultivate) Program was introduced to make it easier for small farmers to understand and apply fertilizer recommendations. First, recommendations were scaled to a smaller area. One lima represented one-quarter of a hectare. Extensionists then distributed lima packages, which included a 25-meter rope, marked at meter intervals to aid crop spacing, and a plastic 500 gram beaker to measure fertilizer. The system was designed so

that farmers could apply one to two standard bags of fertilizer (50 kg) to one lima depending on the formulation. Lima crop memos suggesting appropriate fertilizer application levels in terms of the rope and beaker system were developed for each province (McPhillips and Wood 1990:94-95).

6.0. IMPACTS OF INVESTMENTS IN MAIZE RESEARCH AND DISSEMINATION, PART ONE: TECHNOLOGY ADOPTION AND RATE OF RETURN RESULTS

6.1. Results from the MSU/MAFF/RDSB Small/Medium Farmer Maize Adoption Survey

6.1.1. Socio-economic characteristics

The MSU/MAFF/RDSB survey team interviewed 462 farmers between April-July 1992. After data cleaning, 433 responses were considered valid and used in a preliminary descriptive analysis of the sample. Of the 433 farmers, 109 were from Region I, 220 from Region II, and 104 from Region III (Table 5). All of the respondents had grown local or improved maize at some time, and more than half said they had planted a Zambian improved maize variety[6] in at least one season. The proportion varied by region: less than a third of Region I farmers had tried an improved variety, while over half in Region III and almost two-thirds in Region II had done so. Most farmers who tried improved maize continued to use it in successive seasons; improved maize users had been planting these varieties for four seasons on average.

[6]"Zambian improved varieties" refers to the Zambian varieties and hybrids described in Table 4: MM501, MM502, MM504, MM601, MM603, MM604, MM752, MM612, MMV600 and MMV400.

Table 5: Socio-economic characteristics of small-and medium-scale farmers

	Region I	Region II	Region III	Total	Imp. maize adopters	Non-adopters
Number of respondents	109	220	104	433	237	195
Have ever grown maize (local or improved)(%)	100.0	100.0	100.0	100.0		
Have grown improved maize at least one season (%)	32.4***	64.5***	57.7***	54.9		
Avg. farm size (ha)	2.24***	4.05***	2.56***	3.23	4.56***	1.64***
Sex of respondent(s)						
Male (%)	57.9	63.6	62.5	61.9		
Female (%)	36.7	30.5	34.6	33.0		
Both (%)	5.5	5.9	2.9	5.1		
Mean no. of persons in household[a]	6.6***	8.4***	6.3***	7.4	8.6***	6.1***
Mean no. of persons in household under age 15	3.2	3.9	3.5	3.7	4.2***	3.0***
Mean grade in school completed (respondent)	4.3*	5.0*	5.8*	5.0	5.9***	3.9***

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992
[a] Defined as eating from the same pot daily
* $p < .05$
** $p < .01$
*** $p < .001$

Average total farm size was slightly over three hectares, and differed between regions, with smaller farms in Regions I and III (Table 5). Size differed significantly between improved maize adopters and non-adopters. Non-adopters had farms averaging 1.6 hectares, and adopters' farms were 4.6 hectares on average.

Almost two-thirds of the survey respondents were men, and one-third were women (Table 5). The mean number of persons living in sample households was 7.4, with an average 3.7 persons under the age of 15. Households were smaller in Regions I and II than Region III. Respondents on average had completed five years of school. Differences between adopters

and non-adopters were highly significant for these variables, with non-adopters having smaller households and less education than adopters.

Half the farmers in the sample used hand hoes as their sole means of land preparation (Table 6). Almost 90 per cent of Region III farmers said they used only hand hoes, a far greater proportion than Regions I and III, where 59 and 34 per cent respectively used only hand hoes. One-third of the sample farmers cultivated their fields mainly with oxen, with the greatest concentration of oxen-users in Region II. Ten per cent of farmers used a combination of hand hoe and oxen.

Table 6: Means of cultivation

(per cent of all farmers)

Method of cultivation[a]	Region I	Region II	Region III	All regions
Hand hoe only	58.7	34.4	89.2	53.6
Oxen only	30.3	51.8	4.9	35.2
Tractor only, or combination of tractor and oxen or hand hoe	3.7	2.3	0.0	2.1
Hand hoe and oxen	7.3	11.5	5.9	9.1
Total	100.0	100.0	100.0	100.0
n	109	218	102	429

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992

[a] In general, differences in field preparation methods between improved maize adopters and non-adopters were significant at $p < .001$. Non-adopters were more likely than improved maize adopters to be hand hoe users. Differences between regions were significant at $p < .001$.

Table 6 shows the proportions of farmers in each region using different means of land preparation. When proportions of land area prepared using hand hoe, oxen, or a combination are compared (Table 7), oxen use predominates in Regions I and II. Over the whole sample, 61.3 per cent of the field area was prepared with oxen, and 31 per cent of the land was cultivated with hand hoes.

Table 7: Land area cultivated by different methods

(per cent of farm area)

Method of cultivation	Region I	Region II	Region III	All regions
Hand hoe only	40.8	15.4	82.3	31.0
Oxen only	51.1	76.7	11.4	61.3
Tractor only	.3	1.8	0.0	1.3
Hand hoe and oxen	6.4	4.1	6.4	4.9
Hand hoe and tractor	.7	0.0	0.0	0.1
Oxen and tractor	0.0	1.6	0.0	1.1
Hand hoe, oxen and tractor	.7	.3	0.0	.3
Total	100.0	100.0	100.0	100.0

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992

6.1.2. Maize area as a proportion of total farm area

Improved maize users were asked to recall their cropping patterns during the period 1983-92[7]. They reported planting an average of 64 per cent of their farm area in maize, both improved and unimproved varieties[8], in 1991 (Table 8). Table 9 traces the proportion of farm area planted to improved and unimproved maize in successive seasons, by farmers who first adopted improved varieties in 1984. Comparing the proportion of total farm area planted to maize in the 1983 season (pre-adoption), with area proportions in successive seasons shows no significant differences. This seems to suggest that although adopters may have substituted improved for unimproved maize varieties, they did not generally replace non-maize crops with maize.

[7] Appendix 1 contains details of techniques used to elicit information on cropping patterns from sample farmers.

[8] "Unimproved varieties" refers to local varieties, SR52, as well as a number of Zimbabwean hybrids used by Zambian farmers: CG4141, PNR473, R201, R215, ZS 206, and ZS225.

Table 8: Proportion of total farm area planted in maize (improved and local) by improved maize adopters, 1991

	Region I	Region II	Region III	All
Maize area/total farm area (%)[a]	62	66	59	64
n =	33	136	50	219

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992.
[a] Regional differences were not significant at $p < .05$.

Table 9: Proportion of total farm area planted in maize before and after adoption[a]

Year	Mean proportion of total farm area planted in maize (improved and unimproved)[b] (%)	n
1983 (pre-adoption)	65	27
1984	68	33
1985	70	32
1986	67	33
1987	65	32
1988	64	32
1989	62	32
1990	64	33
1991	57	30

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992
[a] By farmers adopting improved maize in 1984
[b] Differences between per cent of farm area planted to maize in 1983 (pre-adoption) and successive years were not significant at $p < .05$.

6.1.3. Area and rate of improved maize adoption by small/medium farmers

Survey results suggest that adoption of improved maize varieties by small and medium-scale farmers was rapid and extensive following their introduction in the 1984-5 season. Improved varieties were planted on .8 per cent of small/medium maize area in 1984-5, the first year that MM752 was available in limited quantities (Table 10, Figure 7). In the following season, almost a quarter of maize area was planted in improved maize. By 1988-89, Zambian

improved varieties were planted on almost half the total small/medium maize area, and the proportion had climbed to almost 60 per cent by 1991-92.

Adoption rates differ dramatically between regions (Table 10, Figure 7). In 1991-2, improved maize was planted on almost three-quarters of maize area in Region II, but less than a quarter of Region I maize area was improved, and less than 40 per cent of Region III area. Also, while adoption rates in Region II have continued to grow, in Regions I and III adoption peaked in 1989-90 and has since declined. Possible explanations for the declining rate include higher fertilizer prices and increased difficulty in obtaining credit and securing inputs on time in more remote areas beginning in the late 80s.

MSU/MAFF/RDSB adoption rates differed slightly from those estimated in a study of hybrid maize adoption in Eastern Province carried out in 1985-6 (Jha et al. 1991). That study estimated hybrid maize adoption to be 42.7%, 34.4% and 31.1% in Region 2 sites and 3.2% in Region 1 sites. MSU/MAFF/RDSB adoption estimates for the 1985-6 season were 29% in Region and 7% in Region 1. However, the Jha et al. study included adoption of SR52 and Zimbabwean hybrids in addition to Zambian improved hybrids.

Table 10: Small and medium farmer adoption of improved maize, 1983-92

(per cent of total small/medium maize area)

	83-84	84-85[a]	85-86	86-87	87-88	88-89	89-90	90-91	91-92
Region 1 n=111	0	n/a	7.0	18.9	12.4	16.4	25.2	22.4	23.6
Region 2 n=225	0	n/a	29.0	40.6	49.0	58.8	62.7	69.0	71.9
Region 3 n=97	0	n/a	19.1	26.6	35.2	27.5	44.0	37.6	38.1
Total n=433	0	.8	23.4	34.6	40.7	47.0	53.0	55.1	58.6

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992, except 1984-5, based on Zamseed sales estimates

[a] Survey results showed much higher rates of adoption than were possible given Zamseed sales of improved seeds that season (see Appendix 10, Table 59). Farmers interviewed may have confused SR52 and MM752, both of which were available in 1984-5. Adoption estimates for 1984-5 were based on Zamseed sales estimates.

6.1.4. Area and rate of improved maize adoption by all farmers

Adoption data from the small/medium farmer adoption survey were combined with available national data and other estimates of the division of maize area and production between large and small/medium farmers, to estimate the total proportion of maize area

Figure 7: Small and medium farmer adoption of improved maize

in Zambia planted in improved varieties. Table 11 summarizes the estimates of small/medium and large farmer maize area, production and yields.

Table 11: Maize area and production by farmer category, 1983-92

Year	Area (ml. ha)	Production (ml. tons)	Yield (tons/ha)
1983-84 total	.564	.93	1.65
large	.06	.330	5.5
small,medium	.504	.600	1.19
1984-85 total	.576	1.214	2.11
large	.06	.362	6.03
small,medium	.516	.852	1.65
1985-86 total	.532	1.427	2.68
large	.06	.384	6.39
small,medium	.472	1.043	2.21
1986-87 total	.659	1.003	1.52
large	.06	.362	6.03
small,medium	.599	.641	1.07
1987-88 total	.692	1.834	2.65
large	.06	.362	6.03
small,medium	.632	1.472	2.33
1988-89 total	.797	1.997	2.5
large	.06	.362	6.03
small,medium	.737	1.635	2.22
1989-90 total	.668	1.464	2.19
large	.051	.307	6.03
small,medium	.617	1.157	1.87
1990-91 total	.579	1.448	2.5
large	.044	.266	6.03
small,medium	.535	1.182	2.21
1991-92 total	.477	.515	1.08
large	.06	.362	6.03
small,medium	.417	.153	.37

Sources: Totals, all years, from Central Statistical Office Crop Forecasting Survey results. 1989-90, 1990-91 data for large, small/medium farmers from Central Statistical Office data. Other years are estimated based on Gibson (1987).

The estimated total maize area in Zambia, including local, improved and imported varieties, was 564,000 hectares in 1983. Total maize area climbed to almost 800,000 hectares in the late 80s, but has declined since then, probably due to the combined disincentive effects of low

producer prices, higher fertilizer prices, lack of credit and an increasingly unreliable input delivery and product marketing system.

Table 12 combines adoption data from all farmer groups to estimate total improved maize area from 1983-92, and projected area from 1993-2001. Estimates of large farmer maize area planted in improved varieties are based on responses to the mail-in questionnaire distributed to large maize farmers, and Zamseed sales records (Appendix 10). More than 60 per cent of maize area was planted in improved varieties by the 1991-2 season. The total improved maize area increased by more than two-and-a-half times between 1985-6 and 1988-9, but has declined with overall maize area since 1989.

As a check, adoption estimates from MSU/MAFF/RDSB survey data were compared to estimates based on Zamseed seed sales from 1984-92 (Table 13). Improved maize area

Table 12: Improved maize adoption 1983-92, and projected rates of adoption, 1993-2001

Season	83-4	84-5	85-6	86-7	87-8	88-9	89-90	90-1	91-2	92-3	93-01
Zambian improved maize area,lg farmers[a,b] ('000 ha)	0	7.92	47.34	55.02	53.04	49.80	33.84	37.38	44.94	46.32	46.32
Zambian improved maize area, sm/med farmers[c] ('000 ha)	0	3.92	110.59	207.01	256.96	346.46	327.24	294.65	244.66	257.97	257.97
Total, Zambian improved maize area ('000 ha)	0	11.84	157.93	262.03	310.00	396.26	361.08	332.03	289.60	304.29	304.29
Total maize area[d] ('000 ha)	564	575.6	532.4	659	691.5	797.3	667.9	578.8	477.3	500	500
Improved maize/ total maize area (%)	0	2.06	29.66	39.76	44.83	49.7	54.06	57.37	60.67	60.86	60.86

[a] Allocation of maize area between large and small/medium farmers is based on CSO estimates for 1989, 1990, and estimates in Gibson (1987) for other years.

[b] Estimates of large farmer area planted to improved varieties are based on Zamseed sales records (Appendix 10, Tables 57-66)and MSU/MAFF/RDSB Maize Adoption Survey for 1978-91. 1992-2000 projections are based on 1991 data.

[c] MSU/MAFF/RDSB Maize Adoption Survey data were used to allocate total maize area between different varieties between 1978-91. Projections for 1992-2000 were based on 1991 data.

[d] Central Statistical Office estimates, 1983-92.

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was roughly estimated, assuming that each bag of seed maize is sufficient to plant two hectares of land (personal communication, Gibson, 1993). In general, MSU/MAFF/RDSB survey data were comparable to the estimates based on seed sales, except in the 1984-5 season. Survey data estimates of improved maize area were almost six times greater than the seed-derived estimate, possibly because sample farmers confused MM752 with SR52, both of which were available in 1984-85. For that season only, the seed-derived estimate was substituted for the MSU/MAFF/RDSB survey estimate.

Table 13: Comparison of estimates of area planted to improved maize varieties

Year	Total 50 kg bags of Zambian improved seed sold[a]	Estimated area planted in improved varieties[b] ('000 ha)	MSU/MAFF/RDSB estimates of area planted in improved varieties ('000 ha)
1984/5	5,924	11.84	11.84
1985/6	131,925	263.85	157.93
1986/7	174,297	348.59	262.03
1987/8	80,987	161.97	310
1988/9	179,669	359.34	396.26
1989/90	196,000	392	361.08
1990/1	149,600	299.2	332.03
1991/2	138,635	277.27	289.6

[a] Source: Zamseed records. See Appendix 10.

[b] Assumes that each bag of seed maize is sufficient to plant 2 hectares of land (personal communication, Gibson, 1993).

By any standard, the uptake of improved maize hybrids and varieties in Zambia has been fast and extensive. Zambia can be contrasted with Malawi, which is agro-ecologically similar but has never had more than 20 per cent of aggregate maize area sown to improved hybrids or open-pollinated varieties (Smale 1991). The only other countries in Eastern and Southern

Africa (excluding South Africa) which have such high adoption rates are Zimbabwe, where improved varieties are planted on almost all of the maize area, and Kenya, with improved varieties planted on 65 per cent of the total maize area. In Tanzania, Uganda and Ethiopia, improved maize is planted on only 17, 35 and 16 per cent of the total maize area, respectively (CIMMYT 1990).

6.1.5. Adoption of specific varieties

Zambian farmers were growing many different maize varieties at the time the improved varieties were released from the national maize program. Large farmers used SR52 and several hybrids imported from Zimbabwe, including CG4141, PNR473, R201, R215, ZS206, and ZS225. Small and medium farmers planted local varieties besides SR52 and Zimbabwean hybrids to a limited extent. Table 14 shows how the proportions of maize area planted to each of these variety categories changed between 1983-92.

Table 14: Proportion of maize area planted to different variety categories, 1983-92

(per cent of total large, small/medium maize area)

	83/4	84/5	85/6	86/7	87/8	88/9	89/90	90/1	91/2
Large Farmers									
SR52	87.0	87.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zimb. hybrids[a]	13.0	6.5	21.0	8.0	11.6	17.0	43.6	37.7	25.1
Zambian improved	0.0	6.5	78.9	91.7	88.4	83.0	56.4	62.3	74.9
Total	100.0	100.0	99.9	99.7	100.0	100.0	100.0	100.0	100.0
Small/ Med. Farmers									
Local	65.5	62.3	48.1	41.1	37.2	33.4	29.6	28.2	26.0
SR52	24.3	31.3	24.3	20.7	18.7	0.0	0.0	0.0	0.0
Zimb. hybrids	10.2	5.5	4.2	3.6	3.2	19.7	17.5	16.7	15.4
Zambian improved	0.0	.8	23.4	34.6	40.7	47.0	53.0	55.1	58.6
Total	100.0	99.9	100.0	100.0	99.8	100.1	100.1	100.0	100.0

Sources: Estimates of large farmer area planted to specific varieties are based on Zamseed sales records (Appendix 10) and MSU/MAFF/RDSB Large Farmer Maize Adoption Survey results. Allocation of maize area for small/medium farmers is based on results from the MSU/MAFF/RDSB Small/Medium Farmer Maize Adoption Survey.

[a] Zimbabwean hybrids refer to CG4141, PNR473, R201, R215, ZS206, and ZS225.

Among the Zambian improved varieties, MM604, MM603 and MM752 have been the most widely adopted releases. These three hybrids together accounted for almost 80 per cent of all maize seed sold by Zamseed in 1991 (Appendix 10, Table 66). The success of these hybrids, especially MM603 and MM604, is partly due to their high yields and wide adaptability across agro-ecological regions. Also, as Figure 8 shows, Zamseed has increasingly focused seed production on the triple-cross hybrids, MM504, MM603 and MM604. Seed for three-way cross hybrids is cheaper to produce than seed for single cross hybrids, which dominated seed sales in the early to mid-80s, or for open pollinated varieties (CIMMYT 1987).

Figure 8: Shares of single-, double-, triple-cross hybrids and open pollinated varieties in Zamseed sales 1983-92

The selection of maize seed hybrids and varieties available to Zambian farmers has progressively narrowed since 1986 (Appendix 10). The open-pollinated varieties that were the products of the USAID-funded maize research program have not been widely adopted, but have not been widely available, either. Sales of MMV400 and MMV600 peaked in 1986, when they represented nine per cent of total maize seed sales, but have declined since. In 1991, combined sales of the two varieties were only three per cent of total maize seed sales. However, the open-pollinated varieties, especially MMV600, have been popular exports. Since 1987, Zamseed has sold over 40,000 bags of primarily open-pollinated maize seed to Mozambique (Zamseed 1991).

6.1.6. Yield improvement

Estimating the yield improvements gained from farmer adoption of improved maize varieties was one of the most difficult tasks of the study. Yields from on-station trials, presented in Table 4, are obtainable only under medium to high levels of management. While it may be reasonable to assume that large-scale farmers can approach these yields, they are not good estimates of yields under small- and medium-scale management. On-farm trials of the new varieties were carried out by ARPTs in Northern, Eastern and Central Provinces, but the results were extremely variable.

Based on conversations with maize researchers and commercial farmers, the average yield obtained by large farmers using improved varieties was estimated at just over six tons/ha. Estimates of small/medium farmer yields obtained by MSU/MAFF/RDSB survey participants were calculated by summing reported maize retentions and sales and dividing by area planted. Table 15 compares the survey results from estimates of small/medium farmer yields based on CSO production and area estimates. CSO estimates are based on farmer self-reporting of area planted and production, and data from official grain marketing agencies.

Table 15: Comparison of small/medium yield estimates from MSU/MAFF/RDSB Maize Adoption Survey and CSO

tons/ha

	82/3	83/4	84/5	85/6	86/7	87/8	88/9	89/90	90/1	91/2
MSU/ MAFF/ RDSB Survey estimate	n/a	n/a	2.22	2.3	2.36	2.2	2.18	2.24	2.12	n/a
CSO estimate[a]	1.81[b]	1.19	1.65	2.21	1.07	2.33	2.22	1.87	2.21	.37

[a] See Table 11
[b] Estimated from CSO survey of non-commercial farms, 1982/3, 1983/4

MSU/MAFF/RDSB survey estimates were slightly higher than the CSO estimates for most seasons. The more conservative CSO estimates were used in the ROR estimation. The data suggest a general increase in yield levels beginning in the 1985/6 season, when most of the new hybrids and varieties became available. Yields rose from 1.6-1.8 tons/ha to 2.0-2.2 ton/ha, an increase of about 20 per cent, and have fluctuated around this level since.

Calculation of the ROR required an estimate of the yield differences between the improved varieties and other categories of maize, i.e., local, SR52 and Zimbabwean hybrids. The yield advantage of improved Zambian varieties over SR52 was estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties indicated that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson estimated that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms (personal communication, 1993). Based on these estimates, it was assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.

The gap between yields achieved by small/medium farmers compared to large farmers is partly attributable to the more limited access to fertilizer and weaker management skills of the former. Shortage of labor is particularly constraining on smaller farms, and there is a tendency for farmers to plant more land than they can adequately weed. Another factor contributing to lower yields is the tendency among some small farmers to replant part of their hybrid seed rather than purchasing it fresh each season.

6.1.7. Why do small/medium farmers adopt improved maize?

When small/medium farmers were asked why they decided to grow improved maize varieties, they consistently cited high yields and early maturity as the most influential factors across all regions (Table 16). The importance of improved maize as a source of cash and food, and particularly desirable characteristics, such as drought tolerance, size of seeds, or the size and number of cobs, were also frequently mentioned.

6.1.8. Sources of information about improved maize

Farmers named fellow farmers, extension workers, and primary cooperative society staff as their most important sources of information about improved maize (Table 17). Extension workers and other farmers were the most important sources in Regions I and III, while in Region II other farmers and cooperative staff were named more often. Farmers in Region II and Region I also got information about maize from radio programs.

6.1.9. Use of extension, credit, fertilizer and marketing facilities

The high proportion of contacts with extension, credit, fertilizer and marketing agencies reported by sample farmers who adopted improved maize supports the hypothesis that these complementary organizations played a critical role in the adoption decision process (Table 18). More than half of all farmers were visited at least once by an extension agent, and almost 75% in Region I. Half the farmers also reported receiving credit for maize during at least one season. More farmers in Region II received credit (55 per cent) than farmers in Regions I (38 per cent) and III (41 per cent). A striking proportion of farmers had used fertilizer on maize, over 90 per cent in both Regions II and III, and 57 per cent in Region I. Over two-thirds of the farmers reported selling maize after at least one season. This proportion was highest in Region I, where almost 80 per cent of farmers had sold maize, and lower in Regions I and III, where 58 per cent and 62 per cent of respondents had marketed maize, respectively. Regional variations in extension visits, fertilizer use and sale of maize were significant.

Table 16: Why small/medium farmers adopted improved maize

(per cent of farmers)

	Good yields	Early maturing	Source of cash	Food source	Drought tolerant	Cob or seed charac-teristic[a]	Other	n
Region I	31.4	25.7	17.1	8.6	8.6	0.0	8.6	35
Region II	40.4	21.3	11.3	2.8	5.6	4.9	13.7	141
Region III	45.0	20.0	6.7	6.7	0.0	1.7	19.9	60
All Regions	40.3	21.6	11.0	4.6	4.6	3.4	14.5	236

Source: MSU/MAFF/RDSB Maize Adoption Survey

[a] Desirable characteristics included heavy seeds, small seeds, large cobs, multiple cobs

Table 17: Sources of information about improved maize

(per cent of farmers)

	Extension worker	Other farmers	Primary coop society	Radio	Other	n
Region I	42.9	37.1	5.7	5.7	8.7	35
Region II	19.7	34.5	21.1	12.7	11.9	142
Region III	38.3	30.0	16.7	1.7	13.3	60
All regions[a]	27.8	33.3	17.7	8.9	12.3	237

Source: MSU/MAFF/RDSB Maize Adoption Survey

[a] Regional differences were significant at $p < .05$.

Table 18: Use of extension, credit, fertilizer, marketing facilities

(n in parentheses)

	Visited by an extension agent[a,b] (%)	Received credit[c,d] (%)	Used fertilizer on maize[e,f] (%)	Sold maize[g,h] (%)
Region I	73.7 (38)	38.2 (34)	57.1 (35)	57.6 (33)
Region II	44.4 (160)	55.3 (159)	94.4 (160)	78.8 (160)
Region III	55.6 (63)	41.3 (63)	92.1 (63)	61.9 (63)
All Regions	51.3 (261)	49.6 (256)	88.8 (258)	71.9 (256)

Source: MSU/MAFF/RDSB Maize Adoption Survey, 1992

[a] At least one visit from an extension agent.

[b] Regional differences were significant at $p < .001$.

[c] Received credit at least one season.

[d] Regional differences were not significant at $p < .05$.

[e] Used fertilizer at least one season.

[f] Regional differences were significant at $p < .001$.

[g] Sold maize at least once.

[h] Regional differences were significant at $p < .05$.

6.2. Rate of return (ARR) analysis

6.2.1. Financial (market) prices

Quantitative assessments of the costs and benefits of research and related investments were made by estimating the financial (market) value of the increased maize production (benefit), the additional production costs associated with the new technology and the costs of carrying out the various programs. The total estimated area under improved maize from 1983-2001 was shown in Table 12. The 1983-92 estimates are based on MSU/MAFF/RDSB Maize Adoption Survey data. For the 1993-2001 period, it is assumed that the adoption rate is constant at the 1991-92 level. This is probably a conservative estimate since there are already indications that liberalization of the maize market beginning in 1992 has motivated increased plantings of improved maize.

Estimates of the value of the increased maize production from 1978-2001 can be found in Appendix 3, Tables 27-29. Appendix 9 contains estimates of production costs for unimproved and improved maize varieties for small/medium and large farmers using hand hoes, oxen and tractors for cultivation. Estimated expenditures by GRZ and donors on maize research and the seed industry, maize extension, and maize marketing are detailed in Appendices 6,7 and 8, respectively.

6.2.2. Conversion of financial to economic prices

The financial values of these benefits and costs were then adjusted, using shadow prices, to reflect the true costs of the factors of production to society. These adjustments were necessary because of the presence of significant distortions in market prices through subsidies and taxes imposed by the government and artificially imposed official exchange rates.

Adjusting financial to economic prices involves deducting direct transfers such as taxes and subsidies, and loan receipts and repayments, and adjusting the prices of traded and indirectly traded goods. In the Zambia study, four steps were followed to convert financial to economic prices: (1) estimating the shadow exchange rate; (2) establishing what proportion of costs represent tradeable items; (3) converting that amount to local currency terms using the shadow exchange rate; and (4) estimating the import parity price for maize and other commodities such as fertilizer and seed whose market prices are significantly distorted, and substituting the import parity price for the market price in the economic analysis.

6.2.2.1. Shadow exchange rate

The cross-constant real ZK/USD rate is used as the shadow exchange rate (SER) to convert kwacha values into dollar values in the economic analysis. Calculation of the SER is shown in Table 23 (Appendix 2). This method for estimating the SER follows Harber (1991,1992). The SER is based upon purchasing power principles, using a projection of what was considered an appropriate exchange rate in September 1985. Harber (1991) calculated the "appropriate" exchange rate as follows:

> "The parallel rate in September 1985 was approximately ZK8/USD1. A general rule of thumb to use in estimating appropriate or equilibrium exchange rates is to deduct 20-30 per cent from parallel rates to remove the risk premium included in the parallel rate. Assuming a 25 per cent risk premium in September 1985, the "appropriate" exchange rate for that time is estimated at ZK6/USD1 or ZK6.17/SDR1. To arrive at the "appropriate" rate for other periods, this rate is adjusted according to movements in Zambia's consumer prices and the Industrial Country price index from International Financial Statistics to find the nominal exchange rate that would maintain a constant real exchange rate of ZK6/USD1 in September 1985." (Harber 1991:10).

The ZK/SDR rate is converted back to U.S. dollar terms using the USD/SDR exchange rate to arrive at the cross constant real ZK/USD exchange rate, used here as the SER. The cross constant exchange rate is used in order to eliminate the fluctuations of the USD against other (non-kwacha) currencies which would be reflected in a direct USD/ZK rate calculation.

The tables in Appendices 4,5,6 and 7 (GRZ and donor expenditures on maize research, the seed industry, extension, marketing, and production costs) show both financial and economic prices for expenditure items. Footnotes to the economic tables show the proportion of tradeable goods in each category that was converted to economic prices using the SER.

6.2.2.2. Import parity prices

The existence of both government subsidies and implicit taxes on maize means that the official maize price set by the government does not reflect the real resource cost of producing maize in Zambia. For the economic analysis, the import parity price of maize was substituted for the administrative price used in the financial analysis. Since Zambia was a net maize importer in most years between 1978-92, and the investments in maize research and dissemination were primarily intended to increase maize production for domestic consumption to replace imported maize, it is logical to use the import rather than the export parity price. The objective is to find

the price at which the import substitute can be sold domestically if it has to compete with imports (Gittinger 1982:80).

Calculation of the import parity price for maize is shown in Table 24 (Appendix 2). In non-drought years, Zimbabwe has been the principal supplier of imported maize to Zambia, and the FOB price at the point of export from the Zimbabwean depot closest to the Zimbabwe/Zambia border is used as the basis for the calculation. Transport and handling costs are added to arrive at the border price. Transportation to Lusaka, Ndola and Livingstone, and insurance and unloading costs, estimated at 10% of the border price, are added to get the CIF price at each of these major consumption centers. The financial transportation rates are adjusted to economic prices by assuming that 75% of the cost of rail and truck transport is composed of tradeable goods and valued at the SER.

The alternative to domestic production of maize is importing it (from Zimbabawe) and marketing it directly at one of the major consumption centers, Ndola, Lusaka or Livingstone. The price the Zambian farmer would receive is the price at the nearest marketing center minus the cost of transporting the maize from his farm gate to the market. Farmgate prices are estimated for each province, starting with the market price at the nearest major consumption center, and subtracting the costs of 100 kilometers of intra-provincial transport and handling, again assumed to be 10% of the border price. Finally, an average farmgate price for the country was calculated by weighting each province's farmgate price by its national market share for each year.

Table 25 (Appendix 2) shows the calculation of the import parity price for two of the most widely-used fertilizers for maize, Compound D and Ammonium Nitrate. The import parity price is used because Zambia is a net importer of fertilizer: the Nitrogen Chemicals of Zambia (NCZ) fertilizer plant supplies less than 50% of national requirements (GRZ 1989:200). Most of the commercial imports come from Europe. Starting from the CIF Lusaka price (available for 1988/89, and assumed constant for other years), the price of fertilizer at rural depots in each province was calculated by adding transport and handling costs (assumed to be 10% of the Lusaka CIF price) from Lusaka to each provincial capital plus 100 kilometers of intraprovincial transportation. A countrywide average rural depot price was estimated by weighting each province's depot price by its share of national fertilizer consumption.

Import parity prices for the most commonly used Zimbabwean short-season maize hybrids, R201 and R215, are calculated in Table 26 (Appendix 2). Border prices were estimated by adding transport and handling charges from the nearest Zimbabwean depot. A CIF Lusaka/point of sale price was obtained by adding the cost of rail transportation from the border to Lusaka, then estimating additional insurance, internal transport and unloading costs as 20% of the border

price. It is assumed that most imported seed is used in Central and Southern Provinces, within 100 kilometers of Lusaka.

6.2.3. Calculation of the economic rate of return

6.2.3.1. Benefit-cost method

Table 27 (Appendix 3) shows the calculation of the financial rate of return using the benefit-cost method. In Table 28 (Appendix 3), adjusted economic prices are substituted for the financial prices to calculate the economic rate of return. A stream of net benefits is obtained by subtracting total expenditures, including additional production costs, from the calculated gross benefit, which is the additional production value generated by the new technology and related investments, for each season. The internal rate of return (IRR) is the discount rate that just makes the net present value of the net benefit stream equal zero.

6.2.3.2. Akino-Hayami method (index number)

The Akino-Hayami (index number) and benefit-cost methods of estimating the ARR are similar, differing primarily in their treatment of supply and demand elasticities. Using the same production and economic price data as the benefit-cost approach, the Akino-Hayami method (Table 29, Appendix 3) explicitly incorporates supply and demand elasticities in the ARR estimate, while the benefit-cost method does not. This is equivalent to assuming that supply is perfectly inelastic and demand is perfectly elastic in the benefit-cost case. These assumptions are not valid in the Zambia case, where recent estimates suggest that consumer demand for maize is highly inelastic, and supply is somewhat elastic (Harber 1992, Nakaponda 1992).

Both methods are used in this analysis: the advantage of the Akino-Hayami method is the explicit incorporation of elasticities, while the benefit-cost tableau offers a more transparent view of the data and assumptions used in the analysis.

The net benefit stream for the Akino-Hayami method is derived in a slightly different way than in the benefit-cost case, and the results vary somewhat. Total benefits are the sum of areas A0C and ABC (Figure 3), with

area A0C calculated as:
K-factor * total production value,
where
K-factor = proportion of area planted in improved varieties * yield gain from improved varieties/improved varieties' yield;

and area ABC calculated as:
.5 * area A0C + K-factor * (1 + price elasticity of supply)^2/(price elasticity of supply + price elasticity of demand).

Net benefits are obtained (as in the benefit-cost approach) by subtracting total costs, including additional production costs, and costs of research, extension, seed industry, and marketing from gross benefits in each year, and an internal rate of return is generated.

6.2.4. Results of the economic rate of return analysis

A summary of the results of the economic rate of return analysis is presented in Table 19. Rates of return were calculated for two periods, 1978-91 and 1978-2001 (projected), under a variety of cost scenarios. Estimating the ROR under different cost conditions is a type of sensitivity analysis, to test the hypothesis that the rate of return is sensitive to the inclusion of costs other than research that are associated with the adoption of new technology.

When all costs were included in the analysis (additional production costs associated with the new technology, and maize-related costs of research, extension, seed industry and marketing) the ROR for the 1978-91 period was negative for both the cost-benefit and Akino-Hayami methods of calculation. Extending the analysis period to 2001 results in a positive ROR of 36.3 per cent using the cost-benefit method, and 37.3 per cent using the Akino-Hayami approach. The critical difference is the assumption that GRZ expenditures on maize marketing drop sharply after 1992, according to the new government's plan to completely liberalize the sector.

When marketing costs[9] are excluded from the calculation, the rates of return are sharply positive. For the 1978-91 period, using benefit-cost analysis, RORs range from 89.6 per cent when all costs except marketing are included, to 103 per cent when only additional production and research costs are included. When the period of reference is extended to 2001, the RORs are higher, ranging from 99.7 per cent to 110.3 per cent. RORs generated using the Akino-Hayami method were slightly lower. For the 1978-91 period, RORs ranged from 83.7 per cent when all costs except marketing were included, to 96.9 per cent, when only production and research costs were included. For the longer period 1978-2001, RORs ranged from 96.2 per cent to 106.2 per cent.

[9]Marketing costs included in the economic analysis are maize-related costs of the Department of Cooperatives and Marketing, including salaries, operating costs, purchase of motor vehicles, and construction of rural storage facilities. Also included are payments to parastatal and cooperative marketing organizations for transportation and handling of maize and fertilizer. Table 37a (Appendix 8) provides a more detailed description of these.

Table 19: Summary of results, economic rate of return (ARR) analysis

(per cent)

	Benefit-Cost Method		Akino-Hayami Method	
Internal rate of return	1978-91	1978-2001	1978-91	1978-2001
Including all costs (additional production, research, extension, seed, marketing costs)	-100.0	36.3	-100.0	37.3
Including additional production, research costs only	103.0	110.3	96.9	106.2
Including additional production, research, extension costs only	97.6	106.2	91.2	102.1
Including additional production, research, extension and seed costs only	89.6	99.7	83.7	96.2

The Zambia results illustrate the real danger in attempting to evaluate the impact of research in isolation from complementary organizations. If the common assumptions for ROR to research studies are adopted, and only additional production and research costs are counted, the resulting ROR is extremely high, between 96.9% and 110.3%. This compares very favorably with RORs calculated for research alone in other African countries. Cocoa research in Nigeria had a return of 42 per cent (Abidogun 1982), the ratio of benefits to costs of African cassava pest research was 149:1 (Norgaard 1988), and Evenson (1987) estimated that the overall ROR to investments in maize and staple crop research in Africa from 1962-80 was 30-40 per cent. Looking at the Zambian ROR, the conclusion would be that investments in maize research have been a tremendous economic success.

The picture changes completely when the costs of all complementary organizations are included in the analysis. For the 1978-91 period, the ROR is negative, suggesting that the general maize development program was uneconomic. The ROR becomes positive, 36.3-37.3%, when the period is extended to 2001, under the assumption that expenditures on maize marketing drop sharply after 1992. This is much lower than the above ROR estimate considering research and production costs only. How should these contrasting results be interpreted?

6.2.5. ROR results in the context of comparative advantage

The argument supporting the calculation of an ROR to research plus complementary organizations as a package is that these investments together facilitate technology development and technology acceptance by farmers. The contributions of non-research organizations to the technology process are significant and difficult to disaggregate; they share the credit for the benefits arising from development and adoption of new technology.

It follows that the maize-related costs incurred by these organizations must be accounted for. The inclusion of marketing costs in the Zambian case dramatically lowers the ROR to the package of investments in maize variety development and adoption, that is, investments in research, extension, the seed industry and marketing organizations. In other developing countries investments in technology development have also been accompanied by investments in an organizational infrastructure that aids the dissemination and adoption of the technology after it is developed.

Technology rarely spreads on its own. However, when other studies have calculated rates of return to research without accounting for complementary investments[10], they are in effect attributing all of the benefits of technology adoption (increased yields and/or increased area) to the research organization alone. This study argues that these benefits are the joint result of investments in extension, the seed industry and marketing organizations, as well as research. Failing to include these costs as well as those of research in an ROR calculation is, at best, inaccurate. The Zambia study suggests that the results of rate of return to research studies are overstated if they calculate an ROR counting the benefits of technology adoption but only the costs of research. At worst, crediting research investments alone with a high ROR can send dangerously misleading policy signals, if this masks additional investments needed to facilitate adoption of technology by farmers that in turn affect economic feasibility. In Zambia, these additional investments (in marketing) made the entire maize investment package uneconomic.

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[10] Most, but not all, studies have ignored complementary investments. For a summary of returns to agricultural research studies, see Oehmke et al. 1992. A number of authors have included the impact of one additional investment, usually extension, in their rate of return calculations (Pray 1978; Librero and Perez 1987; Lu, Cline and Quance 1979). Studies by other MSU researchers include a quantitative and/or qualitative assessment of the impact of one or more complementary investments on returns to research. Studies of Mali, Cameroon and Uganda analyzed the impact of research plus extension (Boughton and Henry de Frahan 1992; Sterns 1993; Laker-Ojok 1993). Mazzucato (1991) examined the impact of research in the presence of policy distortions and Henry de Frahan (1990) estimated the future impact of research investments in Mali with simultaneous investments in extension, infrastructure and policy.

It does not necessarily follow that the inclusion of complementary investments in other technology impact assessments will have such a dramatic effect on returns as in Zambia. Accounting for the additional costs of extension services and the seed industry had little impact on the ROR in Zambia (Table 19). Only the marketing programs were pivotal, and poor management made the maize marketing, input and consumer price subsidy programs in Zambia much more expensive than they could have been. The unsustainability of these programs, which by the late 1980s consumed almost 17 per cent of the total government budget (GRZ 1990:15), resulted in their near-total phaseout after the Chiluba government came to power in late 1991.

In addition to the budgetary impact of the maize marketing programs, a recent study supports the contention that the impact of past government price controls, subsidies and taxes was to skew smallholder labor and land use toward maize and away from other crops. Distortion coefficients were derived from a multiple crop production function within a static equilibrium framework, and the results are presented in Table 20. A distortion coefficient greater than one indicates that less labor and land inputs were being used than if no market distortions existed. All crops except maize have distortion coefficients greater than one in almost all years, especially after the 1984-5 season. The results might be even more skewed in favor of maize if the effects of easier access to product markets, extension advice, credit and seed were included in these calculations. Since the distortion coefficients also represent marginal value products for the individual crops, and these are not equal, it can be said that smallholder agriculture in Zambia does not exhibit productive efficiency, or, in other words, that allocative efficiency within the sector does not exist (World Bank 1992:40-41).

Table 20: Factor (land and labor) distortion coefficients, 1966-90

Year	Maize	Virginia tobacco	Seed cotton	Sunflower	Soybeans	Groundnuts
1966/7	0.08	12.50	0.71	0.24	0.20	0.33
1979/80	0.00	1.15	1.96	0.29	0.69	3.33
1984/85	0.22	2.00	3.23	1.41	1.35	4.35
1985/86	0.68	11.11	4.00	8.33	5.56	1.79
1986/87	0.76	14.29	7.69	5.88	5.26	1.69
1987/88	0.45	25.00	14.29	16.67	12.50	4.00
1988/89	0.75	25.00	20.00	12.50	14.29	6.67
1989/90	1.52	33.33	33.33	10.00	11.11	10.00

Source: World Bank 1992:41

Results of a domestic resource cost (DRC) analysis from the same study (Table 21) also illustrate the impact of policies on allocative efficiency. The DRC measures the cost in domestic resources to produce a unit of output for export or import-substitution.

A DRC below one means that the commodity is being produced relatively efficiently, and production could be expanded for export or import substitution. Table 21 shows DRCs for Zambian smallholders under two scenarios, using the official exchange rate and an exchange rate adjusted for overvaluation[11]. The analysis shows that Zambian smallholders have a comparative advantage in producing almost all commodities under both exchange rates, but comparative advantage is strengthened markedly when the exchange rate is adjusted to market levels, by an average of about 40 per cent (World Bank 1992). Zambian smallholders have strong comparative advantage in beef cattle, cotton, sunflower, and groundnuts, all of which are exportable, but diversification has been delayed (70 per cent of crop area is planted in maize) because of the policy and organizational bias favoring maize production.

[11] The Zambia ARR analysis incorporates an estimate of the domestic resource costs for maize. The use of economic (border) prices, including an import parity price for maize, adjusts for the effect of overvalued currency, as in Table 21. Beyond this, accounting for the costs of programs that facilitated adoption of technology reflects an additional component of "domestic resource cost" that is not included in traditional DRC estimates: the economic cost of implementing government programs that influence adoption. In the ex-post Zambia study, actual program costs were used. The implication is that a more realistic estimate emerges when the costs of supportive programs -- with the explicit acknowledgement that these programs may not be efficiently implemented -- are included as part of the package of "domestic resource costs" required to produce a commodity.

Table 21: Effect of overvalued currency on domestic resource cost estimates, 1989

Commodity[a]	Exch. rate: ZK25= USD1	Exch. rate: ZK40=US D1
Cassava	.70	0.44
Cotton	0.12	0.07
Groundnuts (Chalimbana)	0.70	0.44
Groundnuts (Makuru Red)	0.42	0.27
Maize	0.84	0.21
Millet	1.32	0.83
Paddy Rice	0.68	0.47
Sorghum	1.15	0.72
Soybeans	1.43	0.91
Sunflower	0.48	0.31
Wheat, rainfed	0.95	0.57
Beef cattle, native	0.54	0.26

Source: World Bank 1992:45-6

[a] Assumes smallholders use of existing technology.

Basing policy recommendations on the ROR to research programs in isolation from the effects and costs of complementary organizations, like tunnel vision, risks missing critical side issues. One set of issues concerns how dependent the success of the research investment is upon simultaneous investments in related organizations, and their associated costs. In Zambia, the rapid uptake of the new maize varieties, and the high level of contacts between improved maize adopters and extension and input/product marketing agencies, points to the critical importance of policies and complementary organizations in facilitating technology adoption.

The second set of issues involves allocative efficiency, the impact of investments in one sub-sector upon the efficiency of other sub-sectors. The distortion coefficient analysis confirms that the impact of government policies over the last two decades has been to skew incentives toward maize production. Domestic resource cost estimates show that Zambian smallholders have the potential to expand production of many other crops besides maize profitably.

It is beyond the scope of this paper to estimate the impact of foregone investments in non-maize sub-sectors, but it is already clear that liberalization of commodity and foreign exchange markets has produced a strong positive response among large-scale farmers along the line of rail. Plantings of burley tobacco doubled in the 1992-93 season, there was a record cotton planting, wheat

production is expected to meet all of the domestic demand, there is a large groundnut crop, and an exportable surplus of maize is predicted (USAID 1993). At the same time, smallholders in remote areas are being verbally encouraged by MAFF to shift from maize to higher value and more easily transportable crops for cash, and to crops better suited to local agro-ecological conditions for food. However, the extent of private sector interest in promoting, financing and marketing non-maize crops in more isolated areas, and the government's future role in encouraging private or public/private cooperation to provide the complementary services that would stimulate the transition, are still unknown.

7.0. IMPACTS OF INVESTMENTS IN MAIZE RESEARCH AND DISSEMINATION, PART TWO: ORGANIZATIONAL ISSUES

7.1. Formulation of location-specific agronomic and varietal recommendations

Adoption of improved varieties is the most visible and easily quantifiable impact of investment in maize research and complementary investments, but there have been other important results. On-farm trials conducted in Central Province, for example, found that recommended levels of fertilizer application could be reduced significantly with little effect on smallholder maize yields, confirming what smallholders were actually practicing. ARPT teams also found that short-duration open-pollinated varieties such as MMV400, originally intended and recommended for Region I, are also popular among farmers in higher rainfall areas as a source of early green maize during the hungry period before the regular harvest. Because of labor shortages, small farmers often delay weeding and fertilizer application. On-farm experimentation found that mixing the basal and top dressing fertilizer combined with the first weeding gave a 25 per cent yield advantage over the more usual practice, a split application of basal dressing at planting and a late top dressing and weeding 4-6 weeks afterwards (Low and Waddington 1991: 118-119).

While these and other recommendations have the potential to decrease costs and reduce the maize yield gap between small and large farmers, they have not been successfully developed into extension messages for dissemination to farmers. Formal fertilizer application recommendations have not been modified to reflect the Central Province results. The mixed basal and top fertilizer dressing technique has not been accepted as a general extension recommendation, and was incorrectly demonstrated in one province (Low and Waddington 1991:120-1).

The communication problems between the ARPTs and extension workers could result from rigidities in the technical school curriculum and the Training and Visit system. They stress ideal management practices and make it difficult for extension staff to accept and recommend less-than-optimal practices. Also, practices that save resources or provide indirect benefits to other crops, without raising the yield of the target crops, are difficult to extend through demonstrations and require a more systems-oriented approach (Low and Waddington 1991:121). These examples of new and apparently viable technology that did not spread illustrate how the impact of research can be frozen without adequate support from related agencies like extension.

7.2. Fragmentation of maize research and extension programs

Coordination and communication between researchers and extension agents, and between researchers themselves, have also been hampered by the way that GRZ and donors have implemented projects intended to strengthen research and extension. The provincial ARPTs have been supported by individual donors, e.g., Central Province ARPT was initially supported by USAID, the Netherlands supports the Western Province ARPT, etc. These separately funded teams, which include both Zambian and expatriate researchers, have tended to operate semi-autonomously, causing difficulties in coordination and management from the national level. The practical implications of different sources and management of funds are that field staff who should work together, e.g., ARPT team members and extension staff, or ARPT and CSRT members, receive different salaries, travel per diems, and have different pools of operating resources. This causes friction between personnel and inhibits coordination. These problems have also been evident in the maize breeding program, parts of which were funded by USAID, SIDA and FAO. A 1989 SIDA evaluation reported, " . . . the extent of professional jealousy between the proponents of the two approaches (hybrid vs. open-pollinated varieties) is now considerable . . . The problem is symptomatic of the difficulties the Research Branch is faced with in attempting to control a multiplicity of programs with inadequate managerial capacity" (Eriksen et al. 1989:35).

Disparities in program funding levels have been accentuated by the GRZ's frequent inability to continue funding programs initiated by donors after project funding ends. Research and extension staff members in some programs have alternately enjoyed and endured a roller-coaster ride through years of high funding and donor activity descending sharply into periods of scarce operating funds after donor withdrawal. For example, Zambia's first ARPT in Central Province was supported by the USAID ZAMARE project until 1988. The ARPT consisted of an agricultural economist, an agronomist and a research-extension liaison officer (RELO). From 1982-7 the team conducted 52 on-farm agronomic research trials and 19 test demonstrations at 457 sites. By 1989, however, the RELO had left, and in 1992, only an agronomist and rural sociologist were left on the team. Because of staff and operational funding constraints, USAID estimated that in 1989 the ARPT team was operating at only 30 per cent of the level achieved during the ZAMARE-assisted years (USAID 1989:13-14).

The difficulty of fostering an evolution from separately-financed and managed donor projects to a cohesive government-led program of research and extension is reflected in the leakage of long-term trainees from government service following completion of their training and the end of the donor project. Of the 48 participants successfully trained in the USAID project (5 Ph.D., 19 M.S. and 24 B.S. degrees), 29 participants came from the Research Branch, and 19 from the Extension Branch. By 1989, 22 Research Branch participants either remained with MAFF or had been seconded to other projects, and only 11 of the 19 extension trainees remained with MAFF or were seconded to related projects.

7.3. Sustainability of the maize breeding program

Similarly, the achievements of investments in maize research and related organizations are clouded by evidence that after more than a decade of training, maize breeding in Zambia is still heavily reliant on expatriate technical assistance. Two Ph.D. breeders have been trained; both have returned to the Research Branch, but one was promoted to an administrative position almost immediately upon his return, and the second is considered too inexperienced to successfully lead a team still divided into open-pollinated and hybrid camps. "Zambianization" of the maize breeding team is still several years away, with the return of a third breeder from Ph.D. training abroad. Capacity is thin at the lower levels, too; all of the CIMMYT-trained maize researchers, except the 2 Ph.D. level breeders previously mentioned, have left the program (Gelaw, personal communication, August 1991).

Frustration with the low civil service salaries and the meager resources available to fund research program operating costs are the most frequent reasons given for job dissatisfaction or for resigning a post. The withdrawal of donors at the end of projects causes difficult adjustment problems for researchers. They face more stringent research budgets and often the end of personal fringe benefits such as generous travel per diems that serve as de facto salary supplements.

7.4. Impact of commercial maize on farming systems changes

Evidence on the impact of commercial maize on farming systems on rural household food security and nutritional status is mixed. A study carried out in Northern Province found that some aspects of commercial maize production contribute to rural poverty, such as low profitability or displacement of staple crops (Sharpe 1990:601). However, the high financial ARR estimated by this study (including additional research and production costs) suggests that farmers who adopted improved varieties could realize significant income gains through the sale of commercial maize, given the environment of subsidized fertilizer and transportation costs that existed through the 1980s. The higher income could potentially improve food security if it is spent on foodstuffs, but it may not be. MSU/MAFF/RDSB survey results also suggested that total maize area did not increase significantly following adoption of improved varieties in the mid-80s, implying some stability in traditional crop production since area under non-maize traditional crops apparently remained unchanged. This does not preclude the possibility of an earlier shift from traditional crops to maize (local and SR52) which would not have been reflected in the MSU/MAFF/RDSB data.

In the environment of fertilizer and transportation subsidies prevailing until 1992, it was profitable for small farmers to adopt and grow hybrid maize for the market. Now that these subsidies have been largely eliminated, it is expected that the area of commercial maize production will retract to larger farms and areas close to major transportation arteries and cities. In more remote areas, farming systems may shift back to more traditional crops and open-pollinated maize.

The ARPTs have developed descriptive analyses of traditional farming systems, and advocated a more diversified research and extension portfolio, but with little impact until it became evident last year that fundamental policy changes in the maize sector were about to be carried out. Except for

recently released improved sorghum varieties, few research results for non-maize crops are available and/or being disseminated to small/medium farmers. A recent study of seed availability found that farmers' most common complaint was the lack of non-maize seeds at the local level (GRZ 1991c:v).

8.0. CONCLUSIONS

Today, over 60 per cent of Zambia's total maize area is planted in improved maize varieties that were developed in Zambia and released between 1984 and 1988. Only Zimbabwe and Kenya have higher adoption rates in sub-Saharan Africa. The development of the short-season hybrids, and their rapid and extensive adoption by farmers, was the product of several key factors: (1) sustained funding of the same experienced breeder over more than a decade; (2) concurrent investment in the seed industry so that multiplication and dissemination of the new varieties was immediate; and (3) implementation of a package of pricing and marketing policies -- including pan-territorial, pan-seasonal pricing for maize, heavy fertilizer subsidies, and the establishment of primary cooperative depots as de facto credit, input and product marketing centers throughout the country. The set of marketing and price policies stimulated maize production and fertilizer use among small farmers, especially those in areas remote from consumption centers. These ultimately proved unsustainable. The marketing and fertilizer bill for the government consumed more than 8 per cent of the total government budget by the late 1980s, and government intervention in maize production and marketing was largely discontinued by late 1992.

This paper has tried to show how the impact of research investments is integrally bound up with investments in complementary organizations such as extension, the seed industry and marketing. With better data than exists in most sub-Saharan African countries, it might be possible to separate the impacts of these related investments using econometric methods. A more common alternative is to attribute all benefits of technology adoption to the research program, in other words implicitly assuming investments in complementary organizations that facilitate adoption are held constant. Griliches' pioneering study (1958) of the impact of increased production from hybrid corn research was the first to devalue the contributions of non-research organizations in this way.

Such analyses of research impact, when carried out in developed countries, might anger extension, seed industry and marketing personnel (who in self-defense might order their own studies, showing the impact of technology adoption attributed to their separate organizations). Beyond the misrepresentation of the complexity of the technology development and dissemination process, there may not be any serious effect, since facilitative organizations, public and private, are well-established in developed countries and funding is relatively constant. When new technology becomes available, the mechanisms are already in place to get it out to users.

This is not so in most of developing Africa. The transitory nature of donor agency funding, and the difficulty countries have in sustaining public or private investment levels after donor assistance ends, means that the capacity of technology-related organizations down the line -- research, extension, seed, marketing -- can rarely be taken for granted. The danger in carrying out analyses of research impact that suppress the role of other organizations is the possibility of giving misleading signals for future investment--advising investment in research only, when research may not have

impact without support from other organizations, or underestimating the costs involved. The Zambia study provides a dramatic example. Attributing all of the benefits of technology development and adoption to research, and counting only additional production and research costs, the ROR exceeds 100%, suggesting the research investment was an outstanding success. However, when the costs of all of the complementary organizations are also included (extension, seed, marketing), the ROR is negative, indicating that the whole maize investment program was uneconomic from 1978-91.

The analysis suggests that marketing investments were the critical factor that caused the ROR to turn negative. It would be interesting to simulate the impact of maize research, extension and seed investments without the supporting parastatal marketing structure, to see the impact on the ROR itself and the differences in the spatial distribution of benefits that would surely result. Such an exercise would reflect the process taking place in Zambia today as the GRZ moves to a privatized maize marketing system.

The study employs and argues for a messier approach to ex-post and ex-ante impact assessment, using both quantitative and qualitative techniques that emphasize an understanding of the policy and organizational context of technology development and dissemination. Attention to three levels is important. First, to the research organization itself: in Zambia, the GRZ and donors could note the success of long-term support for one experienced breeder, but also the slowness to Zambianize the breeding program despite significant training investments, and the fragmentation of programs and professional jealousies that result when sub-programs funded by different donors are not well-coordinated. Second, the sub-sector: in Zambia, all components--the seed industry, extension service, credit, input and product marketing--were tuned almost exclusively to maize. These were costs the GRZ eventually could not afford, but their role as catalysts to maize adoption is indisputable. Finally, across the agricultural sector: factor distortion coefficients show how skewed government policies favored maize production against other enterprises, and the negative ROR for 1978-91, when all costs are included, shows that these heavy investments in the maize sector were uneconomic. Results of the domestic resource cost analysis show that Zambia has largely unexploited comparative advantage in many crops besides maize, some of which, like sorghum, are more suitable for dry areas and less risky for small farmers.

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Appendix 1: Design for small/medium farmer maize adoption survey

The sample of farmers interviewed in the 1992 MSU/MAFF/RDSB Maize Adoption Survey was a subset of households included in the Central Statistical Office's sampling frame for the 1991/92 Census of Agriculture. The CSO sampling frame is the only national sampling frame available for small and medium-scale agricultural households, used to generate information about farm characteristics, and crop forecasts and production information for seven major crops at the national, provincial and district levels.

CSO Census of Agriculture sampling frame

The Census of Agriculture sampling frame was derived from the population census of 1990. For the population census, the country is divided into CSAs (Census Supervisory Areas) whose major boundaries are defined by geographical landmarks such as rivers, power lines, etc. CSAs are subdivided into Standard Enumeration Areas (SEAs), also delineated by geographical boundaries, composed of 100-120 households, estimated to be a manageable workload for one enumerator. Each CSA has approximately 5 SEAs. CSAs can be aggregated to both district and provincial levels.

During the 1990 Population Census, an extra questionnaire was attached to get information from each household on its involvement in agriculture. This information was used to stratify SEAs into seven crop zones. Sample SEAs (or clusters) for the Census of Agriculture were selected using a stratified two-stage process with probability proportional to size. Each year a listing of households is conducted in each sample SEA. The last sampling stage consists of selecting households by farm size stratum within each sample SEA.

MSU/MAFF/RDSB Maize Adoption Survey sample

Because of resource constraints that made a full-country sample unfeasible, the research team decided to limit the sample selection to the three top maize-producing districts within the four major maize-producing provinces of Zambia, according to CSO statistics. Provinces and districts selected were:

Central Province: Kabwe Rural, Mkushi and Mumbwa Districts
Southern Province: Choma, Kalomo, Mazabuka Districts
Eastern Province: Chipata, Lundazi, Petauke Districts
Northern Province: Isoka, Mbala, Mpika Districts

The objectives of the Maize Adoption Survey included cross-comparisons between agro-ecological regions, areas considered remote/close to service centers, and different size categories of farmers. Information on farm size was readily available, but neither of the other characteristics had been used to construct the original Census of Agriculture sample. Working

with CSO staff, agro-ecological boundaries were superimposed on a national map of all CSAs and SEAs, and SEAs in the chosen provinces/districts were stratified accordingly. CSO staff derived weights to permit aggregation of survey results by agro-ecological region. The research team and CSO staff also stratified SEAs as "remote" or "close" according to their distance from major roads and major towns.

Sample selection was two-stage. In the first stage, one "remote" and one "close" SEA from each agro-ecological region represented within a selected district was chosen systematically. At the second stage, 14 households were chosen from each SEA, seven small-scale (0-4.99 ha) and seven medium-scale (5-19.99 ha). Since there were few medium-scale households in a given SEA, all medium-scale households were selected, and small-scale households were selected systematically. The sample drawn using this method underrepresented Regions I and III. As a correction, an additional 4 SEAs in Regions I and II were systematically selected, and 2 SEAs were dropped from Region II. The final sample was distributed between strata as follows:

(no. of households)

	Small/close	Medium/close	Small/remote	Medium/remote	Total
Region I	43	13	48	8	112
Region II	94	60	61	23	238
Region III	46	10	51	5	112
Total	183	83	160	36	462

CSO provided detailed site maps to help the team locate sample SEAs. In the field, district agricultural officers and extension agents frequently accompanied the team to make introductions to the village headmen and aid in finding individual households selected for the sample.

Enumerators visiting SEAs made every effort to locate and interview the individuals designated in the sample selection process. This was not always possible, as each SEA was visited only once for 1-2 days and the selected individuals were not always available. Usually, a neighbor of the absent person was substituted. During the field work, some persons listed as "medium-scale" farmers by CSO actually reported landholdings that put them in the "small-scale" category. This caused a contraction in the numbers of medium-scale farmers in the cells above. The results reported in this paper were not affected, since small/medium categories of farmers were combined.

Questionnaire Design and Interviewing

The questionnaire used in the survey appears as Appendix 2. Because of the complexity of the questionnaire, it was decided to intensively train a small group of enumerators to carry out all

interviews with close supervision from the senior researchers, instead of relying on CSO enumerators resident in each province. Four enumerators, each fluent in three or more local languages and most with prior survey experience, joined the project in March 1992. After one month of training, field work began in April and was completed in early July 1992.

Farmers were asked if they had ever used improved maize varieties, and, if so, in what season they began them. Improved maize users were then asked to recall their cropping patterns, beginning the season before they began using improved maize. For some farmers, the recall period was extremely long, up to eight years. To improve the quality of data, enumerators developed a list of significant historical events for each province and district to use as memory aids during interviews.

Accurate information about farm size and allocation of area to different crops is notoriously difficult to extract from oral interviews, but resources did not allow measurement of individual farm fields. Enumerators were asked to probe carefully to find out what unit of measurement the farmer was most comfortable with. Then farmers were asked to estimate the current size of each field in that unit, and to review the history of each field, e.g., noting in what years additional areas were cleared. This information enabled later calculation of the size of each field in each year. Each enumerator carried a wooden model divided into twelve blocks. Farmers were asked to imagine that the model represented, e.g., field A in 1991, and asked to allocate the field to different crops using the blocks, e.g., four blocks to MM603, 4 blocks to local maize, two blocks to bean/pumpkin intercrop and two blocks not cleared. Later, these proportions were combined with the information on field size in a given season to give estimates of field area planted to a particular crop in square meters.

Appendix 2: Calculation of shadow exchange rate and import parity prices

Table 22: Actual SEK/SDR end-of-period exchange rates, 1979-92[a]

Year	SEK/SDR
1979	5.4623
1980	5.5771
1981	6.484
1982	8.0466
1983	8.3766
1984	8.8116
1985	8.365
1986	8.3409
1987	8.2963
1988	8.2855
1989	8.1833
1990	8.1063
1991	7.9096
1992	7.8896

[a] Source: IMF International Financial Statistics

Table 23: Calculation of shadow exchange rate[a]

Date	Nominal K/US$	Constant Real K/US$	Zambia Prices	Industrial Country Prices	Real K/US$	Nominal K/SDR	Constant Real K/SDR	Real K/SDR	Actual US$/SDR	Cross Constant Real K/US$[b]
1978	0.79	3.89	32.29	60.50	1.47	1.02	4.00	1.91	1.30	3.07
1979	0.78	3.91	35.43	66.00	1.45	1.02	4.03	1.90	1.32	3.06
1980	0.80	3.92	39.55	73.60	1.49	1.02	4.03	1.90	1.28	3.16
1981	0.88	4.02	44.69	81.00	1.59	1.02	4.14	1.85	1.16	3.56
1982	0.93	4.24	50.76	87.20	1.60	1.02	4.37	1.75	1.10	3.96
1983	1.51	4.82	60.71	91.80	2.28	1.28	4.96	1.94	1.05	4.74
1984	2.20	5.53	72.86	96.10	2.90	2.16	5.69	2.85	0.98	5.80
1985	5.70	7.29	100.00	100.00	5.70	6.26	7.50	6.26	1.10	6.83
1986	12.71	10.82	151.85	102.30	8.56	15.55	11.13	10.48	1.22	9.10
1987	8.00	15.03	217.16	105.30	3.88	11.35	15.47	5.50	1.42	10.90
1988	10.00	22.65	337.80	108.70	3.22	13.46	23.31	4.33	1.35	17.32
1989	21.65	42.65	663.46	113.40	3.70	27.94	43.88	4.78	1.31	33.39
1990	42.73	131.44	2142.00	118.80	2.37	60.98	135.23	3.38	1.42	95.05
1991	89.29	245.37	4247.70	126.20	2.65	126.58	252.44	3.76	1.43	176.53
1992	161.29	483.46	8495.40	128.10	2.43	232.56	497.39	3.51	1.43	347.82

[a] Source: International Monetary Fund International Financial Statistics

[b] The cross-constant real K/US$ rate is used as the shadow exchange rate to convert kwacha values into dollar values in the economic analysis. The method for estimating the shadow exchange rate follows Harber, 1991 and 1992. The shadow exchange rate is based upon purchasing power parity principles, using a projection of what was considered to be an appropriate exchange rate in September, 1985. Harber (1991) calculated the "appropriate" exchange rate as follows:

> "The parallel rate in September 1985 was approximately K8/US$. A general rule of thumb to use in estimating appropriate or equilibrium exchange rates is to deduct 20-30 per cent from parallel rates to remove the risk premium included in the parallel rate. Assuming a 25 per cent risk premium in September 1985, the "appropriate" exchange rate for that time is estimated at K6/US$ or K6.17/SDR. TO arrive at the "appropriate" rate for other time periods, this rate is adjusted according to movements in Zambia's consumer prices and the Industrial Country price index from the International Financial Statistics in order to find the nominal exchange rate which would maintain a constant real exchange rate of K6/US$ in September 1985." (Harber, 1991:10)

The K/SDR rate is then converted back to U.S. dollar terms using the US$/SDR exchange rate to arrive at the cross constant real K/US$ exchange rate, used here as the shadow exchange rate. The cross constant exchange rate is used in order to eliminate the fluctuations of the US$ against other (non-kwacha) currencies which would be reflected in a direct US$/K rate calculation

Table 24: Calculation of economic import parity price for maize

Year	Official Price Zim$[a]	Exch. Rate US/Zim$[a]	Price USD	SER ZK/USD[b]	Nominal ZK/USD[b]	Pan-Territorial Price ZK	Transport Cost to Zambia Border ZK[c]	Border Price ZK[c]	Rail Transport LVGSTN-LSK[d]	Rail Transport LSK-NDOLA[d]	Truck Transport 1-50 Km ZK/Ton/Km[e]	Truck Transport 51-100 Km ZK/Ton/Km[e]
1978	57.10	1.48	84.51	3.07	0.79	259.44	63.86	323.30	118.75	187.50	0.35	0.28
1979	63.90	1.47	93.93	3.06	0.78	287.43	63.65	351.08	118.28	186.75	0.35	0.29
1980	89.00	1.55	137.95	3.16	0.8	435.92	65.73	501.65	122.08	192.75	0.35	0.29
1981	137.00	1.45	198.65	3.56	0.88	707.19	74.05	781.24	137.28	216.75	0.36	0.30
1982	137.00	1.32	180.84	3.96	0.93	716.13	82.37	798.49	152.12	240.19	0.38	0.31
1983	157.00	0.99	155.43	4.74	1.51	736.74	98.59	835.33	186.79	294.94	0.34	0.29
1984	177.00	0.80	141.60	5.80	2.2	821.28	120.64	941.92	232.75	367.50	0.56	0.45
1985	222.00	0.62	137.64	6.83	5.7	940.08	142.06	1082.15	311.01	491.06	0.80	0.75
1986	222.00	0.60	133.20	9.10	12.71	1212.12	189.28	1401.40	475.12	750.19	0.63	0.55
1987	222.00	0.60	133.20	10.90	8	1451.88	226.72	1678.60	483.31	763.13	1.16	1.02
1988	245.00	0.56	137.20	17.32	10	2376.30	360.26	2736.56	735.78	1161.75	2.25	1.86
1989	285.00	0.47	133.95	33.39	21.65	4472.59	694.51	5167.10	1446.61	2284.13	5.63	4.64
1990	305.00	0.40	122.00	95.05	42.73	11596.10	1977.04	13573.14	3893.58	6147.75	13.81	11.39
1991	360.00	0.32	115.20	176.53	89.29	20336.26	3671.82	24008.08	7349.20	11604.00	22.82	19.32
1992	1070.00	0.19	203.30	347.82	161.29	70711.81	7234.66	77946.46	14306.41	22589.06	45.17	38.26

(continued next page)

Table 24, continued. Calculation of Economic Import Parity Price for Maize

Truck Transport 101-200 Km ZK/Ton/Km[e]	Truck Transport 200+ Km ZK/Ton/Km[e]	CIF Lusaka[f]	CIF Ndola[f]	CIF Lvgstn[g]	Farm Gate Lvgstn[h]	Farm Gate Mongu[i]	Farm Gate Ndola[j]	Farm Gate Kabwe[k]	Farm Gate Kasama[l]	Farm Gate Chipata[m]	Farm Gate Solwezi[n]	Farm Gate Mansa[o]	Farm Gate Lusaka[p]	Farm Gate Choma[q]	Weighted Imp. Parity Price[r]
0.22	0.19	474.38	543.13	355.63	327.14	391.35	482.31	383.66	331.74	270.78	433.52	392.88	413.56	373.69	349.23
0.22	0.19	504.47	572.94	386.19	357.46	418.22	509.10	410.46	331.90	296.59	459.88	418.89	440.63	400.40	372.82
0.22	0.19	673.89	744.57	551.82	522.90	572.26	665.49	564.45	487.16	449.86	615.95	574.70	594.81	554.34	526.98
0.23	0.20	996.64	1076.12	859.37	829.81	865.91	968.44	857.93	786.14	740.78	917.79	875.63	888.96	847.58	820.92
0.24	0.21	1030.46	1118.53	878.34	847.35	895.45	1007.69	887.08	816.54	764.25	954.59	910.38	919.62	876.23	848.94
0.23	0.18	1105.66	1213.80	918.86	890.22	974.75	1101.62	961.83	915.75	856.39	1054.77	1015.76	993.48	955.19	929.31
0.33	0.22	1268.86	1403.61	1036.11	991.57	1126.34	1264.87	1085.02	999.94	962.63	1207.63	1159.97	1130.12	1083.35	1055.27
0.47	0.34	1501.37	1681.42	1190.36	1115.70	1324.12	1498.54	1254.91	1125.07	1059.34	1409.98	1336.23	1318.49	1246.12	1218.28
0.43	0.35	2016.66	2291.73	1541.54	1486.45	1783.93	2096.50	1763.00	1753.26	1555.12	2005.48	1929.70	1821.43	1747.06	1738.29
0.80	0.65	2329.77	2609.59	1846.46	1744.71	1993.17	2339.98	1951.99	1704.56	1572.37	2173.27	2034.46	2060.16	1923.94	1860.52
1.55	1.24	3745.99	4171.97	3010.22	2824.34	3141.47	3712.43	3077.34	2484.07	2354.58	3393.96	3128.77	3286.46	3026.22	2850.11
3.94	3.66	7130.43	7967.94	5683.81	5219.60	5552.78	6987.02	5617.77	3863.59	3399.13	6047.06	5264.38	6149.50	5381.45	4977.51
9.67	9.30	18824.03	21078.20	14930.45	13790.97	14726.48	18581.41	15022.00	10914.40	9330.72	16190.31	14199.28	16327.23	14373.42	13530.81
15.14	12.55	33758.09	38012.89	26408.89	24476.84	28057.93	33680.03	27380.72	21670.44	19991.14	30455.88	27771.18	29425.23	26790.71	25667.73
29.97	24.82	100047.51	108330.2	85741.11	81914.87	85730.29	96709.29	84380.52	72942.11	69764.03	90331.25	85020.34	88426.63	83215.00	80914.14

[a] Source: Government of Zimbabwe, Government Maize Board Annual Reports 1978-92

[b] See Table 23.

[c] Personal communication, J. Oliver, MAFF Logistics and Control Center. Assumed that 75% of total rail cost composed of imported goods, therefore 75% of total cost converted to ZK at SER, 25% at nominal rate.

[d] Closest large depot is approximately 130 kms from Zimbabwe/Zambia border at Chirundu. Transport cost is estimated at USD $.16/ton/km (personal communication, 1993, T. Jayne)

[e] Insurance and unloading costs estimated at 10% of border price

[f] Livingstone price = border price + 10% loading, insurance charges

[g] Livingstone FG = Livingstone CIF - (transport cost*100 km+handling,misc.costs (.1*border price))

[h] Mongu FG = Lusaka CIF- (transport cost*417 km (Lusaka-Mongu)-transport cost*100 km (intra-provincial))

[i] Source: GRZ Ministry of Cooperatives, Dept. of Marketing, Logistics and Information Center, Lusaka, for 1984-90 data; other years estimated. Assumed that 75% of truck transport cost composed of imported goods.

[j] Ndola FG= Ndola CIF - (transport cost*100km + handling, misc (.1*border price)

[k] Kabwe FG = Lusaka CIF - (transport cost*135kms(Lusaka-Kabwe)+transport cost*100km +handling, misc.(.1*border price)

[l] Kasama FG = Ndola CIF - (transport cost*793km (Ndola-Kasama)+transport cost*100km+handling, misc (.1*border price)

[m] Chipata FG = Lusaka CIF - (transport cost*752km (Lusaka-Chipata)+transportation cost*100)+handling, misc. (.1*border price))

[n] Solwezi FG = Ndola CIF - (transport cost*257(Ndola-Solwezi)+transport cost*100km + handling, misc. (.1*border price)

[o] Mansa FG = Ndola CIF - (transport cost*471(Ndola-Mansa)+transport cost*100 km + handling, misc. (1.*border price)

[p] Lusaka FG = Lusaka CIF - (transport cost*100 + handling, misc.(.1*border price)

[q] Choma FG = Lusaka CIF - (transport cost*210 km(Lusaka-Choma)+transport cost*100)+handling, misc.(.1*border cost)

[r] Weighted according to provincial shares in the national maize market. See Table 2: Provincial Shares of the National Maize Market, 1982-92. Shares for other years estimated.

Table 25: Economic import parity prices, Compound D and ammonium nitrate fertilizers

Year	SER ZK/USD[a]	Compound D CIF Lsk USD[b]	Amm. Nitrate CIF Lsk USD[b]	Compound D CIF Lsk ZK[b]	Amm. Nitrate CIF Lsk ZK[b]	Truck Transport 1-50 Km ZK/Ton/Km[c]	Truck Transport 51-100 Km ZK/Ton/Km[c]	Truck Transport 101-200 Km ZK/Ton/Km[c]	Truck Transport 200+ Km ZK/Ton/Km[c]
1978	3.07	162.8	119.8	499.9	367.8	0.35	0.28	0.22	0.19
1979	3.06	162.8	119.8	498.2	366.6	0.35	0.29	0.22	0.19
1980	3.16	162.8	119.8	514.5	378.6	0.35	0.29	0.22	0.19
1981	3.56	162.8	119.8	579.6	426.5	0.36	0.30	0.23	0.20
1982	3.96	162.8	119.8	644.8	474.4	0.38	0.31	0.24	0.21
1983	4.74	162.8	119.8	771.8	567.9	0.34	0.29	0.23	0.18
1984	5.8	162.8	119.8	944.3	694.9	0.56	0.45	0.33	0.22
1985	6.83	162.8	119.8	1112.0	818.3	0.80	0.75	0.47	0.34
1986	9.1	162.8	119.8	1481.6	1090.2	0.63	0.55	0.43	0.35
1987	10.9	162.8	119.8	1774.7	1305.9	1.16	1.02	0.80	0.65
1988	17.32	162.8	119.8	2820.0	2075.0	2.25	1.86	1.55	1.24
1989	33.39	162.8	119.8	5436.5	4000.2	5.63	4.64	3.94	3.66
1990	95.05	162.8	119.8	15475.8	11387.3	13.81	11.39	9.67	9.30
1991	176.53	162.8	119.8	28742.2	21148.9	22.82	19.32	15.14	12.55
1992	347.82	162.8	119.8	56631.2	41670.1	45.17	38.26	29.97	24.82

(continued next page)

Table 25, continued. Economic import parity prices, Compound D and ammonium nitrate fertilizers

	Depot Mongu[e]		Depot Ndola[f]		Depot Kabwe[g]		Depot Kasama[h]	
Year	Comp. D	Amm. Nit.	Comp. D	Amm. Nit.	Comp. D	Amm. Nit.	Comp. D	Amm. Nit.
1978	657.1	511.8	644.5	499.3	607.5	462.3	740.9	595.6
1979	656.3	511.5	643.7	498.9	606.7	462.0	740.1	595.3
1980	674.2	524.7	661.6	512.1	624.7	475.1	758.0	608.5
1981	751.0	582.6	737.8	569.4	698.6	530.2	839.2	670.8
1982	827.8	640.4	813.9	626.6	772.6	585.3	920.4	733.0
1983	953.0	728.7	941.1	716.8	909.0	684.7	1032.4	808.1
1984	1175.5	901.1	1161.0	886.6	1128.3	853.9	1272.5	998.1
1985	1440.0	1116.9	1417.6	1094.4	1361.7	1038.5	1590.0	1266.8
1986	1830.8	1400.2	1807.7	1377.1	1742.9	1312.3	1985.1	1554.5
1987	2325.2	1809.5	2282.3	1766.6	2162.2	1646.4	2611.9	2096.1
1988	3805.1	2985.6	3723.2	2903.7	3497.3	2677.8	4351.9	3532.4
1989	7970.3	6390.5	7728.8	6148.9	6976.0	5396.2	9584.4	8004.6
1990	22040.5	17543.2	21426.7	16929.4	19467.8	14970.5	26141.8	21644.5
1991	38781.8	30429.2	37953.5	29600.9	35592.3	27239.7	44316.3	35963.7
1992	76470.3	60013.1	74832.2	58375.0	70166.3	53709.1	87415.9	70958.7

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Table 25, continued. Economic import parity prices, Compound D and ammonium nitrate fertilizers

Year	Depot Chipata[i] Comp. D	Amm. Nit.	Depot Solwezi[j] Comp. D	Amm. Nit.	Depot Mansa[k] Comp. D	Amm. Nit.	Depot Lusaka[l] Comp. D	Amm. Nit.	Depot Choma[m] Comp. D	Amm. Nit.	Weighted Imp. Parity Price[n] Comp. D	Amm. Nit.
1978	720.7	575.5	685.9	540.7	687.5	542.2	577.8	432.6	617.7	472.5	651.8	506.5
1979	719.9	575.1	685.2	540.4	686.7	541.9	577.0	432.3	616.9	472.2	651.0	506.2
1980	737.8	588.3	703.1	553.5	704.6	555.1	595.0	445.4	634.9	485.3	668.9	519.4
1981	818.0	649.6	781.4	613.0	783.0	614.6	667.6	499.2	709.6	541.2	745.3	576.9
1982	898.2	710.8	859.7	672.4	861.4	674.0	740.2	552.9	784.3	597.0	821.8	634.5
1983	1013.3	789.0	980.4	756.1	981.8	757.5	877.9	653.7	915.7	691.5	948.7	724.4
1984	1249.2	974.8	1209.0	934.5	1210.7	936.3	1083.8	809.3	1130.0	855.5	1171.8	897.4
1985	1553.9	1230.8	1491.7	1168.5	1494.4	1171.3	1298.2	975.1	1369.6	1046.5	1433.0	1109.9
1986	1948.0	1517.4	1884.0	1453.4	1886.8	1456.2	1684.8	1254.2	1758.3	1327.7	1821.8	1391.2
1987	2543.0	2027.2	2424.0	1908.3	2429.2	1913.5	2054.2	1538.4	2190.7	1674.9	2308.6	1792.9
1988	4220.5	3401.0	3993.6	3174.1	4003.5	3184.0	3288.0	2468.5	3548.4	2728.9	3774.2	2954.7
1989	9196.4	7616.6	8526.7	6946.8	8555.9	6976.1	6444.1	4864.3	7212.7	5632.9	7858.2	6278.3
1990	25156.0	20658.7	23454.1	18956.8	23528.5	19031.2	18162.4	13665.1	20115.4	15618.1	21744.2	17246.9
1991	42986.0	34633.4	40689.4	32336.8	40789.8	32437.2	33548.4	25195.8	36183.9	27831.3	38450.9	30098.3
1992	84785.0	68327.8	80242.9	63785.7	80441.5	63984.3	66120.3	49663.1	71332.5	54875.3	75816.9	59359.7
1993	84785.0	68327.8	80242.9	63785.7	80441.5	63984.3	66120.3	49663.1	71332.5	54875.3	75816.9	59359.7

[a] See Table 23.
[b] Source: GRZ, 1989 for CIF in ZK for 1988/89. CIF in USD was obtained by dividing by SER for 1988. The CIF in USD was assumed constant for other years, and converted to ZK by multiplying by the SER for each year.
[c] Source: GRZ Ministry of Cooperatives, Dept. of Marketing, Logistics and Information Center, Lusaka, for 1984-90 data; other years estimated. Assumed that 75% of truck transport cost composed of imported goods.

[d] Livingstone rural depot = Lusaka CIF + transport cost*475km (Lusaka-Livingstone) + transport cost*100 km (intra-provincial)+handling,misc.costs (.1*Lusaka CIF)
[e] Mongu rural depot = Lusaka CIF + transport cost*417 km (Lusaka-Mongu)+transport cost*100 km (intra-provincial) + handling, misc. (.1*Lusaka CIF)
[f] Ndola rural depot = Lusaka CIF + transport cost*351 km (Lusaka-Ndola) + transport cost*100km + handling, misc (.1*Lusaka CIF)
[g] Kabwe rural depot = Lusaka CIF + transport cost*135kms(Lusaka-Kabwe) + transport cost*100km + handling, misc.(.1*Lusaka CIF)
[h] Kasama rural depot = Lusaka CIF + transport cost*858km (Lusaka-Kasama)+transport cost*100km+handling, misc (.1*Lusaka CIF)
[i] Chipata rural depot = Lusaka CIF + transport cost*752km (Lusaka-Chipata) + transportation cost*100 + handling, misc. (.1*Lusaka CIF)
[j] Solwezi rural depot = Lusaka CIF + transport cost*569(Lusaka-Solwezi)+transport cost*100km + handling, misc. (.1* Lusaka CIF)
[k] Mansa rural depot = Lusaka CIF + transport cost*577 (Lusaka-Mansa)+ transport cost*100 km + handling, misc. (1.* Lusaka CIF)
[l] Lusaka rural depot = Lusaka CIF + transport cost*100 + handling, misc.(.1*Lusaka CIF)
[m] Choma rural depot = Lusaka CIF + transport cost*210 km(Lusaka-Choma) + transport cost*100 + handling, misc.(.1*Lusaka CIF)
[n] Weighted according to 1986/7-87/8 average provincial shares in the national fertilizer market. Source: GRZ, 1989. Western: 2.96%; Copperbelt, 4.91%; Central, 24.43 %; Northern, 9.32%; Eastern, 23.88%; Northwestern, 1.46%; Luapula, 2.26%; Lusaka, 11.55%; Southern, 19.23%.

Table 26: Calculation of import parity prices for Zimbabwean short-season maize hybrids (R201, R215)

price per 50 kg bag

YEAR	OFF. PRICE ZIM$[a]	EXCH. RATE US/ZIM$[a]	PRICE USD	SER ZK/USD[b]	NOM. ZK/USD[b]	PAN-TERR. PRICE ZK	TRANS. COST TO ZAMBIA BORDER ZK[c]	BORDER PRICE ZK[c]	RAIL TRANS. LVGSTN-LSK[d]	CIF LUSAKA[e]
1978	15.20	1.48	22.50	3.07	0.79	69.08	3.19	72.27	5.94	92.66
1979	15.31	1.47	22.50	3.06	0.78	68.85	3.18	72.03	5.91	92.35
1980	14.52	1.55	22.50	3.16	0.8	71.10	3.29	74.39	6.10	95.37
1981	15.52	1.45	22.50	3.56	0.88	80.10	3.70	83.80	6.86	107.43
1982	17.05	1.32	22.50	3.96	0.93	89.10	4.12	93.22	7.61	119.47
1983	22.73	0.99	22.50	4.74	1.51	106.65	4.93	111.58	9.34	143.24
1984	28.13	0.80	22.50	5.80	2.2	130.50	6.03	136.53	11.64	175.48
1985	36.29	0.62	22.50	6.83	5.7	153.68	7.10	160.78	15.55	208.48
1986	37.50	0.60	22.50	9.10	12.71	204.75	9.46	214.21	23.76	280.81
1987	37.50	0.60	22.50	10.90	8	245.25	11.34	256.59	24.17	332.07
1988	37.50	0.56	21.00	17.32	10	363.72	18.01	381.73	36.79	494.87
1989	50.00	0.47	23.50	33.39	21.65	784.67	34.73	819.39	72.33	1055.6
1990	65.50	0.40	26.20	95.05	42.73	2490.31	98.85	2589.16	194.68	3301.7
1991	72.50	0.32	23.20	176.53	89.29	4095.50	183.59	4279.09	367.46	5502.4
1992	122.11	0.19	23.20	347.82	161.29	8069.42	361.73	8431.16	715.32	10832.7

[a] Source: Economics and Inputs Department, Commercial Farmers' Union, Zimbabwe for 1987-91. Prices for other years estimated. Prices are for short-season Zimbabwean maize hybrids, such as R201, R215, which are most commonly imported by Zambia.

[b] See Table 23.

[c] Closest large depot is approximately 130 kms from Zimbabwe/Zambia border at Chirundu. Transport cost is estimated at USD $.16/ton/km (personal communication, 1993, T. Jayne)

[d] MAFF Logistics and Information Center. Assumed that 75% of total rail cost composed of imported goods, therefore 75% of total cost converted to ZK at SER, 25% at nominal rate.

[e] Insurance, internal transport and unloading costs estimated at 20% of border price. It is assumed that most imported seed is used in Central and Southern Province within 100 kms of Lusaka.

Appendix 3: Calculation of financial and economic ARR

Table 27: ARR financial analysis, benefit-cost method, part I

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
BENEFITS											
WITHOUT RESEARCH											
Total area (mln hectares)[a,b]	0.502	0.540	0.745	0.550	0.434	0.564	0.576	0.532	0.659	0.692	0.797
Tot LG[c]	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian[d,e]	0.010	0.010	0.010	0.010	0.008	0.008	0.008	0.008	0.008	0.008	0.008
LG, SR52[f]	0.050	0.050	0.050	0.050	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Tot SM/MED[g,h]	0.442	0.480	0.685	0.490	0.374	0.504	0.516	0.472	0.599	0.632	0.737
SM/MED, local	0.290	0.314	0.449	0.321	0.245	0.330	0.338	0.309	0.392	0.414	0.483
SM/MED, non-Zambian	0.045	0.049	0.070	0.050	0.038	0.051	0.053	0.048	0.061	0.064	0.075
SM/MED, SR52	0.107	0.117	0.166	0.119	0.091	0.122	0.125	0.115	0.146	0.153	0.179
Yield (tons/ha)[i,j]											
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
LG, non-Zambian	5.84	5.84	5.84	5.84	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52	5.43	5.43	5.43	5.43	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Avg SM/MED	0.96	0.64	1.16	1.02	1.44	1.19	2.26	2.01	0.94	2.00	1.79
SM/MED, local	0.83	0.56	1.00	0.88	1.24	1.03	1.43	1.74	0.81	1.73	1.55
SM/MED, non-Zambian	1.36	0.91	1.64	1.44	2.04	1.69	2.35	2.86	1.33	2.83	2.55
SM/MED, SR52	1.13	0.76	1.37	1.20	1.70	1.41	1.96	2.39	1.11	2.37	2.13
Production (mln tons)[k]											
LG, non-Zambian	0.056	0.056	0.056	0.056	0.046	0.046	0.046	0.046	0.046	0.046	0.046
LG, SR-52	0.274	0.274	0.274	0.274	0.284	0.284	0.284	0.284	0.284	0.284	0.284
TOTAL LG	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
SM/MED, local	0.240	0.176	0.449	0.282	0.304	0.340	0.483	0.538	0.318	0.716	0.749
SM/MED, non-Zambian	0.061	0.045	0.115	0.072	0.078	0.087	0.124	0.138	0.081	0.182	0.192
SM/MED, SR-52	0.121	0.089	0.228	0.143	0.155	0.173	0.246	0.274	0.162	0.364	0.382
TOTAL SM/MED	0.423	0.309	0.791	0.497	0.537	0.600	0.852	0.951	0.561	1.262	1.322
Total Production	0.753	0.639	1.121	0.827	0.867	0.930	1.182	1.281	0.891	1.592	1.652
Price (ZK/ton)[l]	100	130	150	178	203	272	315	611	867	889	1389

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Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Production Value (mln ZK)											
LG, non-Zambian	5.61	7.29	8.41	9.97	9.28	12.42	14.36	27.88	39.55	40.56	63.38
LG, SR52	27.37	35.58	41.05	48.65	57.85	77.44	89.52	173.85	246.56	252.88	395.13
Total LG	32.97	42.87	49.46	58.62	67.12	89.87	103.88	201.74	286.11	293.44	458.50
SM/MED, local	24.03	22.88	67.31	50.16	61.83	92.56	151.97	329.02	275.43	636.08	1039.65
SM/MED, non-Zambian	6.13	5.79	17.19	12.78	15.84	23.65	38.89	84.22	70.43	162.03	266.35
SM/MED, SR52	12.14	11.52	34.21	25.38	31.45	47.01	77.27	167.66	140.03	323.28	530.03
Total SM/MED	42.31	40.20	118.71	88.32	109.12	163.22	268.13	580.90	485.88	1121.39	1836.02
Total Production Value (1)	75.28	83.06	168.17	146.94	176.24	253.09	372.01	782.64	771.98	1414.83	2294.52
WITH RESEARCH											
Total area (mln hectares)[m,n]	0.502	0.540	0.745	0.550	0.434	0.564	0.576	0.532	0.659	0.692	0.797
Total Large[o]	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian	0.010	0.010	0.010	0.010	0.008	0.008	0.008	0.013	0.005	0.007	0.010
LG, SR52	0.050	0.050	0.050	0.050	0.052	0.052	0.052	0.000	0.000	0.000	0.000
LG, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.047	0.055	0.053	0.050
Total SM/MED[p]	0.442	0.480	0.685	0.490	0.374	0.504	0.516	0.472	0.599	0.632	0.737
SM/MED, local	0.290	0.314	0.449	0.321	0.245	0.330	0.321	0.227	0.246	0.235	0.246
SM/MED, non-Zambian	0.045	0.049	0.070	0.050	0.038	0.051	0.028	0.020	0.017	0.020	0.145
SM/MED, SR52	0.107	0.117	0.166	0.119	0.091	0.122	0.161	0.115	0.124	0.118	0.000
SM/MED, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.111	0.207	0.257	0.346
Yield (tons/ha)[q,r]											
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.62	6.39	6.03	6.03	6.03
LG, non-Zambian	5.84	5.84	5.84	5.84	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52	5.43	5.43	5.43	5.43	5.45	5.45	5.45				
LG, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	6.54	6.54	6.05	6.06	6.07
Avg SM/MED	0.96	0.64	1.16	1.02	1.44	1.19	1.65	2.21	1.06	2.33	2.22
SM/MED, local	0.83	0.56	1.00	0.88	1.24	1.03	1.43	1.74	0.81	1.73	1.55
SM/MED, non-Zambian	1.36	0.91	1.64	1.44	2.04	1.69	2.35	2.86	1.33	2.83	2.55
SM/MED, SR52	1.13	0.76	1.37	1.20	1.70	1.41	1.96	2.39	1.11	2.37	2.13
SM/MED, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	2.35	2.86	1.33	2.83	2.55

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Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Production (mln tons)[s]											
LG, non-Zambian	0.056	0.056	0.056	0.056	0.046	0.046	0.045	0.074	0.029	0.041	0.060
LG, SR52	0.274	0.274	0.274	0.274	0.284	0.284	0.282	0.000	0.000	0.000	0.000
LG, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.310	0.333	0.321	0.302
LG total	0.330	0.330	0.330	0.330	0.330	0.330	0.379	0.384	0.362	0.362	0.362
SM/MED, local	0.240	0.176	0.449	0.282	0.304	0.340	0.459	0.395	0.199	0.407	0.381
SM/MED, non-Zambian	0.061	0.045	0.115	0.072	0.078	0.087	0.066	0.057	0.023	0.058	0.371
SM/MED, SR52	0.121	0.089	0.228	0.143	0.155	0.173	0.316	0.274	0.138	0.281	0.000
SM/MED, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.316	0.275	0.727	0.883
TOTAL SM/MED	0.423	0.309	0.791	0.497	0.537	0.600	0.851	1.042	0.635	1.473	1.636
Total Production	0.754	0.636	1.118	0.825	0.867	0.929	1.214	1.427	1.003	1.834	1.997
Price (ZK/ton)	100	130	150	178	203	272	315	611	867	889	1389
Production value (mln ZK)											
LG, non-Zambian	5.61	7.29	8.41	9.97	9.28	12.42	14.24	45.26	25.25	36.19	82.88
LG, SR52	27.37	35.58	41.05	48.65	57.85	77.44	88.81	0.00	0.00	0.00	0.00
LG, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	16.30	189.20	288.49	285.71	419.84
Total LG	32.97	42.87	49.46	58.62	67.12	89.87	119.36	234.46	313.74	321.90	502.72
SM/MED, local	24.03	22.88	67.31	50.16	61.83	92.56	144.56	241.46	172.83	361.74	529.82
SM/MED, non-Zambian	6.13	5.79	17.19	12.78	15.84	23.65	20.82	34.76	19.60	51.47	514.94
SM/MED, SR52	12.14	11.52	34.21	25.38	31.45	47.05	99.55	167.45	119.45	249.44	0.00
SM/MED, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	2.90	193.28	238.62	646.39	1227.04
Total SM/MED	42.31	40.20	118.71	88.32	109.12	163.26	267.83	636.96	550.50	1309.04	2271.80
Total Production Value (2)	75.28	83.06	168.17	146.94	176.24	253.12	387.19	871.42	864.24	1630.94	2774.52
Add'l Benefit (3)=(2)-(1)	0.00	0.00	0.00	0.00	0.00	0.00	15.18	88.79	92.26	216.11	480.00
COSTS											
Without Research											
Prod. costs (mln ZK)[t]											
LG, SR52, non-Zambian	28.69	28.69	28.69	28.69	31.98	45.14	63.86	134.15	334.57	264.66	302.66
SM/MED, local, no oxen	6.22	6.59	9.80	6.92	5.47	8.98	16.15	44.11	127.62	106.69	184.11
SM/MED, local, oxen	7.27	7.67	11.46	8.09	6.42	10.54	18.98	51.96	149.19	125.72	219.95
SM/MED, SR52, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, SR52, non-Zambian, oxen	18.65	19.93	29.18	20.71	18.03	33.79	50.39	95.82	278.06	252.06	422.04
Total Prod. costs (4)	60.83	62.87	79.13	64.41	61.89	98.45	149.38	326.04	889.45	749.13	1128.76

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Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
With Research											
Prod. costs (mln ZK)											
LG, SR52, non-Zambian	28.69	28.69	28.69	28.69	31.98	45.14	63.36	28.31	27.77	30.70	51.45
LG, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	8.51	107.16	308.51	235.19	252.55
SM/MED, local, no oxen	6.22	6.59	9.80	6.92	5.47	8.98	15.36	32.37	80.08	60.67	93.83
SM/MED, local, oxen	7.27	7.67	11.46	8.09	6.42	10.54	18.06	38.14	93.61	71.50	112.09
SM/MED, SR52, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, SR52, non-Zambian, oxen	18.65	19.93	29.18	20.71	18.03	33.79	53.72	77.91	189.96	160.66	241.23
SM/MED, Zambian improved, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.15	8.6	36.24	39.67	74.94
SM/MED, Zambian improved, oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.84	46.74	195.51	216.83	411.2
Total Prod. costs (5)	60.83	62.87	79.13	64.41	61.89	98.45	159.99	340.42	931.68	815.22	1237.30
Research costs (mln ZK)											
GRZ expenditures [u]	0.43	0.53	0.65	0.55	0.74	0.73	1.08	1.16	1.91	2.50	4.51
USAID expenditures [v]						0.83	1.57	4.26	9.33	2.03	
SIDA expenditures [w]		0.06	0.07	0.25	0.26	0.30	0.47	0.73	7.37	7.47	9.47
FAO/UNDP expenditures [x]	0.14	0.13	0.14	0.15	0.16	0.21	0.38	0.99	2.20	0.69	0.87
CIMMYT expenditures [y]			0.01	0.01	0.01	0.03	0.07	0.52	0.96	0.94	1.07
Total Research costs (6)	0.57	0.72	0.86	0.97	1.18	2.10	3.56	7.65	21.77	13.63	15.92
Extension costs (mln ZK) [z]											
GRZ and donor expenditures							12.82	18.78	35.02	29.65	36.94
Total Extension costs (7)							12.82	18.78	35.02	29.65	36.94
Seed industry costs (mln ZK)[aa]											
SIDA expenditures		0.16	0.19	0.48	0.60	0.60	0.82	1.87	14.06	9.25	13.05
Zamseed investment expenditures				1.44	0.30	2.71	0.86	0.94	1.10	0.00	0.25
Total seed industry costs (8)	0.00	0.16	0.19	1.92	0.90	3.30	1.68	2.82	15.15	9.25	13.30

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Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Marketing costs and subsidies(mln ZK)[bb]											
GRZ and donor expenditures							83.44	135.97	569.17	642.20	1417.68
Total marketing costs (9)							83.44	135.97	569.17	642.20	1417.68
Total Production, Research, Extension, Seed, Mkting Costs (10)	61.40	63.76	80.18	67.29	63.97	103.85	261.5	505.64	1572.8	1509.95	2721.14
Total Add'l Costs (11)=(10)-(4)	0.57	0.89	1.05	2.88	2.08	5.41	112.12	179.6	683.35	760.83	1592.37
Net Benefit, incl. all costs (12)=(3)-(11)	-0.57	-0.89	-1.05	-2.88	-2.08	-5.41	-96.94	-90.81	-591.10	-544.71	-1112.38
Net Benefit, including add. prod., research costs only (13)=(3)-[(5)+(6)-(4)]	-0.57	-0.72	-0.86	-0.97	-1.18	-2.10	1.0	66.76	28.25	136.39	355.54
Net benefit, incl. add. prod., research,extension costs only (14)=(3)-[(5)+(6)+(7)-(4)]	-0.57	-0.72	-0.86	-0.97	-1.18	-2.10	-11.82	47.98	-6.77	106.74	318.6
Net benefit, incl. add. prod., research, extension, seed costs only (15)=(3)-[(5)+(6)+(7)+(8)-(4)]	-0.57	-0.89	-1.05	-2.88	-2.08	-5.41	-13.50	45.16	-21.93	97.49	305.31
IRR (%), including all costs, 1978-2001 ==>	24.8										
1978-91 ==>	-100.0										
IRR (%), including add. prod., research costs only, 1978-2001 ==>	114.4										
1978-91 only ==	104.5										
IRR (%), including add. prod., research and extension costs only, 1978-2001	107.2										
1978-91 only ==>	93.4										
IRR (%), including add. prod., research, extension and seed costs only, 1978-2001 ==>	99.4										
1978-91 only ==>	82.4										

(For footnotes, see end of Part II of table.)

Table 27: ARR financial analysis, benefit-cost method, part II

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
BENEFITS												
WITHOUT RESEARCH												
Total area (mln hectares)[a,b]	0.668	0.579	0.477	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Tot LG[c]	0.051	0.044	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian[d,e]	0.007	0.006	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
LG, SR52[f]	0.044	0.038	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Tot SM/MED[g,h]	0.617	0.535	0.417	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
SM/MED, local	0.404	0.350	0.273	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288
SM/MED, non-Zambian	0.063	0.055	0.043	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
SM/MED, SR52	0.150	0.130	0.101	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
Yield (tons/ha)[i,j]												
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
LG, non-Zambian	5.86	5.86	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Avg SM/MED	1.49	1.76	0.29	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
SM/MED, local	1.29	1.52	0.25	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
SM/MED, non-Zambian	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
SM/MED, SR52	1.77	2.08	0.34	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
Production (mln tons)[k]												
LG, non-Zambian	0.039	0.034	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
LG, SR52	0.242	0.209	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284
TOTAL LG	0.280	0.242	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
SM/MED, local	0.521	0.532	0.068	0.409	0.409	0.409	0.409	0.409	0.409	0.409	0.409	0.409
SM/MED, non-Zambian	0.133	0.136	0.017	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104
SM/MED, SR52	0.265	0.270	0.034	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207
TOTAL SM/MED	0.920	0.939	0.120	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
Total Production	1.200	1.181	0.450	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051
Price (ZK/ton)[l]	3158	5556	33330	40000	40000	40000	40000	40000	40000	40000	40000	40000

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Production Value (mln ZK)												
LG, non-Zambian	122.54	186.39	1520.85	1825.20	1825.20	1825.20	1825.20	1825.20	1825.20	1825.20	1825.20	1825.20
LG, SR52	762.70	1160.09	9482.05	11379.60	11379.60	11379.60	11379.60	11379.60	11379.60	11379.60	11379.60	11379.60
Total LG	885.25	1346.48	11002.90	13204.80	13204.80	13204.80	13204.80	13204.80	13204.80	13204.80	13204.80	13204.80
SM/MED, local	1646.15	2957.82	2277.53	16369.76	16369.76	16369.76	16369.76	16369.76	16369.76	16369.76	16369.76	16369.76
SM/MED, non-Zambian	421.28	754.55	581.66	4164.86	4164.86	4164.86	4164.86	4164.86	4164.86	4164.86	4164.86	4164.86
SM/MED, SR52	837.95	1501.61	1149.13	8296.99	8296.99	8296.99	8296.99	8296.99	8296.99	8296.99	8296.99	8296.99
Total SM/MED	2905.39	5213.97	4008.32	28831.62	28831.62	28831.62	28831.62	28831.62	28831.62	28831.62	28831.62	28831.62
Total Production Value (1)	3790.63	6560.45	15011.22	42036.42	42036.42	42036.42	42036.42	42036.42	42036.42	42036.42	42036.42	42036.42
WITH RESEARCH												
Total area (mln hectares)[m,n]	0.668	0.579	0.477	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Total Large[o]	0.051	0.044	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian	0.022	0.017	0.015	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
LG, SR52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LG, Zambian improved	0.029	0.027	0.045	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Total SM/MED[p]	0.617	0.535	0.417	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
SM/MED, local	0.182	0.151	0.108	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
SM/MED, non-Zambian	0.108	0.089	0.064	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
SM/MED, SR52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SM/MED, Zambian improved	0.327	0.295	0.245	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258
Yield (tons/ha)[q,r]												
Avg LG	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03
LG, non-Zambian	5.86	5.86	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52												
LG, Zambian improved	6.17	6.14	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09
Avg SM/MED	1.88	2.21	0.37	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09
SM/MED, local	1.29	1.52	0.25	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
SM/MED, non-Zambian	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
SM/MED, SR52	1.77	2.08	0.34	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
SM/MED, Zambian improved	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Production (mln tons)[s]												
LG, non-Zambian	0.130	0.097	0.088	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
LG, SR52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LG, Zambian improved	0.177	0.168	0.274	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
LG total	0.307	0.266	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362
SM/MED, local	0.235	0.229	0.027	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162
SM/MED, non-Zambian	0.229	0.222	0.026	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157
SM/MED, SR52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SM/MED, Zambian improved	0.694	0.734	0.100	0.598	0.598	0.598	0.598	0.598	0.598	0.598	0.598	0.598
TOTAL SM/MED	1.158	1.184	0.154	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918
Total Production	1.464	1.448	0.515	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250
Price (ZK/ton)	3158	5556	33330	40000	40000	40000	40000	40000	40000	40000	40000	40000
Production value (mln ZK)												
LG, non-Zambian	410.98	540.52	2936.41	3201.12	3201.12	3201.12	3201.12	3201.12	3201.12	3201.12	3201.12	3201.12
LG, SR52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LG, Zambian improved	559.76	935.90	9121.91	11283.55	11283.55	11283.55	11283.55	11283.55	11283.55	11283.55	11283.55	11283.55
Total LG	970.75	1476.43	12058.31	14484.67	14484.67	14484.67	14484.67	14484.67	14484.67	14484.67	14484.67	14484.67
SM/MED, local	742.65	1271.18	904.06	6497.92	6497.92	6497.92	6497.92	6497.92	6497.92	6497.92	6497.92	6497.92
SM/MED, non-Zambian	721.97	1232.43	876.48	6275.88	6275.88	6275.88	6275.88	6275.88	6275.88	6275.88	6275.88	6275.88
SM/MED, SR52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, Zambian improved	2190.68	4076.03	3343.39	23939.80	23939.80	23939.80	23939.80	23939.80	23939.80	23939.80	23939.80	23939.80
Total SM/MED	3655.29	6579.64	5123.93	36713.60	36713.60	36713.60	36713.60	36713.60	36713.60	36713.60	36713.60	36713.60
Total Production Value (2)	4626.04	8056.07	17182.25	51198.27	51198.27	51198.27	51198.27	51198.27	51198.27	51198.27	51198.27	51198.27
Add'l Benefit (3)=(2)-(1)	835.41	1495.62	2171.02	9161.86	9161.86	9161.86	9161.86	9161.86	9161.86	9161.86	9161.86	9161.86
COSTS												
Without Research												
Prod. costs (mln ZK)[t]												
LG, SR52, non-Zambian	890.08	1015.44	2977.60	4958.80	4958.80	4958.80	4958.80	4958.80	4958.80	4958.80	4958.80	4958.80
SM/MED, local, no oxen	250.22	270.42	684.99	1676.08	1676.08	1676.08	1676.08	1676.08	1676.08	1676.08	1676.08	1676.08
SM/MED, local, oxen	334.68	370.06	677.77	1761.86	1761.86	1761.86	1761.86	1761.86	1761.86	1761.86	1761.86	1761.86
SM/MED, SR52, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, SR52, non-Zambian, oxen	832.68	941.15	1594.69	3811.91	3811.91	3811.91	3811.91	3811.91	3811.91	3811.91	3811.91	3811.91
Total Prod. costs (4)	2307.66	2597.08	5935.05	12208.65	12208.65	12208.65	12208.65	12208.65	12208.65	12208.65	12208.65	12208.65

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
With Research												
Prod. costs (mln ZK)												
LG, SR52, non-Zambian	388.08	382.82	747.38	1130.61	1130.61	1130.61	1130.61	1130.61	1130.61	1130.61	1130.61	1130.61
LG, Zambian improved	505.09	634.58	2242.72	3853.17	3853.17	3853.17	3853.17	3853.17	3853.17	3853.17	3853.17	3853.17
SM/MED, local, no oxen	112.89	116.22	271.91	665.31	665.31	665.31	665.31	665.31	665.31	665.31	665.31	665.31
SM/MED, local, oxen	150.99	159.04	269.04	699.36	699.36	699.36	699.36	699.36	699.36	699.36	699.36	699.36
SM/MED, SR52, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, SR52, non-Zambian, oxen	421.89	454.48	710.44	1698.23	1698.23	1698.23	1698.23	1698.23	1698.23	1698.23	1698.23	1698.23
SM/MED, Zambian improved, no oxen	168.13	194.54	379.32	848.24	848.24	848.24	848.24	848.24	848.24	848.24	848.24	848.24
SM/MED, Zambian improved, oxen	983.96	1148.28	1897.94	4327.95	4327.95	4327.95	4327.95	4327.95	4327.95	4327.95	4327.95	4327.95
Total Prod. costs (5)	2731.01	3089.96	6518.74	13222.87	13222.87	13222.87	13222.87	13222.87	13222.87	13222.87	13222.87	13222.87
Research costs (mln ZK)												
GRZ expenditures[u]	5.16	14.08	112.10	205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96
USAID expenditures[v]												
SIDA expenditures[w]	21.28	52.75	103.28	189.75	189.75	189.75	189.75	189.75	189.75	189.75	189.75	189.75
FAO/UNDP expenditures[x]	1.84	3.72	7.67	14.10								
CIMMYT expenditures[y]	2.37	3.70	7.51	14.23	14.23	14.23	14.23	14.23	14.23	14.23	14.23	14.23
Total Research costs (6)	30.65	74.25	230.56	424.03	409.93	409.93	409.93	409.93	409.93	409.93	409.93	409.93
Extension costs (mln ZK)[z]												
GRZ and donor expenditures	51.45	97.50	225.57	414.43	414.43	414.43	414.43	414.43	414.43	414.43	414.43	414.43
Total Extension costs (7)	51.45	97.50	225.57	414.43	414.43	414.43	414.43	414.43	414.43	414.43	414.43	414.43
Seed industry costs (mln ZK)[aa]												
SIDA expenditures	22.87	49.45	102.63	188.56	188.56	188.56	188.56	188.56	188.56	188.56	188.56	188.56
Zamseed investment expenditures	0.75	2.88	1.19	16.61	16.61	16.61	16.61	16.61	16.61	16.61	16.61	16.61
Total seed industry costs (8)	23.61	52.33	103.82	205.17	205.17	205.17	205.17	205.17	205.17	205.17	205.17	205.17

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Marketing costs and subsidies(mln ZK) bb/												
GRZ and donor expenditures	1590.70	3375.11	7009.16	6463.16	3255.92	48.69	48.69	48.69	48.69	48.69	48.69	48.69
Total marketing costs (9)	1590.70	3375.11	7009.16	6463.16	3255.92	48.69	48.69	48.69	48.69	48.69	48.69	48.69
Total Production, Research, Extension, Seed, Mkting Costs (10)	4427.42	6689.14	14087.86	20729.67	17508.34	14301.10	14301.10	14301.10	14301.10	14301.10	14301.10	14301.10
Total Add'l Costs (11)=(10)-(4)	2119.76	4092.07	8152.81	8521.02	5299.69	2092.45	2092.45	2092.45	2092.45	2092.45	2092.45	2092.45
Net Benefit, incl. all costs (12)=(3)-(11)	-1284.35	-2596.44	-5981.78	640.83	3862.17	7069.40	7069.40	7069.40	7069.40	7069.40	7069.40	7069.40
Net Benefit, including add. prod., research costs only (13)=(3)-[(5)+(6)-(4)]	381.41	928.5	1356.77	7723.60	7737.70	7737.70	7737.70	7737.70	7737.70	7737.70	7737.70	7737.70
Net benefit, incl. add. prod., research, extension costs only (14)=(3)-[(5)+(6)+(7)-(4)]	329.96	831.00	1131.20	7309.16	7323.26	7323.26	7323.26	7323.26	7323.26	7323.26	7323.26	7323.26
Net benefit, incl. add. prod., research, extension, seed costs only (15)=(3)-[(5)+(6)+(7)+(8)-(4)]	306.35	778.67	1027.37	7103.99	7118.09	7118.09	7118.09	7118.09	7118.09	7118.09	7118.09	7118.09

[a] Sources: 1979 (WB, 1979); 1982-91 CSO Crop Forecasting Survey; 1978, 1980, 1981, 1992-2000 estimates based on marketing data in Table 1 (marketed amount is on average 62% of production); average yields in 1978, 1980, 1981 are estimated at 1.5 tons/ha. This analysis assumes that total area planted to maize remains the same in the with and without research scenarios.

[b] Allocation of maize area between large and small/medium farmers is based on CSO estimates for 1989, 1990, and estimates in Gibson (1987) for other years.

[c] LG refers to large farmers.

[d] Non-Zambian hybrids refer to CG4141, PNR473, R201, R215, ZS 206, and ZS225.

[e] Estimates of large farmer area planted to specific varieties are based on Zamseed sales records (Appendix 10, Tables 57-66)and MSU/MAFF/RDSB Maize Adoption Survey for 1978-83. 1984-2000 projections are based on the without-research assumption of continued availability of SR-52 and non-Zambian hybrids. Large farmers are assumed to plant SR52 and non-Zambian hybrids in the same proportions during 1984-2000 as in 1983.

[f] Here SR52 refers to the Zambian-produced SR52, originally derived from parents imported from (then) Northern Rhodesia at the time of Zambia's independence in 1964.

[g] SM/MED refers to small and medium-scale farmers.

[h] MSU/MAFF/RDSB Maize Adoption Survey data were used to allocate total maize area between different varieties between 1978-83. Projections for the 1984-2000 without-research case were based on the assumption of continued availability of local, SR52 and non-Zambian varieties, and that farmers continued to plant the varieties in the same proportion during 1984-2000 as in 1983.

[i] Average yields for large farmers are estimated at 5.5 tons/ha on average before improved Zambian varieties became available (Gibson, personal communication, 1993). Average yields for small/medium farmers were obtained by dividing CSO maize production estimates by estimates of maize area planted by small/medium farmers 1978-83. For remaining years yield estimates were derived from CSO area data and yield estimates (see j).

[j] The yield advantage of improved Zambian varieties over SR52 is estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties show that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson (personal communication, 1993) estimates that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms. On this basis, it is assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.

[k] Sources: CSO, World Bank for 1978-83 (see Table 2). 1983-1991 estimates based on CSO area data and yield estimates (see j). 1992-2000 estimates based on 1991.

[l] Sources: CSO, MAWD.

[m] Sources: 1979 (WB, 1979); 1982-91 CSO Crop Forecasting Survey; 1978, 1980, 1981, 1992-2000 estimates based on marketing data in Table 1 (marketed amount is on average 62 per cent of production); average yields in 1978, 1980, 1981 are estimated at 1.5 tons/ha. This analysis assumes that total area planted to maize remains the same in the with and without research scenarios.

[n] Allocation of maize area between large and small/medium farmers is based on CSO estimates for 1989, 1990, and estimates in Gibson (1987) for other years.
[o] Estimates of large farmer area planted to specific varieties are based on Zamseed sales records (Appendix 10, Tables 57-66)and MSU/MAFF/RDSB Maize Adoption Survey for 1978-91. 1992-2000 projections are based on 1991 data.
[p] MSU/MAFF/RDSB Maize Adoption Survey data were used to allocate total maize area between different varieties between 1978-91. Projections for 1992-2000 were based on 1991 data.
[q] Average yields for large farmers are estimated at 5.5 tons/ha on average before improved Zambian varieties became available (Gibson, personal communication, 1993). Average large farmer yields were estimated to increase to 6 tons/ha and above following the introduction of improved Zambian varieties. Average yields for small/medium farmers were obtained by dividing CSO maize production estimates by estimates of maize area planted by small/medium farmers 1978-91. 1992-2000 estimates were based on 1991 data.
[r] The yield advantage of improved Zambian varieties over SR52 is estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties show that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson (personal communication, 1993) estimates that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms. On this basis, it is assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.
[s] Sources: CSO, World Bank for 1978-91 (see Table 2). 1992-2000 estimates based on 1991 data.
[t] See Appendix 9, Tables 38, 40, 42, 45, 48, 50, 52, 55. Estimates of per cent of SM/MED farmers using oxen, hand hoe based on MSU/MAFF/RDSB Maize Adoption Survey, 1991
[u] See Appendix 6, Table 30. 1992-2000 expenditure estimates based on 1991 levels.
[v] See Appendix 6, Table 31. Converted to ZK using nominal ZK/SDR and USD/SDR rates (Appendix 2, Table 23).
[w] See Appendix 6, Table 32. 1986-91 converted to ZK using nominal ZK/SDR and SEK/SDR rates (Appendix 2, Table 22). 1992-2000 expenditures are estimated.
[x] See Appendix 6, Table 33. Converted to ZK using nominal ZK/SDR and USD/SDR rates (Appendix 2, Table 23).
[y] See Appendix 6, Table 34. Converted to ZK using nominal ZK/SDR and USD/SDR rates (Appendix 2, Table 23).
[z] See Appendix 7, Table 36. 1992-2000 estimates based on 1991 expenditure.
[aa] See Appendix 6, Tables 32, 35. 1992-2000 estimates based on 1991 expenditure.
[bb] See Appendix 7, Table 37. 1992 and 1993 estimates assume GRZ spending on subsidies declines to 50% and 25% of 1991 expenditures, respectively. Subsidy expenditures for the period 1994-2000 are assumed to decline to 0. Dept. of Coop/Mkting expenditures are assumed to remain constant at 1991 levels for the 1992-2000 period.1992-2000 expenditures estimated at 0 based on GRZ plan to end its participation in maize marketing

Table 28: ARR economic analysis, benefit-cost method, part I

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
BENEFITS											
WITHOUT RESEARCH											
Total area (mln hectares)[a,b]	0.502	0.540	0.745	0.550	0.434	0.564	0.576	0.532	0.659	0.692	0.797
Tot LG[c]	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian[d,e]	0.010	0.010	0.010	0.010	0.008	0.008	0.008	0.008	0.008	0.008	0.008
LG, SR52[f]	0.050	0.050	0.050	0.050	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Tot SM/MED[g,h]	0.442	0.480	0.685	0.490	0.374	0.504	0.516	0.472	0.599	0.632	0.737
SM/MED, local	0.290	0.314	0.449	0.321	0.245	0.330	0.338	0.309	0.392	0.414	0.483
SM/MED, non-Zambian	0.045	0.049	0.070	0.050	0.038	0.051	0.053	0.048	0.061	0.064	0.075
SM/MED,SR52	0.107	0.117	0.166	0.119	0.091	0.122	0.125	0.115	0.146	0.153	0.179
Yield (tons/ha)[i,j]											
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
LG, non-Zambian	5.84	5.84	5.84	5.84	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52	5.43	5.43	5.43	5.43	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Avg SM/MED	0.96	0.64	1.16	1.02	1.44	1.19	2.26	2.01	0.94	2.00	1.79
SM/MED, local	0.83	0.56	1.00	0.88	1.24	1.03	1.43	1.74	0.81	1.73	1.55
SM/MED, non-Zambian	1.36	0.91	1.64	1.44	2.04	1.69	2.35	2.86	1.33	2.83	2.55
SM/MED,SR52	1.13	0.76	1.37	1.20	1.70	1.41	1.96	2.39	1.11	2.37	2.13
Production (mln tons)[k]											
LG, non-Zambian	0.056	0.056	0.056	0.056	0.046	0.046	0.046	0.046	0.046	0.046	0.046
LG, SR52	0.274	0.274	0.274	0.274	0.284	0.284	0.284	0.284	0.284	0.284	0.284
TOTAL LG	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
SM/MED, local	0.240	0.176	0.449	0.282	0.304	0.340	0.483	0.538	0.318	0.716	0.749
SM/MED, non-Zambian	0.061	0.045	0.115	0.072	0.078	0.087	0.124	0.138	0.081	0.182	0.192
SM/MED,SR52	0.121	0.089	0.228	0.143	0.155	0.173	0.246	0.274	0.162	0.364	0.382
TOTAL SM/MED	0.423	0.309	0.791	0.497	0.537	0.600	0.852	0.951	0.561	1.262	1.322
Total Production	0.753	0.639	1.121	0.827	0.867	0.930	1.182	1.281	0.891	1.592	1.652
Price (ZK/ton)[n]	349.23	372.82	526.98	820.92	848.94	929.31	1055.27	1218.28	1738.29	1860.52	2850.11

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Production value (mln ZK)											
LG, non-Zambian	19.58	20.90	29.54	46.02	38.74	42.40	48.15	55.59	79.32	84.90	130.05
LG, SR52	95.57	102.03	144.22	224.66	241.51	264.38	300.21	346.59	494.53	529.30	810.83
Total LG	115.15	122.93	173.76	270.69	280.25	306.78	348.37	402.18	573.84	614.19	940.88
SM/MED, local	83.94	65.63	236.48	231.62	258.15	315.99	509.63	655.91	552.43	1331.36	2133.43
SM/MED, non-Zambian	21.42	16.61	60.39	59.02	66.14	80.74	130.42	167.89	141.25	339.15	546.57
SM/MED,SR52	42.40	33.04	120.19	117.18	131.30	160.48	259.14	334.24	280.85	676.65	1087.66
Total SM/MED	147.75	115.28	417.06	407.82	455.59	557.20	899.19	1158.05	974.53	2347.16	3767.66
Total Production Value (1)	262.90	238.21	590.83	678.51	735.84	863.99	1247.56	1560.23	1548.38	2961.35	4708.54
WITH RESEARCH											
Total area (mln hectares)[m,n]	0.502	0.540	0.745	0.550	0.434	0.564	0.576	0.532	0.659	0.692	0.797
Total Large[o]	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian	0.010	0.010	0.010	0.010	0.008	0.008	0.008	0.013	0.005	0.007	0.010
LG, SR52	0.050	0.050	0.050	0.050	0.052	0.052	0.052	0.000	0.000	0.000	0.000
LG, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.047	0.055	0.053	0.050
Total SM/MED[p]	0.442	0.480	0.685	0.490	0.374	0.504	0.516	0.472	0.599	0.632	0.737
SM/MED, local	0.290	0.314	0.449	0.321	0.245	0.330	0.321	0.227	0.246	0.235	0.246
SM/MED, non-Zambian	0.045	0.049	0.070	0.050	0.038	0.051	0.028	0.020	0.017	0.020	0.145
SM/MED, SR52	0.107	0.117	0.166	0.119	0.091	0.122	0.161	0.115	0.124	0.118	0.000
SM/MED, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.111	0.207	0.257	0.346
Yield (tons/ha)[q,r]											
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.62	6.39	6.03	6.03	6.03
LG, non-Zambian	5.84	5.84	5.84	5.84	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52	5.43	5.43	5.43	5.43	5.45	5.45	5.45				
LG, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	6.54	6.54	6.05	6.06	6.07
Avg SM/MED	0.96	0.64	1.16	1.02	1.44	1.19	1.65	2.21	1.06	2.33	2.22
SM/MED, local	0.83	0.56	1.00	0.88	1.24	1.03	1.43	1.74	0.81	1.73	1.55
SM/MED, non-Zambian	1.36	0.91	1.64	1.44	2.04	1.69	2.35	2.86	1.33	2.83	2.55
SM/MED,SR52	1.13	0.76	1.37	1.20	1.70	1.41	1.96	2.39	1.11	2.37	2.13
SM/MED, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	2.35	2.86	1.33	2.83	2.55

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Production (mln tons)[s]											
LG, non-Zambian	0.056	0.056	0.056	0.056	0.046	0.046	0.045	0.074	0.029	0.041	0.060
LG, SR52	0.274	0.274	0.274	0.274	0.284	0.284	0.282	0.000	0.000	0.000	0.000
LG, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.310	0.333	0.321	0.302
LG total	0.330	0.330	0.330	0.330	0.330	0.330	0.379	0.384	0.362	0.362	0.362
SM/MED, local	0.240	0.176	0.449	0.282	0.304	0.340	0.459	0.395	0.199	0.407	0.381
SM/MED, non-Zambian	0.061	0.045	0.115	0.072	0.078	0.087	0.066	0.057	0.023	0.058	0.371
SM/MED, SR52	0.121	0.089	0.228	0.143	0.155	0.173	0.316	0.274	0.138	0.281	0.000
SM/MED, Zambian improved	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.316	0.275	0.727	0.883
TOTAL SM/MED	0.423	0.309	0.791	0.497	0.537	0.600	0.851	1.042	0.635	1.473	1.636
Total Production	0.754	0.636	1.118	0.825	0.867	0.929	1.214	1.427	1.003	1.834	1.997
Price (ZK/ton)	349.23	372.82	526.98	820.92	848.94	929.31	1055.27	1218.28	1738.29	1860.52	2850.11
Production value (mln ZK)											
LG, non-Zambian	19.58	20.90	29.54	46.02	38.74	42.40	47.77	90.23	50.64	75.75	170.07
LG, SR52	95.57	102.03	144.22	224.66	241.51	264.38	297.84	0.00	0.00	0.00	0.00
LG, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	54.66	377.18	578.63	598.01	861.55
Total LG	115.15	122.93	173.76	270.69	280.25	306.78	400.27	467.41	629.27	673.77	1031.61
SM/MED, local	83.94	65.63	236.48	231.62	258.15	315.99	484.81	481.37	346.64	757.15	1087.24
SM/MED, non-Zambian	21.42	16.61	60.39	59.02	66.14	80.74	69.81	69.30	39.32	107.73	1056.70
SM/MED,SR52	42.40	33.04	120.19	117.18	131.30	160.60	333.85	333.83	239.59	522.10	0.00
SM/MED, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	9.72	385.32	478.60	1352.95	2517.98
Total SM/MED	147.75	115.28	417.06	407.82	455.59	557.33	898.19	1269.82	1104.15	2739.93	4661.91
Total Production Value (2)	262.90	238.21	590.83	678.51	735.84	864.11	1298.46	1737.23	1733.42	3413.70	5693.53
Add'l Benefit (3)=(2)-(1)	0.00	0.00	0.00	0.00	0.00	0.00	50.90	177.00	185.04	452.34	984.99
COSTS											
Without Research[t]											
Prod. costs (mln ZK)											
LG, non-Zambian	13.45	13.52	13.71	14.47	12.57	13.02	17.57	22.71	38.67	45.89	65.19
LG, SR52	68.59	68.96	69.85	73.51	81.22	83.79	114.25	147.62	253.07	301.32	429.08
SM/MED, local, no oxen	7.28	7.37	11.81	8.23	6.98	10.37	18.68	45.03	125.51	111.07	194.61
SM/MED, local, oxen	8.62	8.67	14.04	9.76	8.34	12.31	22.24	53.14	146.48	131.34	233.43
SM/MED, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, non-Zambian, oxen	10.35	10.91	16.62	12.63	10.73	16.40	23.61	38.45	87.68	89.99	162.56
SM/MED, SR-52, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SM/MED, SR-52, oxen	22.04	23.30	35.30	26.56	22.34	34.21	50.94	84.91	199.45	202.00	369.7
Total Prod. costs (4)	130.33	132.72	161.33	145.16	142.18	170.09	247.3	391.86	850.86	881.62	1454.56

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
With Research											
Prod. costs ('mln ZK)											
LG, non-Zambian	13.45	13.52	13.71	14.47	12.57	13.02	17.44	36.86	24.69	40.95	85.24
LG, SR-52	68.59	68.96	69.85	73.51	81.22	83.79	113.34	0.00	0.00	0.00	0.00
LG, Zambian improved	0.00	0.00	0.00	0.00	0.00	0.00	17.54	135.71	268.75	308.51	412.43
SM/MED, local, no oxen	7.28	7.37	11.81	8.23	6.98	10.37	17.77	33.04	78.76	63.17	99.18
SM/MED, local, oxen	8.62	8.67	14.04	9.76	8.34	12.31	21.15	39.00	91.91	74.69	118.96
SM/MED, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, non-Zambian, oxen	10.35	10.91	16.62	12.63	10.73	16.40	12.64	15.87	24.40	28.59	314.28
SM/MED, SR-52, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, SR-52, oxen	22.04	23.30	35.30	26.56	22.34	34.21	65.66	84.81	170.15	155.87	0.00
SM/MED, Zambian improved, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.23	11.21	37.12	46.38	96.84
SM/MED, Zambian improved, oxen	0.00	0.00	0.00	0.00	0.00	0.00	1.27	61.86	200.65	255.78	538.28
Total Prod. costs (5)	130.33	132.72	161.33	145.16	142.18	170.09	267.05	418.36	896.44	973.93	1665.21
Research costs (mln ZK)											
GRZ expenditures[u]	1.09	1.33	1.71	1.30	1.87	1.38	1.66	1.22	1.74	2.89	6.11
USAID expenditures[v]						2.91	3.74	4.99	7.06	2.66	
SIDA expenditures[w]		0.21	0.24	0.90	0.99	0.85	1.12	0.85	5.59	9.77	15.37
FAO/UNDP expenditures[x]	0.47	0.45	0.49	0.55	0.60	0.60	0.91	1.15	1.67	0.91	1.41
CIMMYT expenditures[y]			0.03	0.05	0.06	0.08	0.17	0.61	0.73	1.23	1.74
Total Research costs (6)	1.56	1.99	2.47	2.79	3.52	5.82	7.60	8.82	16.79	17.46	24.62
Extension costs (mln ZK)[z]											
GRZ and donor expenditures							22.27	20.82	29.00	36.51	52.97
Total Extension costs (7)							22.27	20.82	29.00	36.51	52.97
Seed industry costs (mln ZK)[aa]											
SIDA expenditures		0.57	0.66	1.72	2.26	1.68	1.97	2.19	10.66	12.10	21.16
Zamseed investment expenditures				1.44	0.30	2.71	0.86	0.94	1.10	0.00	0.25
Total seed industry costs (8)	0.00	0.57	0.66	3.16	2.56	4.39	2.83	3.13	11.76	12.10	21.41

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Marketing costs and subsidies (mln ZK)[bb]											
GRZ and donor expenditures							145.96	148.41	493.78	750.77	1902.07
Total marketing costs (9)							145.96	148.41	493.78	750.77	1902.07
Total Production, Research, Extension, Seed, Mkting Costs (10)	131.89	135.28	164.46	151.11	148.26	180.30	445.71	599.55	1447.76	1790.77	3666.29
Total Add'l Costs (11)=(10)-(4)	1.56	2.56	3.13	5.95	6.09	10.20	198.41	207.69	596.90	909.14	2211.72
Net Benefit , incl. all costs (12)=(3)-(11)	-1.56	-2.56	-3.13	-5.95	-6.09	-10.20	-147.51	-30.69	-411.86	-456.80	-1226.73
Net Benefit, including add. prod., research costs only (13)=(3)-[(5)+(6)-(4)]	-1.56	-1.99	-2.47	-2.79	-3.52	-5.82	23.55	141.68	122.67	342.58	749.73
Net benefit, incl. add. prod., research extension costs only (14)=(3)-[(5)+(6)+(7)-(4)]	-1.56	-1.99	-2.47	-2.79	-3.52	-5.82	1.28	120.86	93.67	306.07	696.75
Net benefit, incl. add. prod., research extension, seed costs only (15)=(3)-[(5)+(6)+(7)+(8)-(4)]	-1.56	-2.56	-3.13	-5.95	-6.09	-10.20	-1.55	117.72	81.91	293.97	675.34
IRR (%), including all costs ====> 1978-2001	36.3										
1978-91 ==>	-100.0										
IRR (%), including add. prod., research costs only, 1978-2001 ==>	110.3										
1978-91 ==>	103.0										
IRR (%), including add. prod., research and extension costs only, 1978-2001 ==>	106.1										
1978-91 ==>	97.6										
IRR (%), including add. prod., research, extension and seed costs only, 1978-2001 ==>	99.7										
1978-91 ==>	89.6										

(For footnotes, see end of Part II of table.)

Table 28: ARR economic analysis, benefit-cost method, part II

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
BENEFITS												
WITHOUT RESEARCH												
Total area (mln hectares)[a,b]	0.668	0.579	0.477	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Tot LG[c]	0.051	0.044	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian[d,e]	0.007	0.006	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
LG, SR52[f]	0.044	0.038	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Tot SM/MED[g,h]	0.617	0.535	0.417	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
SM/MED, local	0.404	0.350	0.273	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288
SM/MED, non-Zambian	0.063	0.055	0.043	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
SM/MED, SR52	0.150	0.130	0.101	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
Yield (tons/ha)[i,j]												
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
LG, non-Zambian	5.86	5.86	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR52	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Avg SM/MED	1.49	1.76	0.29	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
SM/MED, local	1.29	1.52	0.25	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
SM/MED, non-Zambian	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
SM/MED, SR52	1.77	2.08	0.34	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
Production (mln tons)[k]												
LG, non-Zambian	0.039	0.034	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
LG, SR52	0.242	0.209	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284
TOTAL LG	0.280	0.242	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
SM/MED, local	0.521	0.532	0.068	0.409	0.409	0.409	0.409	0.409	0.409	0.409	0.409	0.409
SM/MED, non-Zambian	0.133	0.136	0.017	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104
SM/MED, SR52	0.265	0.270	0.034	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207
TOTAL SM/MED	0.920	0.939	0.120	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
Total Production	1.200	1.181	0.450	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051
Price (ZK/ton)[l]	4977.51	13530.81	25667.73	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Production value (mln ZK)												
LG, non-Zambian	193.16	453.95	1171.22	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11
LG, SR52	1202.23	2825.45	7302.21	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26
Total LG	1395.39	3279.40	8473.43	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38
SM/MED, local	2594.78	7203.90	1753.95	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63
SM/MED, non-Zambian	664.06	1837.73	447.94	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91
SM/MED,SR52	1320.84	3657.23	884.95	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60
Total SM/MED	4579.67	12698.86	3086.84	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14
Total Production Value (1)	5975.06	15978.26	11560.28	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51
WITH RESEARCH												
Total area (mln hectares)[m,n]	0.668	0.579	0.477	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Total Large[o]	0.051	0.044	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian	0.022	0.017	0.015	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
LG, SR-52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LG, Zambian improved	0.029	0.027	0.045	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Total SM/MED[p]	0.617	0.535	0.417	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
SM/MED, local	0.182	0.151	0.108	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
SM/MED, non-Zambian	0.108	0.089	0.064	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
SM/MED, SR-52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SM/MED, Zambian improved	0.327	0.295	0.245	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258
Yield (tons/ha)[q,r]												
Avg LG	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03	6.03
LG, non-Zambian	5.86	5.86	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR-52												
LG, Zambian improved	6.17	6.14	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09
Avg SM/MED	1.88	2.21	0.37	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09
SM/MED, local	1.29	1.52	0.25	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
SM/MED, non-Zambian	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
SM/MED,SR-52	1.77	2.08	0.34	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
SM/MED, Zambian improved	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Production (mln tons)[s]												
LG, non-Zambian	0.130	0.097	0.088	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
LG, SR-52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LG, Zambian improved	0.177	0.168	0.274	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
LG total	0.307	0.266	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362
SM/MED, local	0.235	0.229	0.027	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162
SM/MED, non-Zambian	0.229	0.222	0.026	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157
SM/MED, SR-52	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SM/MED, Zambian improved	0.694	0.734	0.100	0.598	0.598	0.598	0.598	0.598	0.598	0.598	0.598	0.598
TOTAL SM/MED	1.158	1.184	0.154	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918
Total Production	1.464	1.448	0.515	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250
Price (ZK/ton)	4977.51	13530.81	25667.73	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14
Production value (mln ZK)												
LG, non-Zambian	647.82	1316.47	2261.35	6475.40	6475.40	6475.40	6475.40	6475.40	6475.40	6475.40	6475.40	6475.40
LG, SR-52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LG, Zambian improved	882.34	2279.44	7024.86	22824.97	22824.97	22824.97	22824.97	22824.97	22824.97	22824.97	22824.97	22824.97
Total LG	1530.16	3595.90	9286.22	29300.37	29300.37	29300.37	29300.37	29300.37	29300.37	29300.37	29300.37	29300.37
SM/MED, local	1170.62	3096.03	696.22	13144.34	13144.34	13144.34	13144.34	13144.34	13144.34	13144.34	13144.34	13144.34
SM/MED, non-Zambian	1138.01	3001.63	674.98	12695.18	12695.18	12695.18	12695.18	12695.18	12695.18	12695.18	12695.18	12695.18
SM/MED,SR-52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, Zambian improved	3453.10	9927.36	2574.78	48426.71	48426.71	48426.71	48426.71	48426.71	48426.71	48426.71	48426.71	48426.71
Total SM/MED	5761.73	16025.01	3945.99	74266.23	74266.23	74266.23	74266.23	74266.23	74266.23	74266.23	74266.23	74266.23
TotaProduction Value (2)	7291.89	19620.92	13232.20	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60
Add'l Benefit (3)=(2)-(1)	1316.83	3642.66	1671.92	18533.09	18533.09	18533.09	18533.09	18533.09	18533.09	18533.09	18533.09	18533.09
COSTS												
Without Research												
Prod. costs (mln ZK)[t]												
LG, non-Zambian	143.64	343.04	713.77	1267.48	1267.48	1267.48	1267.48	1267.48	1267.48	1267.48	1267.48	1267.48
LG, SR-52	944.65	2245.01	4658.72	8293.41	8293.41	8293.41	8293.41	8293.41	8293.41	8293.41	8293.41	8293.41
SM/MED, local, no oxen	267.76	298.98	697.56	1848.82	1848.82	1848.82	1848.82	1848.82	1848.82	1848.82	1848.82	1848.82
SM/MED, local, oxen	357.19	406.70	693.90	1983.51	1983.51	1983.51	1983.51	1983.51	1983.51	1983.51	1983.51	1983.51
SM/MED, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, non-Zambian, oxen	259.33	440.50	683.08	1654.48	1654.48	1654.48	1654.48	1654.48	1654.48	1654.48	1654.48	1654.48
SM/MED, SR-52, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SM/MED, SR-52, oxen	580.28	938.96	1506.28	3678.95	3678.95	3678.95	3678.95	3678.95	3678.95	3678.95	3678.95	3678.95
Total Prod. costs (4)	2552.85	4673.19	8953.31	18726.66	18726.66	18726.66	18726.66	18726.66	18726.66	18726.66	18726.66	18726.66

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
With Research												
Prod. costs ('mln ZK)												
LG, non-Zambian	481.74	994.83	1378.13	2222.97	2222.97	2222.97	2222.97	2222.97	2222.97	2222.97	2222.97	2222.97
LG, SR-52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LG, Zambian improved	618.45	1612.98	4042.29	7427.06	7427.06	7427.06	7427.06	7427.06	7427.06	7427.06	7427.06	7427.06
SM/MED, local, no oxen	120.80	128.49	276.90	733.88	733.88	733.88	733.88	733.88	733.88	733.88	733.88	733.88
SM/MED, local, oxen	161.14	174.79	275.44	787.35	787.35	787.35	787.35	787.35	787.35	787.35	787.35	787.35
SM/MED, non-Zambian, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, non-Zambian, oxen	444.41	719.48	1029.30	2493.07	2493.07	2493.07	2493.07	2493.07	2493.07	2493.07	2493.07	2493.07
SM/MED, SR-52, no oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, SR-52, oxen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SM/MED, Zambian improved, no oxen	169.02	289.92	516.96	1222.69	1222.69	1222.69	1222.69	1222.69	1222.69	1222.69	1222.69	1222.69
SM/MED, Zambian improved, oxen	983.93	1697.87	2696.65	6459.70	6459.70	6459.70	6459.70	6459.70	6459.70	6459.70	6459.70	6459.70
Total Prod. costs (5)	2984.70	5622.21	10215.66	21387.81	21387.81	21387.81	21387.81	21387.81	21387.81	21387.81	21387.81	21387.81
Research costs (mln ZK)												
GRZ expenditures[u]	6.10	24.61	200.77	368.66	368.66	368.66	368.66	368.66	368.66	368.66	368.66	368.66
USAID expenditures[v]												
SIDA expenditures[w]	31.08	107.65	189.05	376.27	376.27	376.27	376.27	376.27	376.27	376.27	376.27	376.27
FAO/UNDP expenditures[x]	2.69	7.58	14.05	27.96								
CIMMYT expenditures[y]	3.46	7.55	13.74	28.22	28.22	28.22	28.22	28.22	28.22	28.22	28.22	28.22
Total Research costs (6)	43.32	147.40	417.61	801.11	773.15	773.15	773.15	773.15	773.15	773.15	773.15	773.15
Extension costs (mln ZK)[z]												
GRZ and donor expenditures	65.20	170.86	404.25	742.71	742.71	742.71	742.71	742.71	742.71	742.71	742.71	742.71
Total Extension costs (7)	65.20	170.86	404.25	742.71	742.71	742.71	742.71	742.71	742.71	742.71	742.71	742.71
Seed industry costs (mln ZK)[aa]												
SIDA expenditures	33.41	100.91	187.87	373.92	373.92	373.92	373.92	373.92	373.92	373.92	373.92	373.92
Zamseed investment expenditures	0.75	2.88	1.19	16.61	16.61	16.61	16.61	16.61	16.61	16.61	16.61	16.61
Total seed industry costs (8)	34.15	103.79	189.06	390.53	390.53	390.53	390.53	390.53	390.53	390.53	390.53	390.53

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Marketing costs and subsidies(mln ZK)[bb]												
GRZ and donor expenditures	1993.09	5302.74	10201.25	9936.05	4989.94	48.69	48.69	48.69	48.69	48.69	48.69	48.69
Total marketing costs (9)	1993.09	5302.74	10201.25	9936.05	4989.94	48.69	48.69	48.69	48.69	48.69	48.69	48.69
Total Production, Research, Extension, Seed, Mkting Costs (10)	5120.47	11347.00	21427.82	33258.21	28284.14	23342.89	23342.89	23342.89	23342.89	23342.89	23342.89	23342.89
Total Add'l Costs (11)=(10)-(4)	2567.63	6673.81	12474.51	14531.55	9557.49	4616.23	4616.23	4616.23	4616.23	4616.23	4616.23	4616.23
Net Benefit , incl. all costs (12)=(3)-(11)	-1250.78	-3031.15	-10802.6	4001.54	8975.61	13916.86	13916.86	13916.86	13916.86	13916.86	13916.86	13916.86
Net Benefit, including add. prod., research costs only (13)=(3)-[(5)+(6)-(4)]	841.65	2546.24	-8.03	15070.83	15098.79	15098.79	15098.79	15098.79	15098.79	15098.79	15098.79	15098.79
Net benefit, incl. add. prod., research extension costs only (14)=(3)-[(5)+(6)+(7)-(4)]	776.45	2375.38	-412.28	14328.12	14356.08	14356.08	14356.08	14356.08	14356.08	14356.08	14356.08	14356.08
Net benefit, incl. add. prod., research extension, seed costs only (15)=(3)-[(5)+(6)+(7)+(8)-(4)]	742.3	2271.59	-601.34	13937.59	13965.55	13965.55	13965.55	13965.55	13965.55	13965.55	13965.55	13965.55

[a] Sources: 1979 (WB, 1979); 1982-91 CSO Crop Forecasting Survey; 1978, 1980, 1981, 1992-2000 estimates based on marketing data in Table 1 (marketed amount is on average 62% of production); average yields in 1978, 1980, 1981 are estimated at 1.5 tons/ha. This analysis assumes that total area planted to maize remains the same in the with and without research scenarios.
[b] Allocation of maize area between large and small/medium farmers is based on CSO estimates for 1989, 1990, and estimates in Gibson (1987) for other years.
[c] LG refers to large farmers.
[d] Non-Zambian hybrids refer to CG4141, PNR473, R201, R215, ZS 206, and ZS225.
[e] Estimates of large farmer area planted to specific varieties are based on Zamseed sales records (Appendix 10, Tables 57-66)and MSU/MAFF/RDSB Maize Adoption Survey for 1978-83. 1984-2000 projections are based on the without-research assumption of continued availability of SR-52 and non-Zambian hybrids. Large farmers are assumed to plant SR52 and non-Zambian hybrids in the same proportions during 1984-2000 as in 1983.
[f] Here SR52 refers to the Zambian-produced SR52, originally derived from parents imported from (then) Northern Rhodesia at the time of Zambia's independence in 1964.
[g] SM/MED refers to small and medium-scale farmers.
[h] MSU/MAFF/RDSB Maize Adoption Survey data were used to allocate total maize area between different varieties between 1978-83. Projections for the 1984-2000 without-research case were based on the assumption of continued availability of local, SR52 and non-Zambian varieties, and that farmers continued to plant the varieties in the same proportion during 1984-2000 as in 1983.

[i] Average yields for large farmers are estimated at 5.5 tons/ha on average before improved Zambian varieties became available (Gibson, personal communication, 1993). Average yields for small/medium farmers were obtained by dividing CSO maize production estimates by estimates of maize area planted by small/medium farmers 1978-83. For remaining years yield estimates were derived from CSO area data and yield estimates (see j).
[j] The yield advantage of improved Zambian varieties over SR52 is estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties show that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson (personal communication, 1993) estimates that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms. On this basis, it is assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.
[k] Sources: CSO, World Bank for 1978-83 (see Table 2). 1983-1991 estimates based on CSO area data and yield estimates (see j). 1992-2000 estimates based on 1991.

[l] Import parity price. See Appendix 2, Table 24.
[m] Sources: 1979 (WB, 1979); 1982-91 CSO Crop Forecasting Survey; 1978, 1980, 1981, 1992-2000 estimates based on marketing data in Table 1 (marketed amount is on average 62 per cent of production); average yields in 1978, 1980, 1981 are estimated at 1.5 tons/ha. This analysis assumes that total area planted to maize remains the same in the with and without research scenarios.
[n] Allocation of maize area between large and small/medium farmers is based on CSO estimates for 1989, 1990, and estimates in Gibson (1987) for other years.
[o] Estimates of large farmer area planted to specific varieties are based on Zamseed sales records (Appendix 10, Tables 57-66)and MSU/MAFF/RDSB Maize Adoption Survey for 1978-91. 1992-2000 projections are based on 1991 data.
[p] MSU/MAFF/RDSB Maize Adoption Survey data were used to allocate total maize area between different varieties between 1978-91. Projections for 1992-2000 were based on 1991 data.
[q] Average yields for large farmers are estimated at 5.5 tons/ha on average before improved Zambian varieties became available (Gibson, personal communication, 1993). Average large farmer yields were estimated to increase to 6 tons/ha and above following the introduction of improved Zambian varieties. Average yields for small/medium farmers were obtained by dividing CSO maize production estimates by estimates of maize area planted by small/medium farmers 1978-91. 1992-2000 estimates were based on 1991 data.
[r] The yield advantage of improved Zambian varieties over SR52 is estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties show that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson (personal communication, 1993) estimates that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms. On this basis, it is assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.
[s] Sources: CSO, World Bank for 1978-91 (see Table 2). 1992-2000 estimates based on 1991 data.
[t] See Appendix 9, Tables 39, 41, 43, 44, 46, 47, 48, 51, 53, 54, 56. Estimates of per cent of SM/MED farmers using oxen, hand hoe based on MSU/MAFF/RDSB Maize Adoption Survey, 1991

[u] See Appendix 6, Table 30a. 1992-2000 expenditure estimates based on 1991 levels.
[v] See Appendix 6, Table 31. Converted to ZK using nominal ZK/SDR and USD/SDR rates (Appendix 2, Table 23).
[w] See Appendix 6, Table 32. 1986-91 converted to ZK using nominal ZK/SDR and SEK/SDR rates (Appendix 2, Table 23). 1992-2000 expenditures are estimated.
[x] See Appendix 6, Table 33. Converted to ZK using nominal ZK/SDR and USD/SDR rates (Appendix 2, Table 23).
[y] See Appendix 6, Table 34. Converted to ZK using nominal ZK/SDR and USD/SDR rates (Appendix 2, Table 23).
[z] See Appendix 7, Table 36a. 1992-2000 estimates based on 1991 expenditure.
[aa] See Appendix 6, Tables 32, 35. 1992-2000 estimates based on 1991 expenditure.
[bb] See Appendix 7, Table 37a. 1992 and 1993 estimates assume GRZ spending on subsidies declines to 50% and 25% of 1991 expenditures, respectively. Subsidy expenditures for the period 1994-2000 are assumed to decline to 0. Dept. of Coop/Mkting expenditures are assumed to remain constant at 1991 levels for the 1992-2000 period.1992-2000 expenditures estimated at 0 based on GRZ plan to end its participation in maize marketing

Table 29: ARR economic analysis, Akino-Hayami method, part I

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
BENEFITS											
WITHOUT RESEARCH											
Total area (mln hectares)[a,b]	0.502	0.540	0.745	0.550	0.434	0.564	0.576	0.532	0.659	0.692	0.797
Tot LG[c]	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian[d,e]	0.010	0.010	0.010	0.010	0.008	0.008	0.008	0.008	0.008	0.008	0.008
LG, SR52[f]	0.050	0.050	0.050	0.050	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Tot SM/MED[g,h]	0.442	0.480	0.685	0.490	0.374	0.504	0.516	0.472	0.599	0.632	0.737
SM/MED, local	0.290	0.314	0.449	0.321	0.245	0.330	0.338	0.309	0.392	0.414	0.483
SM/MED, non-Zambian	0.045	0.049	0.070	0.050	0.038	0.051	0.053	0.048	0.061	0.064	0.075
SM/MED,SR52	0.107	0.117	0.166	0.119	0.091	0.122	0.125	0.115	0.146	0.153	0.179
Yield (tons/ha)[i,j]											
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
LG, non-Zambian	5.84	5.84	5.84	5.84	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR-52	5.43	5.43	5.43	5.43	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Avg SM/MED	0.96	0.64	1.16	1.02	1.44	1.19	2.26	2.01	0.94	2.00	1.79
SM/MED, local	0.83	0.56	1.00	0.88	1.24	1.03	1.43	1.74	0.81	1.73	1.55
SM/MED, non-Zambian	1.36	0.91	1.64	1.44	2.04	1.69	2.35	2.86	1.33	2.83	2.55
SM/MED,SR-52	1.13	0.76	1.37	1.20	1.70	1.41	1.96	2.39	1.11	2.37	2.13
Production (mln tons)[k]											
LG, non-Zambian	0.056	0.056	0.056	0.056	0.046	0.046	0.046	0.046	0.046	0.046	0.046
LG, SR-52	0.274	0.274	0.274	0.274	0.284	0.284	0.284	0.284	0.284	0.284	0.284
TOTAL LG	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
SM/MED, local	0.240	0.176	0.449	0.282	0.304	0.340	0.483	0.538	0.318	0.716	0.749
SM/MED, non-Zambian	0.061	0.045	0.115	0.072	0.078	0.087	0.124	0.138	0.081	0.182	0.192
SM/MED,SR-52	0.121	0.089	0.228	0.143	0.155	0.173	0.246	0.274	0.162	0.364	0.382
TOTAL SM/MED	0.423	0.309	0.791	0.497	0.537	0.600	0.852	0.951	0.561	1.262	1.322
Total Production	0.753	0.639	1.121	0.827	0.867	0.930	1.182	1.281	0.891	1.592	1.652
Price (ZK/ton)[l]	349.23	372.82	526.98	820.92	848.94	929.31	1055.27	1218.28	1738.29	1860.52	2850.11

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Production value (mln ZK)											
LG, non-Zambian	19.58	20.90	29.54	46.02	38.74	42.40	48.15	55.59	79.32	84.90	130.05
LG, SR-52	95.57	102.03	144.22	224.66	241.51	264.38	300.21	346.59	494.53	529.30	810.83
Total LG	115.15	122.93	173.76	270.69	280.25	306.78	348.37	402.18	573.84	614.19	940.88
SM/MED, local	83.94	65.63	236.48	231.62	258.15	315.99	509.63	655.91	552.43	1331.36	2133.43
SM/MED, non-Zambian	21.42	16.61	60.39	59.02	66.14	80.74	130.42	167.89	141.25	339.15	546.57
SM/MED,SR-52	42.40	33.04	120.19	117.18	131.30	160.48	259.14	334.24	280.85	676.65	1087.66
Total SM/MED	147.75	115.28	417.06	407.82	455.59	557.20	899.19	1158.05	974.53	2347.16	3767.66
Total Production Value	262.90	238.21	590.83	678.51	735.84	863.99	1247.56	1560.23	1548.38	2961.35	4708.54
WITH RESEARCH											
Total area cultivated (mln hectares)[m]	0.502	0.540	0.745	0.550	0.434	0.564	0.576	0.532	0.659	0.692	0.797
Area in improved varieties[n]	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.158	0.262	0.310	0.396
Proportion, improved varieties (1)	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.297	0.398	0.448	0.497
Weighted yield, local,imported, SR-52 (tons/ha)[o]	1.503	1.180	1.509	1.509	2.001	1.649	2.598	2.405	1.351	2.302	2.072
Weighted yield, improved varieties (tons/ha)[p]	0.000	0.000	0.000	0.000	0.000	0.000	2.787	3.275	1.760	3.110	2.815
Yield gain	0.000	0.000	0.000	0.000	0.000	0.000	0.189	0.869	0.408	0.809	0.743
Yield gain/imp.var.yield (2)	0.000	0.000	0.000	0.000	0.000	0.000	0.068	0.266	0.232	0.260	0.264
K-factor (3) = (1) x (2)[p]	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.079	0.092	0.117	0.131
Price (ZK/ton)	349.23	372.82	526.98	820.92	848.94	929.31	1055.27	1218.28	1738.29	1860.52	2850.11
Total Production (mln tons)	0.75	0.64	1.12	0.82	0.87	0.93	1.21	1.43	1.00	1.83	2.00
Total Production Value (mln ZK) (4)	262.90	238.21	590.83	678.51	735.84	864.11	1298.46	1737.23	1733.42	3413.70	5693.53
Price elasticity of supply[q]	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Price elasticity of demand[q]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Benefit 1: Area A0C (3) x (4)[r]	0.00	0.00	0.00	0.00	0.00	0.00	1.81	136.82	159.90	397.88	746.89
Benefit 2: Area ABC[s]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.56	26.77	84.17	177.83
Total benefits (mln ZK)	0.0	0.0	0.0	0.0	0.0	0.0	1.8	156.4	186.7	482.1	924.7
Total add'l prod. costs[t]	0.00	0.00	0.00	0.00	0.00	0.00	19.75	26.50	45.58	92.31	210.65
Total research costs[u]	1.56	1.99	2.47	2.79	3.52	5.82	7.60	8.82	16.79	17.46	24.62
Total extension costs[v]	0.00	0.00	0.00	0.00	0.00	0.00	22.27	20.82	29.00	36.51	52.97
Total seed costs[w]	0.00	0.57	0.66	3.16	2.56	4.39	2.83	3.13	11.76	12.10	21.41
Total marketing costs[x]	0.00	0.00	0.00	0.00	0.00	0.00	145.96	148.41	493.78	750.77	1902.07
Total net benefit, all costs (mln ZK)	-1.6	-2.6	-3.1	-6.0	-6.1	-10.2	-196.6	-51.3	-410.2	-427.1	-1287.0

Category	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
IRR (%), including all costs, 1978-2001 ==>	37.34										
IRR (%), including all costs, 1978-91 ==>	-100.00										
Total net benefit, add. prod, res. costs only	-1.56	-1.99	-2.47	-2.79	-3.52	-5.82	-25.53	121.06	124.31	372.29	689.45
IRR (%) for above costs, 1978-2001 ==>	106.21										
IRR (%) for above costs, 1978-91 ==>	96.85										
Total net benefit, add. prod.,res.,ext. costs	-1.56	-1.99	-2.47	-2.79	-3.52	-5.82	-47.80	100.24	95.31	335.78	636.47
IRR (%) for above costs, 1978-2001 ==>	102.08										
IRR (%) for above costs, 1978-91 ==>	91.15										
Total net ben., add. prod.,res.,ext.,seed costs	-1.56	-2.56	-3.13	-5.95	-6.09	-10.20	-50.63	97.10	83.55	323.68	615.06
IRR (%) for above costs, 1978-2001 ==>	96.19										
IRR (%) for above costs, 1978-91 ==>	83.67										

(For footnotes, see end of Part II of table.)

Table 29: ARR economic analysis, Akino-Hayami method, part II

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
BENEFITS												
WITHOUT RESEARCH												
Total area (mln hectares)[a,b]	0.668	0.579	0.477	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Tot LG[c]	0.051	0.044	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
LG, non-Zambian[d,e]	0.007	0.006	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
LG, SR52[f]	0.044	0.038	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Tot SM/MED[g,h]	0.617	0.535	0.417	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
SM/MED, local	0.404	0.350	0.273	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288
SM/MED, non-Zambian	0.063	0.055	0.043	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
SM/MED,SR-52	0.150	0.130	0.101	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
Yield (tons/ha)[i,j]												
Avg LG	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
LG, non-Zambian	5.86	5.86	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85	5.85
LG, SR-52	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Avg SM/MED	1.49	1.76	0.29	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
SM/MED, local	1.29	1.52	0.25	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
SM/MED, non-Zambian	2.12	2.49	0.41	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
SM/MED,SR-52	1.77	2.08	0.34	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.94
Production (mln tons)[k]												
LG, non-Zambian	0.039	0.034	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
LG, SR-52	0.242	0.209	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284
TOTAL LG	0.280	0.242	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
SM/MED, local	0.521	0.532	0.068	0.409	0.409	0.409	0.409	0.409	0.409	0.409	0.409	0.409
SM/MED, non-Zambian	0.133	0.136	0.017	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104
SM/MED,SR-52	0.265	0.270	0.034	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207
TOTAL SM/MED	0.920	0.939	0.120	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
Total Production	1.200	1.181	0.450	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051	1.051
Price (ZK/ton)[l]	4977.51	13530.81	25667.73	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Production value (mln ZK)												
LG, non-Zambian	193.16	453.95	1171.22	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11	3692.11
LG, SR-52	1202.23	2825.45	7302.21	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26	23019.26
Total LG	1395.39	3279.40	8473.43	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38	26711.38
SM/MED, local	2594.78	7203.90	1753.95	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63	33113.63
SM/MED, non-Zambian	664.06	1837.73	447.94	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91	8424.91
SM/MED, SR-52	1320.84	3657.23	884.95	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60	16783.60
Total SM/MED	4579.67	12698.86	3086.84	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14	58322.14
Total Production Value	5975.06	15978.26	11560.28	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51	85033.51
WITH RESEARCH												
Total area cultivated (mln hectares)[m]	0.668	0.579	0.477	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Area in improved varieties[n]	0.356	0.322	0.290	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
Proportion, improved varieties (1)	0.533	0.556	0.607	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609
Weighted yield, local,imported, SR52(tons/ha)[o]	1.797	2.040	0.943	2.102	2.102	2.102	2.102	2.102	2.102	2.102	2.102	2.102
Weighted yield, improved varieties (tons/ha)[o]	2.429	2.768	1.124	2.772	2.772	2.772	2.772	2.772	2.772	2.772	2.772	2.772
Yield gain	0.632	0.728	0.181	0.671	0.671	0.671	0.671	0.671	0.671	0.671	0.671	0.671
Yield gain/imp.var.yield (2)	0.260	0.263	0.161	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242
K-factor (3) = (1) x (2)[p]	0.139	0.146	0.098	0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.147
Price (ZK/ton)	4977.51	13530.81	25667.73	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14	80914.14
Total Production (mln tons)	1.46	1.45	0.52	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
TotaProduction Value (mln ZK) (4)	7291.89	19620.92	13232.20	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60	103566.60
Price elasticity of supply[q]	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Price elasticity of demand[q]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Benefit 1: Area A0C (3)x(4)[r]	1010.98	2870.97	1290.46	15250.70	15250.70	15250.70	15250.70	15250.70	15250.70	15250.70	15250.70	15250.70
Benefit 2: Area ABC[s]	254.40	762.46	228.42	4076.02	4076.02	4076.02	4076.02	4076.02	4076.02	4076.02	4076.02	4076.02
Total benefits (mln ZK)	1265.4	3633.4	1518.9	19326.7	19326.7	19326.7	19326.7	19326.7	19326.7	19326.7	19326.7	19326.7
Total add'l prod. costs[t]	431.85	949.02	1262.35	2661.15	2661.15	2661.15	2661.15	2661.15	2661.15	2661.15	2661.15	2661.15
Total research costs[u]	43.32	147.40	417.61	801.11	773.15	773.15	773.15	773.15	773.15	773.15	773.15	773.15
Total extension costs[v]	65.20	170.86	404.25	742.71	742.71	742.71	742.71	742.71	742.71	742.71	742.71	742.71
Total seed costs[w]	34.15	103.79	189.06	390.53	390.53	390.53	390.53	390.53	390.53	390.53	390.53	390.53
Total marketing costs[x]	1993.09	5302.74	10201.25	9936.05	4989.94	48.69	48.69	48.69	48.69	48.69	48.69	48.69
Total net benefit , all costs (mln ZK)	-1302.2	-3040.4	-10955.6	4795.2	9769.2	14710.5	14710.5	14710.5	14710.5	14710.5	14710.5	14710.5

Category	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/2000	2000/01
Total net benefit, add. prod, res. costs only	790.21	2537.01	-161.08	15864.46	15892.42	15892.42	15892.42	15892.42	15892.42	15892.42	15892.42	15892.42
Total net benefit, add. prod.,res.,ext. costs	725.01	2366.14	-565.33	15121.75	15149..71	15149.71	15149.71	15149.71	15149.71	15149.71	15149.71	15149.71
Total net benefit, add. prod.,res.,ext.,seed costs	690.86	2262.35	-754.39	14731.22	14759.18	14759.18	14759.18	14759.18	14759.18	14759.18	14759.18	14759.18

[a] Sources: 1979 (WB, 1979); 1982-91 CSO Crop Forecasting Survey; 1978, 1980, 1981, 1992-2000 estimates based on marketing data in Table 1 (marketed amount is on average 62% of production); average yields in 1978, 1980, 1981 are estimated at 1.5 tons/ha. This analysis assumes that total area planted to maize remains the same in the with and without research scenarios.
[b] Allocation of maize area between large and small/medium farmers is based on CSO estimates for 1989, 1990, and estimates in Gibson (1987) for other years.
[c] LG refers to large farmers.
[d] Non-Zambian hybrids refer to CG4141, PNR473, R201, R215, ZS 206, and ZS225.
[e] Estimates of large farmer area planted to specific varieties are based on Zamseed sales records (Appendix 10, Tables 57-66)and MSU/MAFF/RDSB Maize Adoption Survey for 1978-83. 1984-2000 projections are based on the without-research assumption of continued availability of SR-52 and non-Zambian hybrids. Large farmers are assumed to plant SR52 and non-Zambian hybrids in the same proportions during 1984-2000 as in 1983.
[f] Here SR52 refers to the Zambian-produced SR52, originally derived from parents imported from (then) Northern Rhodesia at the time of Zambia's independence in 1964.
[g] SM/MED refers to small and medium-scale farmers.
[h] MSU/MAFF/RDSB Maize Adoption Survey data were used to allocate total maize area between different varieties between 1978-83. Projections for the 1984-2000 without-research case were based on the assumption of continued availability of local, SR52 and non-Zambian varieties, and that farmers continued to plant the varieties in the same proportion during 1984-2000 as in 1983.

[i] Average yields for large farmers are estimated at 5.5 tons/ha on average before improved Zambian varieties became available (Gibson, personal communication, 1993). Average yields for small/medium farmers were obtained by dividing CSO maize production estimates by estimates of maize area planted by small/medium farmers 1978-83. For remaining years yield estimates were derived from CSO area data and yield estimates (see j).
[j] The yield advantage of improved Zambian varieties over SR52 is estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties show that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson (personal communication, 1993) estimates that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms. On this basis, it is assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.
[k] Sources: CSO, World Bank for 1978-83 (see Table 2). 1983-1991 estimates based on CSO area data and yield estimates (see j). 1992-2000 estimates based on 1991.
[l] Import parity price. See Appendix 2, Table 24.

[m] Sources: 1979 (WB, 1979); 1982-91 CSO Crop Forecasting Survey; 1978, 1980, 1981, 1992-2000 estimates based on marketing data in Table 1 (marketed amount is on average 62 per cent of production); average yields in 1978, 1980, 1981 are estimated at 1.5 tons/ha. This analysis assumes that total area planted to maize remains the same in the with and without research scenarios.
[n] See Table 12.
[o] The yield advantage of improved Zambian varieties over SR52 is estimated at 20 per cent (Ristanovic, 1988). Results of on-farm trials of improved and local maize varieties show that the average ratio of Zambian hybrid yields to local yields was 1.64 from 1984-91. Gibson (personal communication, 1993) estimates that yields of non-Zambian hybrids are 5-10 per cent higher than SR52 on large farms, and 20 per cent higher than SR52 on small and medium farms. On this basis, it is assumed that SR52 yields are 1.37 x local yields; yields of Zambian improved varieties are 1.64 x local yields; yields of Zimbabwean hybrids are 1.075 x SR52 on large farms, and 1.64 x local yields on small/medium farms.
[p] The k-factor is the shift in in the production function resulting from the adoption of improved varieties. The shift in the supply curve (Figure 3) can be approximated by (1 + elasticity of supply).
[q] Based on estimates by Harber (1992) and Nakaponda (1992).
[r] See Figure 3. $A0C = KP_oQ_o$.
[s] See Figure 3. $ABC = 1/2(P_oQ_o)*[K(1+\text{elast. of supply})]^2/\text{elast. of supply} + \text{elast. of demand}$.
[t] See Appendix 9.
[u] See Appendix 6, Tables 30a,31,32,33,34. 1992-2000 expenditure estimates based on 1991 levels.
[v] See Appendix 7, Table 36a.
[w] See Appendix 6, Tables 32, 35. 1992-2000 expenditures are estimated.
[x] See Appendix 8, Table 37a. 1992 and 1993 estimates assume GRZ spending on subsidies declines to 50% and 25% of 1991 expenditures, respectively. Subsidy expenditures for the period 1994-2000 are assumed to decline to 0. Dept. of Coop/Mkting expenditures are assumed to remain constant at 1991 levels for the 1992-2000 period. 1992-2000 expenditures estimated at 0 based on GRZ plan to end its participation in maize marketing.

THE IMPACT OF INVESTMENTS IN MAIZE RESEARCH AND DISSEMINATION IN ZAMBIA
PART TWO: ANNEXES

By

Julie A. Howard[*],

with George M. Chitalu[**] and Sylvester M. Kalonge[***]

Department of Agricultural Economics
Michigan State University

October, 1993

Funding for this research was provided by the United States Agency for International Development (USAID), Africa Bureau, through the Food Security in Africa Cooperative Agreement (No. DAN-1190-A-00-4092-00) and the Food Security II Cooperative Agreement (No. AEP-5459-A-00-2041-00) with the Department of Agricultural Economics, Michigan State University.

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[*] Research Associate, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824-1039.

[**] Research Assistant, Rural Development Studies Bureau, University of Zambia, Lusaka, Zambia.

[***] Research-Extension Liaison Officer, Adaptive Research Planning Team, Western Province, Zambia.

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Appendix 4: Small- and medium-scale farmer maize adoption survey questionnaire

ZAMBIA MAIZE RESEARCH IMPACT STUDY
QUESTIONNAIRE -- PRODUCER MAIZE ADOPTION SURVEY

CSA-SEA # _____

Household No. _____

Village _____

Enumerator _____

Date of Interview _____

Name of Farmer _____

Note: The questionnaire should be discussed with the head of the household (who may be either male or female), and, if possible, with **both** the leading male and female decision-makers.

Introduce yourself politely to the farmer and explain that you are working with the University of Zambia. Explain to the farmer that this survey is being conducted to determine how maize varieties developed by Zambian researchers have been adopted by farmers, and to understand the factors which have influenced farmer decisions about whether to use the new varieties or not. The information will assist national policymakers to design future maize research, extension and marketing systems that better meet the needs of the farmers. Finally, ask if the farmer has any questions.

PART A: BASIC INFORMATION ABOUT THE HOUSEHOLD

1. What is the SEX of the HOUSEHOLD HEAD? (Check one)
   ( ) 1 Female
   ( ) 2 Male
   ( ) 3 Both present

2. What GRADE in SCHOOL did you COMPLETE? (Enter grade completed)
   ___

3. Have you GROWN MAIZE AT SOME TIME during the period 1983-91? (Check one)

() 1 Yes

() 2 No

If "yes," proceed to question 4. If "no," SKIP TO Q29.

4. What is the TOTAL NUMBER OF PERSONS living in this household today? (Include adults, children and other dependents WHO EAT FROM THE SAME POT.)

___

5. Of the TOTAL NUMBER OF PERSONS above, how many are LESS THAN 15 YEARS OF AGE?

PART B: FARM SIZE 1983/84-1991/92

(Note to enumerators: in this section and the ones that follow, the numbers assigned to the fields MUST BE CONSISTENT, i.e. field #1 in question 7 is the same as field #1 in questions 8, 13, 14, and so on.

Now I would like to discuss the SIZE OF YOUR FARM and HOW IT HAS CHANGED DURING THE PAST FEW YEARS.

6. How many fields do you have at the PRESENT time? _____

7. What is the SIZE of field 1 (in hectares, acres, limas or paces--whatever unit the farmer is most comfortable with)? _____

Unit of measure _____

(continue for each field up to the total number of fields in Q6)

What is the SIZE of field 2? _____

What is the SIZE of field 3? _____

What is the SIZE of field 4? _____

What is the SIZE of field 5? _____

What is the SIZE of field 6? _____

TOTAL SIZE _____

HH# ____

8. How did you PREPARE YOUR LAND FOR PLANTING this year? (make sure total number of fields is the same as farmer reported for Q6).

Field Number	Method of Preparation

PREPARATION METHOD CODES

1-Hand hoe	5-Hand hoe and tractor
2-Oxen	6-Hand hoe, oxen and tractor
3-Tractor	7-Oxen and tractor
4-Hand hoe and oxen	8-Other (specify)

9. Have you ever planted IMPROVED MAIZE? By IMPROVED MAIZE, I mean MAIZE SEED THAT HAS BEEN DEVELOPED BY RESEARCHERS AT MT. MAKULU RESEARCH STATION. THIS SEED CAN BE PURCHASED AT THE COOP DEPOT, ZAMSEED RETAIL STORE OR OTHER STOCKISTS. The names of improved maize varieties are MM-752, MM-604, MMV600, etc.

( ) 1 Yes
( ) 2 No

If the answer is YES, PROCEED to question 10.

If the answer is NO, SKIP TO Q29.

10. IN WHAT YEAR did you begin PLANTING IMPROVED MAIZE FROM MT. MAKULU (should be 1984-5 or later; be sure to give the answer in terms of the **season**, e.g. 1985-6; 1988-9)? _____

11. Now I would like to discuss how the TOTAL NUMBER OF YOUR FIELDS AND THE SIZE OF EACH FIELD have changed beginning THE YEAR BEFORE YOU STARTED PLANTING IMPROVED MAIZE. HOW MANY FIELDS did you have in 19__(year before year stated in Q10)? _____

12. Has the NUMBER OF FIELDS or the SIZE of any of the fields changed between 198_ (the year before the farmer began planting improved maize) and the present time?

( ) 1 Yes
( ) 2 No

If NO, SKIP to Q14. If YES, PROCEED to Q13.

HH# _____

13. Please describe the CHANGES in the SIZE AND/OR THE TOTAL NUMBER of FIELDS since you began planting improved maize.

Yr.	Field No.	Type of Change	Amount of Change	Unit

TYPE OF CHANGE CODES

1-Addition of new field
2-Loss of field
3-Expansion of existing field
4-Contraction of existing field

PART C: CROPPING PATTERNS 1983/84-1991/92

14. Now I would like to discuss the AREA you have planted to different crops SINCE THE YEAR BEFORE YOU BEGAN PLANTING IMPROVED MAIZE (SEE Q10) THROUGH THIS CROPPING SEASON. (Note to enumerator: refer to Q13 for the number of fields you should ask about in each year. Introduce the wooden model to the farmer and explain that the model is intended to represent EACH FIELD the farmer has planted in EACH YEAR since the YEAR BEFORE THE FARMER STARTED PLANTING IMPROVED MAIZE FROM MT. MAKULU. If IMPROVED MAIZE AREA or VARIETY changes between years, note this and the reasons for the changes in the last two columns of the table.)

Year	Field No.	Crop	Variety Type (MAIZE ONLY)	Intercrop 0-None 1-22-see crop codes	Area (# of wooden pieces)	Improved maize area/variety change	Reason for improved maize area/variety change (specify)

CROP CODES

1-Maize 12-Pumpkin
2-Sorghum 13-Tobacco
3-Cassava 14-Cotton
4-Millet 15-Other(spec)
5-Soybean 16-Not cropped
6-Rice 17-Can't recall
7-Bean 18-Watermelon
8-Grdnut 19-Okra
9-Sw.pot. 20-Squash
10-Ir.pot. 21-Cucumber
11-Sunflr 22-Yam

VARIETY CODES

1-752 9-600 19-local-Senga
2-604 10-612 20-local-Mumba
3-603 11-SR52 21-popcorn
4-601 12-R201 22-local-Gankata
5-501 13-R215 23-local-Siluutuba
6-502 14-ZS206 24-ZH-1
7-504 15-other 25-yellow maize(spec.)
8-400 16-can't recall (local) 7-other (specify)
17-can't recall(improved)
18-local-Mulenga

AREA/VARIETY CHANGE CODES

1-no change
2-improved maize area increase
3-change to different improved maize variety (specify)
4-improved maize area decrease
5-change from local to improved maize variety
6-change from improved to local maize variety
7-other (specify)
8-imp.maize area increase + change of variety
9-change from Zimb/Rhod.var to Zamb imp var.
10-imp maize area decrease and change of variety
11-change from Zambian to Zimb/Rhod. variety

HH#_____

15. How did you FIND OUT ABOUT IMPROVED MAIZE from Mt. Makulu?

_____
___

_____
___

16. In general, what are the THREE MOST IMPORTANT REASONS WHY YOU STARTED TO GROW IMPROVED MAIZE? Please rank your responses IN ORDER OF IMPORTANCE.

1. _____
2. _____
3. _____

PART D: COMPLEMENTARY INSTITUTIONS

EXTENSION Next I would like to ask you about your EXPERIENCE WITH THE AGRICULTURAL EXTENSION SERVICE.

17. Have you EVER BEEN VISITED by an EXTENSION AGENT?

() 1 Yes
() 2 No

If no, SKIP to Q19. If yes, PROCEED to Q18.

18. What was the PURPOSE(S) of the visit?

_____
_____
_____

19. Have you ever ADOPTED RECOMMENDATIONS concerning improved maize production?

() 1 Yes
() 2 No

If no, SKIP to Q21. If yes, PROCEED to Q20.

20. Please SPECIFY the recommendations you ADOPTED in order of importance. By important, I mean in terms of INCREASING YOUR YIELD. Also, please tell me where or from whom you learned about these recommendations (Note to enumerator: proper names are not needed here, but institutional affiliation, e.g. extension agent, primary society officer, etc. is important.)

MAIZE RECOMMENDATIONS ADOPTED IN ORDER OF IMPORTANCE	SOURCE OF RECOMMENDATION

CREDIT. Now I would like to ask about CREDIT you have RECEIVED in the past for MAIZE-RELATED ACTIVITIES.

21. Have you ever RECEIVED CREDIT for INPUTS USED ON MAIZE, SUCH AS FERTILIZER, SEEDS, OR BAGS, or for OXEN OR OXEN-RELATED IMPLEMENTS, or TRACTOR HIRE for the purpose of PREPARING LAND to be PLANTED to MAIZE?

() 1 Yes
() 2 No

If no, SKIP to Q23. If yes, PROCEED to Q22.

HH#_

22. In WHAT YEARS did you RECEIVE CREDIT for INPUTS USED ON MAIZE, or for OXEN OR OXEN-RELATED IMPLEMENTS, or TRACTOR HIRE for preparing land to be planted to maize? (Note to enumerator: for each year that farmer received credit for maize, oxen/oxen-implements, or tractor hire, ask about the source of credit, type of credit and amount of credit received.)

Year	Type of Credit	Credit Source	Amount	Type	Unit

CREDIT TYPE CODES
1-Maize
2-Oxen/implements
3-Tractor hire
4-Other (specify)

CREDIT SOURCE CODES
1-Lima Bank
2-Primary Society
3-CUSA
4-AFC
5-Commercial Bank
6-Other (specify)
7-Other farmer
8-Church org.
9-ZCF
10-Private seller
11-DCU
12-PCU

TYPE CODES
1-Seeds
2-Fertilizer
3-Bags
4-Oxen
5-Implements
6-Cash
7-Other (specify)

UNIT CODES
1-50 kg
2-90 kg
3-10 kg
4-Kwacha
5-Other (specify)

HH#__

23. For YEARS when you DID NOT RECEIVE CREDIT FOR MAIZE, why not?

Year	Reason

FERTILIZER. Now I would like to discuss FERTILIZER USE ON IMPROVED MAIZE.

24. Have you EVER APPLIED CHEMICAL FERTILIZER to IMPROVED MAIZE?

() 1 Yes
() 2 No

If no, skip to Q26. If yes, proceed to Q25.

25. In WHAT YEARS did you USE CHEMICAL FERTILIZER on IMPROVED MAIZE? (Note to enumerator: for each year that the farmer used fertilizer on maize, ask the type, the type desired [if different from the type received], the source, amount and time of fertilizer delivery. Use a separate line for each type of fertilizer received in each year.)

Year	Fertilizer type received	Fertilizer type desired	Source	Amount	Unit	Time of fertilizer delivery

FERTILIZER CODES

Basal
1-X
2-D
3-A
4-C
5-V
6-R
7-L
8-Other basal
Top
9-Urea
10-Ammonium nitrate
11-Other top

SOURCE CODES

1-Primary society
2-NCZ
3-Namboard
4-Other (specify)
5-DCU
6-PCU
7-Private seller
8-Private voluntary organization
9-CUSA

UNIT CODES

1-50 kg
2-90 kg
3-10 kg
4-Other (spec.)

DELIVERY TIME CODES

1-Before planting
2-Just after planting
3-Germination to 1 month after germ.
4-More than 1 month after germination

HH#____

26. SEED AVAILABILITY. Next I would like to discuss the AVAILABILITY OF IMPROVED MAIZE SEED. (Note to enumerator: look back at Q14. Determine from the table the years when improved maize seed was used, and what type was used. Enter these in the table below. For each year and type of improved maize seed used by the farmer, ask if the type of improved maize used was the type desired. If not, record the type desired. Also ask the source of each type of improved seed, and ask what month the maize seed was available at the source.)

Year	Type of Improved Maize Used	Type of Maize Desired	Source of Improved Maize Seed	When was Maize Seed Delivered?

VARIETY CODES

1-752 8-400
2-604 9- 600
3-603 10-612
4-601 11-R201
5-501 12-R215
6-502 13-ZS206
7-504 14-Other
15-can't recall, but improved

SOURCE CODES

1-Primary society
2-Zamseed Depot
3-Retail shop
4-Replanted
5-Other(specify)
6-DCU
7-PCU
8-Private seller
9-NAMBOARD

DELIVERY TIME CODES

1-Sept. or earlier
2-October
3-November
4-December
5-January
6-Can't recall

MAIZE MARKETING. Finally, I would like to discuss MARKETING of IMPROVED MAIZE.

HH#_____

27. Have you EVER SOLD IMPROVED MAIZE?

()1 Yes
()2 No

If no, TERMINATE the INTERVIEW. Thank the farmer politely for his/her cooperation.
If yes, PROCEED to Q28.

28. During WHAT YEARS did you SELL IMPROVED MAIZE? (Note to enumerator: for each year mentioned by the farmer, ask about AMOUNT of improved maize SOLD, AMOUNT RETAINED, WHERE SOLD, TIME OF COLLECTION/ DELIVERY and TIME of PAYMENT.)

Year	Amt. of improved maize SOLD (No. of 90 kg bags)	Amt. of improved maize RETAINED (No. of 90 kg bags)	Where sold	Collection/ Delivery	Time of Collection/ Delivery	Time of Payment

LOCATION CODES

1-Primary society
2-Private buyer
3-Other (specify)
4-DCU
5-PCU 6-Namboard

COLL./DEL. CODES

1-Collected
2-Delivered

TIME OF COLL./DEL./PAYMENT CODES

1-May 5-Sept.
2-June 6-Oct. or later
3-July
4-August

CONCLUDE the interview and THANK the farmer. Ask if he/she has any questions or comments he/she would like to add.

29. ADDITIONAL COMMENTS_____
_____
_____

Appendix 5: Large farmer maize adoption survey questionnaire

HH#_____

ZAMBIA MAIZE RESEARCH IMPACT STUDY
QUESTIONNAIRE -- COMMERCIAL FARMER MAIZE ADOPTION SURVEY

Note: please complete this questionnaire only if you own or manage a farm on which 15 or more hectares of maize are usually planted each year.

1. District and province where farm is located_____

2. Are you the farm's (check all applicable)..... owner_____

   manager_____

   other(specify)

   _____

3. What is your sex?..... male_____

   female_____

4. What is your age?..... _____

5. How many years of formal education did you complete?..... _____

6. Have you ever planted any of the following maize hybrids/ varieties which were developed at Mt. Makulu Research Station?

MM-752	MM-501	MMV-400
MM-604	MM-502	MMV-600
MM-603	MM-504	
MM-601	MM-612	

   yes_____

   no_____

If you answered "no" to question 6, please skip to question 9.

If you answered "yes" to question 6, please proceed to question 7.

7. In what season did you begin planting an improved maize hybrid/variety from Mt. Makulu (e.g. 1984-5, 1985-6, etc.)? _____

8. Please use the following table to describe the cropping/livestock pattern of your farm beginning the season BEFORE you began using an improved maize hybrid/variety from Mt. Makulu, and continuing through the 1992-93 (plans) season.

a. Describe the crop/livestock pattern for **every** season since you began using improved maize from Mt. Makulu, although you may not have planted maize each year.

b. For each season, please ensure that the sum of the reported hectarages given for crops, livestock and fallow land, equals the correct area of the farm in that year.

c. For seasons in which you changed maize varieties/hybrids, or your hectarage of Mt. Makulu maize changed (increased or decreased) by more than 10%, briefly explain the reason why in the last column.

EXAMPLE. Farmer Z. began growing MM752 in the 1984-5 season. Prior to 1984-85, he grew SR52, then switched to MM752 because he expected higher yields. He continued to grow about the same hectarage of Mt. Makulu improved maize between 1984-88, along with other crops--soybean, tobacco, local maize intercropped with watermelon and pumpkin for the workers--and cattle. In the 1986-7 season, Z. experimented with MM-603 and R215, then switched back to MM-752 the following year because of its superior yield under good management. He decreased his maize area beginning in the 1988-89 season because of unfavorable product and input prices, and because he wanted to increase his cattle herd and his tobacco hectarage (to take advantage of the export retention scheme). In 1991-92, however, Z. increased the maize hectarage again because he anticipated higher producer prices.

(EXAMPLE)

Year	Crop or livestock type	Variety type (MAIZE ONLY)	Intercrop	Area--specify # and unit (acre,ha or lima) or # of animals	Reason for improved maize area/variety change (specify)
83-4	MAIZE	SR-52	-	20 HA	
83-4	MAIZE	LOCAL	PUMPKIN, WATERMELON	5 HA	
83-4	SOYA	-	-	30 HA	
83-4	BEEF CATTLE	-	-	40 HEAD	
83-4	PASTURE/FALLOW	-	-	10 HA	
			TOTAL	65 HA	
84-5	MAIZE	MM752	-	20 HA	EXPECTED HIGHER YIELDS WITH MM752
84-5	MAIZE	LOCAL	PUMPKIN, WATERMELON	5 HA	
84-5	SOYA	-	-	20 HA	
84-5	BEEF CATTLE	-	-	50 HEAD	
84-5	PASTURE/FALLOW	-	-	20 HA	
			TOTAL	65 HA	

(CONTINUES THROUGH 91-2 SEASON) END OF EXAMPLE

HH# _____

Year	Crop or livestock type	Variety type (MAIZE ONLY)	Intercrop	Area-- specify # and unit (acre,ha or lima) or # of animals	Reason for improved maize area/variety change (specify)

9. Please comment on your experience with Mt. Makulu improved maize hybrids/varieties, or, if you have never used Mt. Makulu varieties/hybrids or have discontinued using them, please explain why.

_____

_____

_____

_____

_____

_____

_____

_____

10. What crop problems (including all crops, not just maize) would you like the Research Branch to work on? Please rank these in order of their importance to you.

1._____

_____

2._____

_____

3._____

_____

4._____

_____

5._____

_____

11. Additional comments_____

_____

_____

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR ASSISTANCE.

Appendix 6: GRZ and donor expenditures on maize research and the seed industry

Table 30: Estimated GRZ expenditures on maize-related research, 1978-91 (financial values)[a]

ml. ZK

ITEM	1978[a]	1979	1980	1981	1982	1983
PERSONAL EMOLUMENTS[b]						
Salaries		.1722	.1757	.2106	.2674	.2971
RECURRENT DEPARTMENTAL CHARGES[c]						
General Expenses		.0439	.0521	.0684	.0992	.0937
Traveling on Duty		.015	.0168	.023	.0353	.035
Field Services (General)		.0868	.0987	.1261	.1445	.1614
Seed Production/ Seed Control Services		.0321	.0939[e]	.0311	.0259	.0437
Cereal Research Team						.0144
CAPITAL EXPENDITURES[d]						
Mt. Makulu Research Station		.0118	.0185	---	.0212	.0118
Cereals Research Team		.007	.0371	---		
Seed Production Project[e]		.1409	.1216	.0563[e]	.1045	.0304
Mouldy Maize Project		.0194	.032	.035	.028	
Research Training and Extension[f]				(.2)	(.3089)	(.0293)
Adaptive Research Planning Team[g]					.0158	.0389
TOTAL EXPENDITURES	.4337	.5291	.6464	.5505	.7418	.7264

[a] Based on actual expenditures reported in GRZ Financial Reports, 1979-91

[b] Maize-related amount estimated as 25 per cent of total Agricultural Research Branch salaries. Based on per cent of scientists engaged full-time or part-time in maize research (Kean and Singogo, 1989)

[c] Maize-related amount estimated as 25 per cent of expenditures by the Agricultural Research Branch

[d] Maize-related amount estimated as 25 per cent of expenditures, except for Mouldy Maize Research (100% of expenses attributed to maize research)

[e] Partially funded by Belgium

[f] Fully funded by SIDA; to avoid double-counting, not included in this total

[g] Partially funded by USAID; maize-related amount estimated as 25 per cent of expenditures

Table 30: Estimated GRZ expenditures on maize-related research, 1978-91[a] (financial values) (con't)

ml. ZK

ITEM	1984	1985	1986	1987	1988	1989	1990	1991[m]
PERSONAL EMOLUMENTS[b]								
Salaries	.644	.7277	1.113	1.124	1.698	2.936	2.5	4.825
RECURRENT DEPARTMENTAL CHARGES[c]								
Allowances	.0091	.0293	.0478	.0636	.0986	.1177	.8537	.1568
Purchase of Goods	.0529	.1376	.1975	.1950	.5107	.5888	1.935	1.236
Purchase of Services	.0153	--	.2883	.0376	.7168	.1221	3.173	1.722
CAPITAL EXPENDITURES[d]								
Mt. Makulu Research Station[e]	.0048	.011	.00078	.0055	.0028	.0046	.0386	.4000
Seed Production Project/Seed Control Institute[f]	(.1092)	(.1201)		--	(.5570)	(.1265)	(.1072)	(.75)
Research Training and Extension[g]	.3212	.1964	.1064	.1273	.0778	--		
Adaptive Research Planning Team[h]	.032	.0451	.1392	.9181	1.009	.8515	2.525	16.730
Buildings, Housing, Civil Works[i]		.0223	.0156	.0097	.2247	.1787	.7656	.1675
Agricultural Research Project (ZAREP)[j]				.0182	.1704	.3626	2.286	86.863
Crop Research[k]				(.3276)	(.5568)	(1.227)	(.2297)	(2.078)
Maize Research Extension[l]							(.756)	(.200)
TOTAL EXPENDITURES	1.079	1.160	1.909	2.499	4.508	5.162	14.076	112.10

[h] Partially funded by CIMMYT, Netherlands,SIDA,NORAD,IFAD; maize-related amounted estimated as 25 per cent of expenditures

[i] Partially funded by NORAD, SIDA; maize-related amount estimated as 25 per cent of expenditures

[j] Funded by NORAD, African Development Bank and World Bank; maize-related amount estimated as 25 per cent of expenditures

[k] Funded by SIDA; maize-related amount estimated as 25 per cent of total expenditures. To avoid double-counting, not included in this total.

[l] Funded by FAO/UNDP; 100 per cent of expenditures attributed to maize research. To avoid double-counting, not included in this total.

[m] 1991 data are total provisions for each category; actual expenditure data not available

[n] Estimated; expenditure data not available for 1978

Table 30a: Estimated GRZ expenditures on maize-related research, 1978-91 (economic values)

ml. ZK

ITEM	1978[d]	1979	1980	1981	1982	1983
PERSONAL EMOLUMENTS[a]						
Salaries		.1722	.1757	.2106	.2674	.2971
RECURRENT DEPARTMENTAL CHARGES[b]						
General Expenses		.1401	.1674	.2246	.3416	.244
Traveling on Duty		.015	.0168	.023	.035	.035
Field Services (General)		.277	.3171	.4141	.4976	.4203
Seed Production/ Seed Control Services		.1025	.3017	.1021	.8919	.1138
Cereal Research Team						.0375
CAPITAL EXPENDITURES[c]						
Mt. Makulu Research Station		.0411	.0649	---	.0799	.0333
Cereals Research Team		.0239	.1301	---		
Seed Production Project		.4910	.4265	.202	.3939	.0857
Mouldy Maize Project		.0676	.1126	.1256	.1055	
Research Training and Extension				(.200)	(.3089)	(.0293)
Adaptive Research Planning Team					.0596	.1096
TOTAL EXPENDITURES	1.091	1.331	1.712	1.302	1.870	1.376

[a] There are no tradeable goods in this category

[b] The content of tradeable goods in this category is estimated at 75%, except for traveling on duty and allowances, which have no tradeable goods

[c] Tradeable goods content in this category is estimated at 85%

[d] Estimated; actual expenditure data were unavailable

[e] Estimated; actual expenditure data were unavailable

Table 30a: Estimated GRZ expenditures on maize-related research, 1978-91 (economic values) (con't)

mln ZK

ITEM	1984	1985	1986	1987	1988	1989	1990	1991[e]
PERSONAL EMOLUMENTS[a]								
Salaries	.644	.7277	1.113	1.124	1.698	2.936	2.5	4.825
RECURRENT DEPARTMENTAL CHARGES[b]								
Allowances	.0091	.0293	.0478	.0636	.0986	.1177	.8537	.1568
Purchase of Goods	.1178	.1581	.1554	.248	.7911	.8283	3.712	2.142
Purchase of Services	.0341	--	.2269	.0478	1.110	.1718	6.086	2.984
CAPITAL EXPENDITURES[c]								
Mt. Makulu Research Station	.0115	.0013	.00059	.00719	.00454	.00672	.0788	.7322
Seed Production Project/Seed Control Institute	(.1092)	(.1201)		--	(.557)	(.1265)	(.1072)	(.750)
Research Training and Extension	.768	.2295	.0807	.1665	.1262	--		
Adaptive Research Planning Team	.0765	.0527	.1056	1.201	1.636	1.244	5.153	30.625
Buildings, Housing, Civil Works		.0261	.0118	.0127	.3645	.2611	1.562	.3066
Agricultural Research Project (ZAREP)				.0238	.2764	.5297	4.664	159.001
Crop Research				(.3276)	(.5568)	(1.227)	(.2297)	(2.078)
Maize Research Extension							(.756)	(.200)
TOTAL EXPENDITURES	1.661	1.225	1.742	2.894	6.105	6.095	24.610	200.773

[a] There are no tradeable goods in this category

[b] The content of tradeable goods in this category is estimated at 75%, except for traveling on duty and allowances, which have no tradeable goods

[c] Tradeable goods content in this category is estimated at 85%

[d] Estimated; actual expenditure data were unavailable

[e] Estimated; actual expenditure data were unavailable

Table 31: USAID expenditures on Zambia Agricultural Development, Research and Extension (ZAMARE) 1983-88[a]

ml. USD

ITEM	1983-4	1984-5	1985-6	1986-7	1987-8[b]	TOTAL
Salaries, Travel, Allowances for Field and Home Office Staff	.603	.700	.8266	.8748		3.004
Other Direct Costs	.295	.3127	.2311	.1921		1.031
Participant Training	.8201	.8138	.9206	.844		3.399
Other[c]	1.016	1.016	1.016	1.016	1.016	5.081
TOTAL EXP.	2.734	2.843	2.995	2.927	1.016	12.515
EST. MAIZE-RELATED EXP.[d]	.6836	.7107	.7486	.7318	.2541	3.129
ZK equivalent at OER[e] (mln ZK)	.8333	1.566	4.26	9.327	2.031	
ZK equivalent -- economic value[f] (mln ZK)	2.909	3.738	4.986	7.056	2.659	

[a] Source: USAID (1988), USAID (1991).

[b] Breakdown of expenditures not available for 1987-8

[c] Difference between expenditures reported under contract AFR-0201-C-00-1097 and total life-of-project expenditures for 611-0201.

[d] 25 per cent of total project costs are attributed to maize research and extension. This represents a weighted average of person-years of technical assistance directly related to maize research, proportion of students trained in maize-related areas, and commodities/housing and operational recurrent costs attributed to maize research and extension.

[e] For the financial analysis, USD maize-related expenditures are converted to ZK using the nominal ZK/SDR and SDR/USD rates.

[f] For the economic analysis, 85% of maize-related USD costs are converted to ZK using the SER.

Table 32: SIDA expenditures on research and seed, 1979-92[a]

ml. ZK

ITEM	1979	1980	1981	1982	1983	1984	1985
RESEARCH AND SEED PROGRAMME	.485[b]						
Basic/Breeder seed production		.08			.042	.122	.355[c]
Seed Control/Testing/ SCCI		.1	.15	.17	.15	.554	.322
Seed Company		.15					2.08
Seed Training		.025	.05	.075	.050	.063	.139
Personnel/ Consultancy		.195					
Management Agreement			1	1.055	1.092	1.443	2.140
Housing, Zamseed				.200	.200		
Operation Costs, Research/Mt. Makulu					.074		
ARPT-Luapula Province						.305	.411
TOTAL EXPENDITURES	.485	.550	1.2	1.5	1.608	2.182	5.447
ESTIMATED MAIZE RESEARCH EXPENDITURES[d]	.0606	.0688	.025	.2638	.302	.4675	.7265
ZK equiv. at OER[e]	.0606	.0688	.25	.2638	.302	.4675	.7265
ZK equiv.--economic value[f]	.2113	.2411	.8972	.9942	.8511	1.118	.8489
ESTIMATED MAIZE SEED EXPENDITURES[g]	.1649	.188	.48	.6	.5968	.824	1.872
ZK equiv. at OER	.1649	.188	.480	.600	.5968	.824	1.872
ZK equiv.--economic value	.5746	.6594	1.723	2.262	1.682	1.970	2.188

[a] Source: SIDA Joint GRZ/SIDA Agricultural Sector Support Programme Budget and Annual Review, 1979-1991. Amounts are budgeted amounts, not actual expenditures. Actual expenditure information was not available.

[b] Breakdown of budget not available. Proportions to maize research and maize seed expenditures based on 1980 proportions.

[c] Includes research budget

[d] Maize research expenditures are estimated as follows: 25% of general research-related expenditure categories, i.e. basic/breeder seed production, ARPT, research operation costs, based on per cent of scientists engaged full or part-time in maize research (Kean and Singogo, 1989); 25% of management agreement and personnel/consultancy categories; 100% of maize research expenditures.

Table 32: SIDA expenditures on research and seed, 1979-92[a] (con't)

ml. Swedish kroner

ITEM	1986	1987	1988	1989	1990	1991
RESEARCH AND SEED PROGRAMME						
Agricultural Research and Breeder Seed Production	1.442					
Seed Control/Testing/ SCCI	1.398	1.675	1.5	1.175	1	.840
Seed Company	6.139	2.145	.3	.556		
Seed Training	.735	1.009	1.280	1.729	2.327	3.020
Personnel/ Consultancy						
Management Agreement	10.577	12.074	12.376	13.283	13.106	12.173
Housing, Zamseed						
Maize research		1.466	1.635	1.890	2.703	2.507
ARPT	3.8	3.908	4.410	4.082	4.132	3.614
TOTAL EXPENDITURES	24.091	22.277	21.510	22.715	23.268	22.154
ESTIMATED MAIZE RESEARCH EXPENDITURES[d]	3.955	5.462	5.832	6.231	7.013	6.454
ZK equiv. at OER[e] ('000 ZK)	7.373	7.472	9.473	21.275	52.752	103.277
ZK equiv.--economic value [f] ('000 ZK)	5.593	9.774	15.368	31.081	107.65	189.05
ESTIMATED MAIZE SEED[g] EXPENDITURES	7.54	6.761	8.03	6.697	6.573	6.413
ZK equiv. at OER ('000 ZK)	14.056	9.25	13.045	22.867	49.447	102.633
ZK equiv.--economic value ('000 ZK)	10.663	12.1	21.163	33.406	100.91	187.86

[e] 1979-85 SIDA investments were reported in ZK. It is assumed that these were converted from SEK at the official exchange rate. 1986-91 investments were reported in SEK. These costs were converted to ZK using the ZK/SDR and SEK/SDR rates (Table 23)

[f] For the economic analysis, 85% of maize-related costs are converted to ZK using the SER.

[g] Maize seed expenditures: 40 per cent of seed-related expenditures (seed control/testing, seed company, seed training, personnel/consultancy, management agreement, housing-Zamseed) are attributed to maize, since maize sales represent approximately 40 per cent of the total value of seeds sold by Zamseed (maize sales represented 47.8% of the total value of seeds sold in 1985/6, and 34.7% of total value of seeds sold in 1990/91 (Zamseed records).

[h] For the economic analysis, 85% of maize-related costs are converted to ZK using the SER.

Table 33: FAO/UNDP expenditures on maize research, 1978-87, and maize/legume research, 1987-92[a]

ml. USD

ITEM	1978	1979	1980	1981	1982	1983	1984	1985
TOTAL EXPENDITURES	.1733	.1733	.1733	.1733	.1733	.1733	.1733	.1733
ESTIMATED MAIZE-RELATED EXPENDITURES	.1733	.1733	.1733	.1733	.1733	.1733	.1733	.1733
ZK equiv. at OER[c] ('000 ZK)	.1357	.1342	.1386	.1519	.1602	.2119	.3819	.9877
ZK equiv.--economic value[d] ('000 ZK)	.4685	.4676	.4861	.545	.604	.597	.9131	1.154

ITEM	1986	1987[b]	1988	1989	1990	1991	1992	TOTAL
TOTAL EXPENDITURES	.1733	.1733	.1733	.1733	.1733	.1733	.1733	2.6
ESTIMATED MAIZE-RELATED EXPENDITURES	.1733	.0867	.0867	.0867	.0867	.0867	.0867	2.079
ZK equiv. at OER[c] ('000 ZK)	2.203	.6936	.8672	1.843	3.716	7.674	14.1	33.4
ZK equiv.--economic value[d] ('000 ZK)	1.671	.907	1.407	2.693	7.584	14.048	27.960	61.506

[a] Annual expenditure data was not available. Estimated based on FAO (1990) and personal communications with maize team members.

[b] Beginning in 1987, the FAO/UNDP-funded project expanded to include legume research. Maize-related expenditures are estimated at 50% of the total.

[c] For the financial analysis, USD maize-related expenditures are converted to ZK using the nominal ZK/SDR and SDR/USD rates.

[d] For the economic analysis, 85% of maize-related USD costs are converted to ZK using the SER.

Table 34: CIMMYT expenditures on Zambia maize research 1980-92[a]

ml. USD

Year/Item	1980	1981	1982	1983	1984	1985	1986
BREEDING PROGRAM							
CIMMYT Team Member Visits to Zambia	.01	.01	.01	.01	.01	.01	.01
In-country training						.05	.05
Training at CIMMYT/Mexico		.0014	.0014	.0014	.0014	.0014	.0014
Visiting scientists sent to CIMMYT/ Mexico				.0073	.0073	.0073	.0073
Zambian participation in regional maize workshops						.007	
Zambian maize team training in Harare (@$500)	.002	.002	.002	.002	.002	.002	.002
Subtotal, Breeding Program	.012	.0134	.0134	.0207	.0207	.0777	.0707
MAIZE AGRONOMY AND MAIZE-RELATED ON-FARM RESEARCH							
ARPT planning studies		.0025	.0025				
OFR in-country training					.0075	.0075	
Cooperative research, UNZA							
OFR research, training, Southern Province							
OFR research, training, Lusaka and Central Provinces							.0011
OFR regional training workshops, U.Zimb.				.0034	.0034	.0034	.0034
OFR trial data analysis workshop, Harare							
Maize agronomy courses, CIMMYT/Mexico							
Regional OFR and Maize conferences						.0027	
Subtotal, Maize Agronomy and OFR	0.0	.0025	.0025	.0034	.0109	.0136	.0045
TOTAL CIMMYT EXPENDITURES	.012	.0159	.0159	.0241	.0316	.0913	.0752
ZK equiv. at OER[b] ('mln ZK)	.0096	.01398	.01474	.02938	.06965	.5196	.95849
ZK equiv.--economic value[c] ('mln ZK)	.03367	.05021	.05573	.10151	.16624	.60798	.72545

Table 34: CIMMYT expenditures on Zambia maize research 1980-92 (con't)

ml. USD

Year/Item	1987	1988	1989	1990	1991	1992
BREEDING PROGRAM						
CIMMYT Team Member Visits to Zambia	.01	.01	.01	.01	.01	.01
In-country training	.05	.05	.05	.05	.05	.05
Training at CIMMYT/Mexico	.0014	.0014	.0014	.0014		
Visiting scientists sent to CIMMYT/ Mexico	.0073	.0073	.0073			
Zambian participation in regional maize workshops	.007		.007			
Zambian maize team training in Harare (@$500)	.002	.002	.002	.002	.002	.002
Subtotal, Breeding Program	.0777	.0707	.0777	.0634	.062	.062
MAIZE AGRONOMY AND MAIZE-RELATED ON-FARM RESEARCH						
ARPT planning studies						
OFR in-country training						
Cooperative research, UNZA	.005	.005	.005			
OFR research, training, Southern Province	.009	.009				
OFR research, training, Lusaka and Central Provinces	.0011	.0011	.0011	.0011	.0011	.0011
OFR regional training workshops, U.Zimb.	.0034	.0034	.0034	.0034	.0034	.0034
OFR trial data analysis workshop, Harare	.0015	.0015	.0015	.0015	.0015	.0015
Maize agronomy courses, CIMMYT/Mexico	.0168	.0168	.0168	.0168	.0168	.0168
Regional OFR and Maize conferences	.0027		.0054			.0027
Subtotal, Maize Agronomy and OFR	.0395	.0368	.0332	.0228	.0228	.0255
TOTAL CIMMYT EXPENDITURES	.1172	.1075	.1109	.0862	.0848	.0875
ZK equiv. at OER[b] ('mln ZK)	.93678	1.0718	2.3653	3.7017	7.5063	14.23
ZK equiv.--economic value[c] ('mln ZK)	1.2264	1.7434	3.5023	7.5196	13.85	28.004

[a] Estimates (personal communications: Gelaw, 1991; Waddington, 1993; Low, 1993)

[b] For the financial analysis, USD expenditures are converted to ZK using the nominal ZK/SDR and SDR/USD rates.

[c] For the economic analysis, 85% of USD costs are converted to ZK using the SER.

Table 35: Zamseed investments 1981-2000[a]

ml. ZK

	1981	1982-3	1983-4	1984-5	1985-6	1986-7	1987-8	1988-9	1989-90	1990-91	1991-2	1992-3	1993-2000
Land					2								
Industrial Buildings		.1	.8	.5	.2	1.1	.146		1.797		1.628		
Staff Houses			.4	.4	.2	.3	.146			1.176			
Motor Vehicles	.2		.1		.2	1.2		.1731		.7843		20.938	
Furniture, equipment		.3	.4		1.5	2.9		.3462		1.569			
TOTAL	1	.4	2.6	.9	4.1	5.5	.292	.5194	1.797	3.529	1.628	20.938	20.938
Less SIDA investments[b]		.2	.2		2.08	1.879	.720	.133	.521	0	0	0	0
TOTAL	1	.2	2.4	.9	2.02	3.621	0	.3864	1.276	3.529	1.628	20.938	20.938
Estimated maize seed-related expenditures[c]	.4	.08	.96	.36	.808	1.448	0	.1545	.510	1.412	.651	8.375	8.375
Economic values[d]	1.435	.3016	2.705	.8607	.9442	1.099	0	.2507	.7455	2.881	1.192	16.608	16.608

[a] Source: Norrby, 1986 and Zamseed reports

[b] See Table 32. Includes SIDA expenditures for seed company and housing, Zamseed

[c] 40 per cent of seed-related expenditures are attributed to maize, since maize sales represent approximately 40 per cent of the total value of seeds sold by Zamseed (maize sales represented 47.8% of the total value of seeds sold in 1985/6, and 34.7% of total value of seeds sold in 1990/91 (Zamseed records).

[d] For the economic analysis, 85% of maize seed-related costs are estimated to be tradeable goods.

Appendix 7: GRZ and donor expenditures on maize extension, 1984-91

Table 36: Estimated GRZ and donor expenditures on maize extension, 1984-91 (financial values)[a]

ml. ZK

ITEM	1984	1985	1986	1987	1988
Personal Emoluments	5.559	6.049	8.989	6.455	8.502
Allowances	.1264	.2035	.4134	.272	1.330
Purchase of Goods	.3993	.3043	.479	.5337	1.363
Purchase of Services	.1203	.1454	.2289	.2048	.5036
Training Expenses	.1346	.2085	.35	.3236	.6724
CAPITAL EXPENDITURES					
Lima Program[b]	.209	.1402	.2122	.5114	.4452
Village Agricultural Project, No.Prov.[c]	.2502	.4766	1.973	2.271	3.365
Motor Vehicles		.0457	.0045	.0204	.0029
Staff Housing			.0257	.1676	
Seed Control Institute[b]			.4246	.3848	
NAT'L FARMING INFORMATION SERVICE					
Personal Emoluments	.1431	.1303	.2171	.1748	.3606
Recurrent Charges	.004	.011	.0315	.0601	.0905
Purchase of Goods	.0339	.0635	.1045	.2059	.2742
Purchase of Services	.0042	.0095	.0202	.2925	.3975
Office Equipment, Vehicles		.0279	.0880	.1953	.0756
Rural Information Services		.0093	.0487	.0605	
Staff Housing		.0265	.0264	.0725	
CAPITAL EXPENDITURES -- MAWD HEADQUARTERS					
Integrated Rural Dev. Program (IRDP)[d]	.9641	1.681	4.743	7.790	6.913
IRDP-NW Province[e]	2.239	.9849	1.381	1.643	1.702
IRDP-Serenje, Mpika, Chinsali[f]	.0453	.7319	2.061		.00092
Central Prov. Maize Production Project[g]	.1913	.0747	1.252	1.548	2.13
So. Prov. Ag.Dev. Project[h]	1.988	1.733	2.917	1.117	1.172
North-Western Area Dev. Project[i]	.412	1.335	1.788	2.558	3.356

Table 36: Estimated GRZ and donor expenditures on maize extension, 1984-91 (financial values)(con't)

ml. ZK

ITEM	1984	1985	1986	1987	1988
Eastern Province Ag. Dev. Project[h]		4.386	7.222	2.19	.912
Oxen Supply Training Centre[j]		.004	.0033	.0047	2.358
Ag. Res. and Development[c]				.4954	.6691
Agricultural Extension Services[d]					.0376
Staff Housing			.0192	.0975	.3085
TOTAL MAIZE-RELATED EXPENDITURES	12.823	18.782	35.022	29.648	36.942

[a] Based on actual expenditures reported in GRZ Financial Reports, 1984-91. 40 per cent of total expenditures in each category are attributed to maize extension, except where noted
[b] Partially funded by SIDA and FINNIDA
[c] Partially funded by NORAD
[d] Partially funded by SIDA
[e] Partially funded by the Federal Republic of Germany
[f] Partially funded by the United Kingdom
[g] Partially funded by EEC; 100 % of expenditures attributed to maize
[h] Partially funded by World Bank, IDA loan
[i] Partially funded by IFAD, UK, GTZ, FINNIDA
[j] Partially funded by Netherlands

Table 36: Estimated GRZ and donor expenditures on maize extension, 1984-91 (financial values)(con't)

ml. ZK

ITEM	1989	1990	1991[l]
Personal Emoluments	14.334	20.561	4.746
Allowances	1.417	3.393	.7308
Purchase of Goods	2.109	3.771	.6768
Purchase of Services	.726	1.514	2.308
Training Expenses	4.997	.8667	.1292
CAPITAL EXPENDITURES			
Lima Program[b]	.3539	.6385	.04
Village Agricultural Project, No.Prov.[c]	3.412	3.294	
Motor Vehicles, Movable Assets	.4191	1.983	4.271
Staff Housing			
Seed Control Institute[b]			
NAT'L FARMING INFORMATION SERVICE			
Personal Emoluments	.4023	1.188	3.715
Recurrent Charges	.1386	.6197	.606
Purchase of Goods	.3769	1.367	.5216
Purchase of Services	.5807	1.228	5.222
Office Equipment, Vehicles	.1332	.5123	.7752
Rural Information Services	.0195	.0289	.050
Staff Housing	.0875	.1103	.1404
CAPITAL EXPENDITURES -- MAWD HEADQUARTERS			
Integrated Rural Dev. Program (IRDP)[d]	10.218	26.989	.36
IRDP-NW Province[e]	1.549	6.192	1.575
IRDP-Serenje, Mpika, Chinsali[f]			
Central Prov. Maize Production Project[g]	2.282	4.9	192.547
So. Prov. Ag.Dev. Project[h]	1.301	.7274	.080
North-Western Area Dev. Project[i]	4.427	16.839	1.271

Table 36: Estimated GRZ and donor expenditures on maize extension, 1984-91 (financial values)(con't)

ml. ZK

ITEM	1989	1990	1991
Eastern Province Ag. Dev. Project[h]	.459	.1244	.080
Oxen Supply Training Centre[j]	.1005	.5168	1.68
Ag. Res. and Development[c]	.0284	.03	.6
Agricultural Extension Services[d]	1.25		1.360
Staff Housing	.0345	.1082	.728
Valley Development	.2944		1.360
TOTAL MAIZE-RELATED EXPENDITURES	51.450	97.5	225.572

[a] Based on actual expenditures reported in GRZ Financial Reports, 1984-91. 40 per cent of total expenditures in each category are attributed to maize extension, except where noted

[b] Partially funded by SIDA and FINNIDA

[c] Partially funded by NORAD

[d] Partially funded by SIDA and NORAD

[e] Partially funded by the Federal Republic of Germany

[f] Partially funded by the United Kingdom

[g] Partially funded by EEC; 100 % of expenditures attributed to maize

[h] Partially funded by World Bank, IDA loan

[i] Partially funded by IFAD, UK, GTZ, FINNIDA

[j] Partially funded by Netherlands

[l] 1991 data are total provisions for each category; actual expenditure data not available

Table 36a: Estimated GRZ and donor expenditures on maize extension, 1984-91 (economic values)

ml. ZK

ITEM	1984	1985	1986	1987	1988
Personal Emoluments[a]	5.559	6.049	8.989	6.455	8.502
Allowances[a]	.1264	.2035	.4134	.272	1.33
Purchase of Goods[b]	.8894	.3495	.377	.6788	2.112
Purchase of Services[b]	.2679	.167	.180	.2605	.7801
Training Expenses[a]	.1346	.2085	.350	.3236	.6724
CAPITAL EXPENDITURES[c]					
Lima Program	.4997	.1638	.161	.669	.7222
Village Agricultural Project, No.Prov.	.5982	.557	1.497	2.971	5.458
Motor Vehicles		.0534	.00341	.0267	.0047
Staff Housing			.0195	.2192	
Seed Control Institute			.322	.5034	
NAT'L FARMING INFORMATION SERVICE					
Personal Emoluments[d]	.1431	.1303	.2171	.1748	.3606
Recurrent Charges[e]	.00891	.0123	.0248	.0764	.1402
Purchase of Goods[e]	.0755	.0729	.0822	.2619	.4247
Purchase of Services[e]	.0094	.0109	.0159	.372	.6157
Office Equipment, Vehicles[f]		.0326	.0668	.2555	.1226
Rural Information Services[e]		.0107	.0383	.077	
Staff Housing[f]		.031	.02	.0948	
CAPITAL EXPENDITURES -- MAWD HEADQUARTERS[g]					
Integrated Rural Dev. Program (IRDP)	2.305	1.964	3.598	10.190	11.214
IRDP-NW Province	5.352	1.151	1.048	2.149	2.747
IRDP-Serenje, Mpika, Chinsali	.1083	.8552	1.563		.0015
Central Prov. Maize Production Project	.4574	.0873	.9494	2.025	3.455
So. Prov. Ag.Dev. Project	4.752	2.025	2.213		1.461
North-Western Area Dev. Project	.986	1.560	1.356	3.346	5.444

Table 36a: Estimated GRZ and donor expenditures on maize extension, 1984-91 (economic values)(con't)

ml. ZK

ITEM	1984	1985	1986	1987	1988
Eastern Province Ag. Dev. Project		5.125	5.479	2.864	1.48
Oxen Supply Training Centre		.00467	.0025	.00615	3.825
Ag. Res. and Development				.648	1.085
Agricultural Extension Services					.061
Staff Housing			.0146	.1275	.500
TOTAL MAIZE-RELATED EXPENDITURES	22.273	20.825	29	36.51	52.974

Table 36a: Estimated GRZ and donor expenditures on maize extension, 1984-91 (economic values)(con't)

ml. ZK

ITEM	1989	1990	1991
Personal Emoluments[a]	14.334	20.561	4.746
Allowances[a]	1.417	3.393	.731
Purchase of Goods[b]	2.967	7.233	1.173
Purchase of Services[b]	1.021	2.904	3.999
Training Expenses[a]	4.997	.8667	.1292
CAPITAL EXPENDITURES[c]			
Lima Program	.517	1.303	.0732
Village Agricultural Project, No.Prov.	4.985	6.722	
Motor Vehicles, Movable Assets	.6123	4.046	7.818
Staff Housing			
Seed Control Institute			
NAT'L FARMING INFORMATION SERVICE			
Personal Emoluments[d]	.4023	1.188	3.715
Recurrent Charges[e]	.195	1.189	1.050
Purchase of Goods[e]	.5302	2.622	.9038
Purchase of Services[e]	.8169	2.356	9.049
Office Equipment, Vehicles[f]	.1946	1.045	1.419
Rural Information Services[e]	.0274	.0554	.0866
Staff Housing[f]	.1278	.2251	.257
CAPITAL EXPENDITURES -- MAWD HEADQUARTERS[g]			
Integrated Rural Dev. Program (IRDP)	14.928	55.078	.659
IRDP-NW Province	2.263	12.637	2.883
IRDP-Serenje, Mpika, Chinsali			
Central Prov. Maize Production Project	3.333	9.999	352.454
So. Prov. Ag.Dev. Project	1.9	1.484	.1464
North-Western Area Dev. Project	6.468	34.365	2.326

Table 36a: Estimated GRZ and donor expenditures on maize extension, 1984-91 (economic values)(con't)

mln ZK

ITEM	1989	1990	1991
Eastern Province Ag. Dev. Project	.6706	.2539	.1464
Oxen Supply Training Centre	.1468	1.055	3.075
Ag. Res. and Development	.0415	.0612	1.098
Agricultural Extension Services	1.827		2.489
Staff Housing	.0504	.2208	1.333
Valley Development	.4301		2.489
TOTAL MAIZE-RELATED EXPENDITURES	65.203	170.861	404.25

[a] No tradeable goods
[b] 75% of expenditures are considered tradeable goods and valued at the SER
[c] 85% of all expenditures in this category are considered tradeable goods and valued at the SER
[d] No tradeable goods
[e] 75% of expenditures are considered tradeable goods and valued at the SER
[f] 85% of expenditures are considered tradeable goods and valued at the SER
[g] 85% of all expenditures in this category are considered tradeable goods and valued at the SER

Appendix 8: Estimated GRZ and donor expenditures on maize marketing and related expenditures

Table 37: Estimated GRZ and donor expenditures on maize marketing and related expenditures, 1984-94[a] (financial)

ml. ZK

ITEM	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Dept. of Cooperatives and Marketing											
Personal Emoluments	1.748	1.815	2.444	2.414	3.053	3.865	7.441	22.61			
Allowances	.0088	.245	.142	.118	.171	.185	1.645	.504			
Purchase of Goods	.0382	.067	.1635	.1802	.2676	.371	.5385	1.091			
Purchase of Services	.0421	.0655	.1724	.1715	.6005	.5375	.7467	.684			
Motor Vehicles, movable assets			1.249	.415		.05	.751	1.364			
Rural Storage Facilities				.506	.091	.09	.090	.251			
ECU Project[b]					.5						
TOTAL, est. Dept. of Coop/Mkting expenditures	1.837	1.972	4.170	3.804	4.683	5.098	11.21	26.5	48.69	48.69	
SUBSIDIES											
Fertilizer Handling[c]	6.56			164.7	164.7	285.6	760				
Fertilizer Price Differential Subsidy[c]	9.52										
Subsidies to Namboard	7										
Subsidies to Cooperative Unions	58.5	31.3			770	700	1304				
Milling Subsidy					478.3						
Seed Subsidy				9.7							
Coupon Program						600	1300				
TOTAL, est. subsidies[d]	81.6	134	565	638.4	1413	1586	3364	6983	6415	3207	0
TOTAL, Dept. of Coop/Mkting expenditures and subsidies	83.44	136	569.2	642.2	1418	1591	3375	7009	6463	3256	48.69

[a] Based on actual expenditures reported in GRZ Financial Reports, 1984-91, and subsidy estimates in GRZ, 1990. 100 per cent of total expenditures in each category are attributed to maize marketing. 1991 estimates are provisional or estimates based on 1990 levels; actual expenditure data was not available. 1992 and 1993 estimates assume GRZ spending on subsidies declines to 50% and 25% of 1991 expenditures, respectively. Subsidy expenditures for the period 1994-2000 are assumed to decline to 0. Dept. of Coop/Mkting expenditures are assumed to remain constant at 1991 levels for the 1992-2000 period.

[b] Partially funded by World Bank

[c] 80% of total expenditures were attributed to maize

[d] Subsidy category expenditures above do not add to this total, since complete information about breakdown of subsidy expenditures was not available for any year. Total estimated subsidies data are from GRZ, 1990

Table 37a: Estimated GRZ and donor expenditures on maize marketing and related expenditures, 1984-94 (economic)

ml. ZK

ITEM	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Dept. of Coop. and Marketing											
Personal Emoluments[a]	1.748	1.815	2.444	2.414	3.053	3.865	7.441	22.61			
Allowances[a]	.0088	.0245	.1415	.1176	.1708	.1846	1.645	.504			
Purchase of Goods[b]	.085	.077	.1287	.2292	.4145	.5219	1.033	1.89			
Purchase of Services[b]	.0938	.0752	.1357	.218	.930	.756	1.432	1.185			
Motor Vehicles, movable assets[c]			.947	.544		.073	1.532	2.497			
Rural Storage Facilities[c]				.662	.1476	.132	.1837	.4585			
ECU Project[c]					.811						
TOTAL, est. Dept. of Coop/Mkt. expend.	1.936	1.991	3.79	4.184	5.527	5.532	13.27	29.14	53.54	48.69	48.7
SUBSIDIES											
Fertilizer Handling	15.68			215.5	267.2	417.2	1551				
Fertilizer Price Differential Subsidy[d]											
Subsidies to Namboard	16.74										
Subsidies to Coop. Unions	139.9	36.57			1249	1023	2661				
Milling Subsidy[d]											
Seed Subsidy[d]											
Coupon Program[d]											
TOTAL, est. subsidies[e]	144	146.4	490	746.6	1897	1988	5290	10172	9883	4941	0
TOTAL, Dept. of Coop/Mkt. expend. and subsidies	146	148.4	493.8	750.8	1902	1993	5303	10201	9936	4990	48.7

[a] No tradeable goods in this category

[b] 75% of expenditures are considered tradeable goods and valued at the SER

[c] 85% of expenditures are considered tradeable goods and valued at the SER

[d] Not included in economic analysis

[e] 55% of total estimated subsidies are included in the economic analysis. It is estimated that approximately 45% of subsidies are expenditures on coupons and other price differential categories, which are not included in economic analysis. Of this 55%, 85% of expenditures are considered to be tradeable items, and valued at the SER.

Appendix 9: Production costs

Appendix 10: Zamseed maize seed sales by province and variety, 1981-91

Table 57: Zamseed maize sales by province and variety, 1981-82[a]

(50 KG BAGS) (% OF SALES IN PARENTHESES)

PROVINCE	SR52	ZH1	GRAND TOTAL
SOUTHERN	39338 (95.0)	2276 (5.0)	41614 24.0
EASTERN	7159 (42.0)	10013 (58.0)	17172 (10.0)
LUSAKA	40970 (87.0)	6130 (13.0)	47100 (27.0)
NORTHERN	8300 (100.0)		8300 (5.0)
LUAPULA	2330 (100.0)		2330 (1.0)
COPPERBELT	3884 (100.0)		3884 (2.0)
WESTERN	1897 (87.0)	278 (13.0)	2175 (1.0)
CENTRAL	36426 (80.0)	9195 (20.0)	45621 (26.0)
NORTHWEST	4911 (100.0)		4911 (3.0)
GRAND TOTAL	145215 (0.84)	27892 (16.0)	173107

[a] Source: Zambia Seed Company, Ltd.

Table 58: Zamseed maize sales by province and variety, 1982-83[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	SR52	ZH1	R215	GRAND TOTAL
SOUTHERN	41725 (87.0)	895 (2.0)	5300 (11.0)	47920 (31.0)
EASTERN	28188 (85.0)	955 (3.0)	4000 (12.0)	33143 (22.0)
LUSAKA	5249 (66.0)	739 (9.0)	1968 (25.0)	7956 (5.0)
NORTHERN	19960 (100.0)			19960 (13.0)
LUAPULA	1690 (100.0)			1690 (1.0)
COPPERBELT	3822 (85.0)	700 (15.0)		4522 (3.0)
WESTERN	2208 (82.0)		500 (18.0)	2708 (2.0)
CENTRAL	25281 (84.0)	3076 (10.0)	1800 (6.0)	30156 (20.0)
NORTHWEST	2636 (93.0)	200 (7.0)		2836 (2.0)
GRAND TOTAL	132720 (87.0)	6564 (4.0)	13568 (9.0)	152852
FINAL SALES TOTAL				167008

[a] Source: Zambia Seed Company, Ltd.

Table 59: Zamseed maize sales by province and variety, 1984-85[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	SR52	ZH1	MM752	CG4141	PNR473	OTHER	GRAND TOTAL
SOUTHERN	13980 (40.0)		801 (2.0)	15096 (43.0)	5119 (15.0)	1 (0.0)	34997 (21.0)
EASTERN	52429 (95.0)		1290 (2.0)		1390 (3.0)		55109 (33.0)
LUSAKA	10377 (62.0)	192 (1.0)	958 (6.0)	2406 (14.0)	2529 (15.0)	341 (2.0)	16803 (10.0)
NORTHERN	16200 (98.0)		350 (2.0)				16550 (10.0)
LUAPULA	2180 (99.0)		30 (1.0)				2210 (1.0)
COPPERBELT			154 (100)				154 (0.0)
WESTERN	1940 (68.0)		30 (1.0)	500 (17.0)	400 (14.0)		2870 (2.0)
CENTRAL	24651 (83.0)	772 (3.0)	2047 (7.0)	2298 (8.0)			29768 (18.0)
NORTHWEST	3256 (94.0)		110 (3.0)		115 (3.0)		3481 (2.0)
STOCKISTS	2303 (73.0)		154 (5.0)	358 (11.0)	341 (11.0)		3156 (2.0)
GRAND TOTAL	127316 (77.0)	965 (1.0)	5924 (4.0)	20657 (13.0)	9893 (6.0)	342 (0.0)	165097
FINAL SALES TOTAL							137793

[a] Source: Zambia Seed Company, Ltd. Detailed sales information was not available for 1982-83.
Note: MM752 was released in 1983 and sold through Zamseed beginning in the 1984-85 season. However, no sales data for MM752 is available in the records. Data for SR52 and MM752 sales may have been mixed for this season.

Table 60: Zamseed maize sales by province and variety, 1985-86[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	SR52	ZH1	CG4141	OTHER	MM752	MM501	MM502
SOUTHERN	235 (1.0)		20 (0.0)	70 (0.0)	14780 (56.0)	53 (0.0)	20 (0.0)
EASTERN	7011 (21.0)				22446 (66.0)		
LUSAKA	3550 (17.0)	391 (2.0)	87 (0.0)	357 (2.0)	10637 (51.0)	8 (0.0)	139 (1.0)
NORTHERN	490 (2.0)				13284 (63.0)		
LUAPULA							
COPPERBELT	793 (17.0)	1 (0.0)			3971 (83.0)		
WESTERN				110 (2.0)	1101 (23.0)	115 (2.0)	99 (2.0)
CENTRAL	234 (1.0)	20 (0.0)		523 (2.0)	25257 (79.0)		
NORTHWEST	970 (52.0)				92 (5.0)		
GRAND TOTAL	13283 (9.0)	412 (0.0)	107 (0.0)	1060 (1.0)	91568 (62.0)	176 (0.0)	258 (0.0)

Table 60: Zamseed maize sales by province and variety, 1985-86[a] (con't)

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM504	MM601	MM603	MM604	MMV400	MMV600	GRAND TOTAL
SOUTHERN	444 (2.0)	1397 (5.0)	5667 (21.0)	3303 (12.0)	507 (2.0)		26496 (18.0)
EASTERN	4 (0.0)	40 (0.0)	2268 (7.0)	2123 (6.0)			33892 (23.0)
LUSAKA	771 (4.0)	3069 (15.0)	1661 (8.0)	110 (1.0)	69 (0.0)	14 (0.0)	20863 (14.0)
NORTHERN				7292 (35.0)			21066 (14.0)
LUAPULA			46 (4.0)	660 (62.0)		365 (34.0)	1071 (1.0)
COPPERBELT	10 (0.0)		10 (0.0)				4785 (3.0)
WESTERN	630 (13.0)		2255 (47.0)	500 (10.0)			4810 (3.0)
CENTRAL	370 (1.0)	144 (0.0)	1634 (5.0)	3757 (12.0)			31939 (22.0)
NORTHWEST			2 (0.0)		1 (0.0)	800 (43.0)	1865 (1.0)
GRAND TOTAL	2229 (2.0)	4650 (3.0)	13543 (9.0)	17745 (12.0)	577 (0.0)	1179 (1.0)	146787
FINAL SALES TOTAL							146091

[a] Source: Zambia Seed Company, Ltd.

Table 61: Zamseed maize sales by province and variety, 1986-87[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	SR52	ZH1	CG4141	OTHER	MM752	MM501	MM502
SOUTHERN	30 (0.0)				4035 (9.0)	1 (0.0)	1548 (4.0)
EASTERN	163.2 (1.0)				462 (2.0)		
LUSAKA	1843 (6.0)	194 (1.0)	12 (0.0)		6434 (22.0)	10 (0.0)	209 (1.0)
NORTHERN					4553 (31.0)		
LUAPULA	4 (0.0)				44 (1.0)		
COPPERBELT	3 (0.0)				2488 (29.0)		
WESTERN					200 (3.0)		
CENTRAL					8181 (21.0)		70 (0.0)
NORTHWEST					317 (13.0)		
OTHER	1231 (2.0)				2337 (37.0)		
SERIOES					2170 (51.0)		5 (0.0)
GRAND TOTAL	3275 (2.0)	194 (0.0)	12 (0.0)		31221 (18.0)	11 (0.0)	1832 (1.0)

Table 61: Zamseed maize sales by province and variety, 1986-87[a] (con't)

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM504	MM601	MM603	MM604	MMV400	MMV600	GRAND TOTAL
SOUTHERN	9146 (21.0)	2278 (6.0)	14120 (33.0)	9693 (23.0)	1913 (4.0)	307 (1.0)	43071 (24.0)
EASTERN			6727 (31.0)	14286 (66.0)		59 (0.0)	21697 (12.0)
LUSAKA	2157 (8.0)	2046 (7.0)	9268 (32.0)	2894 (10.0)	495 (2.0)	3078 (11.0)	28640 (16.0)
NORTHERN			110 (1.0)	6450 (44.0)		3602 (24.0)	14715 (8.0)
LUAPULA		10 (0.0)	1685 (57.0)	8 (0.0)		1222 (41.0)	2973 (2.0)
COPPERBELT	310 (4.0)	485 (6.0)	3107 (36.0)	1838 (21.0)	15 (0.0)	394 (5.0)	8641 (5.0)
WESTERN	1822 (3.0)		3013 (50.0)	100 (2.0)	872 (15.0)		6006 (3.0)
CENTRAL	8111.2 (21.0)	881 (2.0)	5609 (14.0)	13484 (34.0)		2822 (7.0)	39157 (22.0)
NORTHWEST			316 (13.0)	80 (3.0)		1644 (70.0)	2357 (1.0)
OTHER			579 (9.0)	1926 (31.0)			6254 (4.0)
SERIOES		601 (14.0)	890 (21.0)	600 (14.0)		180 (3.0)	4266 (2.0)
GRAND TOTAL	21546 (12.0)	6301 (4.0)	45424 (26.0)	51358 (29.0)	3295 (2.0)	13309 (7.0)	177779
FINAL SALES TOTAL							177386

[a] Source: Zambia Seed Company, Ltd.

Table 62: Zamseed maize sales by province and variety, 1987-88[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM752	MM601	MM603	MM604	MM502	MM504	R215	R201	ZS225	GRAND TOTAL
SOUTHERN	2015 (5.0)	431 (1.0)	2241 (5.0)		272 (1.0)	33 (0.0)	21479 (48.0)	17272 (39.0)	880 (2.0)	44623 (24.0)
EASTERN	4022 (13.0)		1 (0.0)	18403 (59.0)	400 (1.0)		3949 (13.0)		4600 (15.0)	31375 (17.0)
LUSAKA	375 (3.0)	125 (1.0)	2883 (22.0)	214 (2.0)	60 (0.0)		4607 (35.0)	1976 (15.0)	2790 (21.0)	13030 (7.0)
NORTHERN	4952 (22.0)	2 (0.0)	11277 (49.0)	1407 (6.0)			5256 (23.0)		14 (0.0)	22908 (12.0)
LUAPULA	450 (10.0)	25 (1.0)	2400 (54.0)				1600 (36.0)			4475 (2.0)
COPPERBELT	2378 (24.0)	1263 (13.0)	770 (8.0)	4 (0.0)			5118 (51.0)	1 (0.0)	443 (4.0)	9977 (5.0)
WESTERN	500 (5.0)		5868 (58.0)				1900 (19.0)	1900 (19.0)		10168 (5.0)
CENTRAL	7481 (19.0)	240 (1.0)	5016 (12.0)	184 (0.0)		5 (0.0)	15041 (37.0)	7073 (18.0)	5141 (13.0)	40181 (21.0)
NORTHWEST	1076 (35.0)		181 (6.0)				1740 (57.0)	60 (0.02)		3057 (2.0)
RETAIL	1788 (19.0)	912 (10.0)	925 (10.0)	132 (1.0)	276 (3.0)		3176 (34.0)	1378 (15.0)	658 (7.0)	9245 (5.0)
GRAND TOTAL	25037 (13.0)	2998 (2.0)	31562 (17.0)	20344 (11.0)	1008 (1.0)	38 (0.0)	63866 (34.0)	29660 (16.0)	14526 (8.0)	189039
FINAL SALES TOTAL										208088

[a] Source: Zambia Seed Company, Ltd.

Table 63: Zamseed maize sales by province and variety, 1988-89[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM752 MM612	MM601 MM502 MM501	MM603 MM604	R201 R215	MMV400	MMV600	MM504	ZS206	GRAND TOTAL
SOUTHERN	2508 (6.0)	611 (1.0)	13697 (32.0)	19631 (46.0)	3666 (8.0)	3222 (7.0)			43335 (16.0)
EASTERN	8912 (24.0)		27947 (75.0)		400 (1.0)				37259 (14.0)
LUSAKA	1199 (9.0)		8479 (61.0)	3101 (22.0)	1000 (7.0)	200 (1.0)			13979 (5.0)
NORTHERN	6638 (21.0)		25287 (79.0)						31925 (12.0)
LUAPULA	516 (7.0)	57 (1.0)	4572 (64.0)			2020 (28.0)			7165 (3.0)
COPPERBELT	1042 (6.0)	3731 (22.0)	12439 (72.0)						17212 (6.0)
WESTERN			5530 (68.0)		1440 (18.0)		1200 (15.0)		8170 (3.0)
CENTRAL	16634 (29.0)	5030 (9.0)	10323 (18.0)	21127 (37.0)		2228 (4.0)	1785 (3.0)	298 (1.0)	57425 (21.0)
NORTHWEST	2363 (32.0)		1400 (19.0)			3593 (49.0)			7356 (3.0)
OTHER									31264 (12.0)
RETAIL									15765 (6.0)
GRAND TOTAL	39812 (15.0)	9429 (4.0)	109674 (41.0)	43859 (16.0)	6106 (2.0)	11663 (4.0)	2985 (1.0)	298 (0.0)	270854
FINAL SALES TOTAL									272093

[a] Source: Zambia Seed Company, Ltd.

Table 64: Zamseed maize sales by province and variety, 1989-90[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM752	MM601	MM603	MM604	MM612	MM502	MM504
SOUTHERN	1320 (3.0)		16558 (38.0)				
EASTERN	4451 (13.0)		2310 (7.0)	23691 (67.0)			
LUSAKA	2320 (12.0)		3060 (16.0)	1820 (9.0)			1000 (5.0)
NORTHERN	3610 (11.0)		11504 (34.0)	12023 (36.0)	6511 (19.0)		
LUAPULA	700 (8.0)		6690 (73.0)	600 (7.0)			
COPPERBELT	3403 (37.0)	800 (9.0)	1989 (21.0)	3106 (33.0)			
WESTERN			5209 (37.0)	3451 (24.0)			600 (4.0)
CENTRAL	16406 (26.0)		9136 (14.0)	20291 (32.0)	2250 (4.0)	200 (0.0)	2972 (5.0)
NORTHWEST	3384 (41.0)		299 (4.0)		1700 (20.0)		
OTHER	1835 (7.0)	731 (3.0)	6974 (27.0)	2846 (11.0)	8 (0.0)	457 (2.0)	128 (1.0)
GRAND TOTAL	37429 (14.0)	1531 (1.0)	63729 (24.0)	67828 (26.0)	10469 (4.0)	657 (0.0)	4700 (2.0)

Table 64: Zamseed maize sales by province and variety, 1989-90[a] (con't)

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MMV400	MMV600	ZS206	R215	R201	GRAND TOTAL
SOUTHERN	2100 (5.0)			8208 (19.0)	15080 (35.0)	43266 (17.0)
EASTERN		810 (2.0)		2505 (7.0)	1470 (4.0)	35237 (13.0)
LUSAKA	400 (2.0)	600 (3.0)		8550 (43.0)	1950 (10.0)	19700 (8.0)
NORTHERN						33648 (13.0)
LUAPULA		1160 (13.0)				9150 (3.0)
COPPERBELT						9298 (4.0)
WESTERN				4840 (34.0)		14100 (5.0)
CENTRAL				10510 (17.0)	1540 (2.0)	63305 (24.0)
NORTHWEST	1 (0.0)	2910 (35.0)				8294 (3.0)
OTHER	96 (0.0)	1580 (6.0)	4189 (16.0)	6433 (25.0)	195 (1.0)	25472 (10.0)
GRAND TOTAL	2597 (1.0)	7060 (3.0)	4189 (2.0)	41046 (16.0)	20235 (8.0)	261470
FINAL SALES TOTAL						300000

[a] Source: Zambia Seed Company, Ltd. Detailed data for 1988 were not available.

Table 65: Zamseed maize sales by province and variety, 1990-91[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM752	MM601	MM603	MM604	MM612	MM502	MM504
SOUTHERN	1514 (3.0)	1257 (3.0)	16475 (38.0)	23082 (53.0)		177 (0.0)	22 (0.0)
EASTERN	15260 (38.0)		973 (2.0)	23755 (59.0)	1 (0.0)		
LUSAKA	2196 (9.0)	888 (4.0)	5644 (24.0)	4280 (18.0)	8 (0.0)	1013 (4.0)	8 (0.0)
NORTHERN			92 (15.0)	100 (17.0)	403 (68.0)		
LUAPULA	444 (9.0)		3200 (65.0)	496 (10.0)	700 (14.0)		
COPPERBELT	143 (4.0)	56 (1.0)	2173 (57.0)	1046 (27.0)			
WESTERN			5901 (88.0)	220 (3.0)			
CENTRAL	14884 (46.0)	175 (1.0)	2118 (7.0)	13634 (42.0)	245 (1.0)	10 (0.0)	
NORTHWEST	1 (2.0)		2 (4.0)	52 (85.0)	6 (9.0)		
GRAND TOTAL	34442 (22.0)	2377 (2.0)	36580 (23.0)	66665 (43.0)	1363 (1.0)	1200 (1.0)	30 (0.0)

Table 65: Zamseed maize sales by province and variety, 1990-91[a] (con't)

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MMV400	MMV600	ZS206	R215	R201	ZS225	GRAND TOTAL
SOUTHERN	386 (1.0)	13 (0.0)	379 (1.0)	383 (1.0)	158 (0.0)		43847 (28.0)
EASTERN	0.8 (0.0)	41.8 (0.0)		40 (0.0)			40072 (26.0)
LUSAKA	326 (1.0)	5614 (24.0)	2635 (11.0)	643 (3.0)	24 (0.0)	121 (1.0)	23401 (15.0)
NORTHERN							595 (0.0)
LUAPULA			100 (2.0)				4940 (3.0)
COPPERBELT	5 (0.0)		420 (11.0)		5 (0.0)		3845 (2.0)
WESTERN	560 (8.0)						6681 (4.0)
CENTRAL			1100 (3.0)	56 (0.0)			32221 (21.0)
NORTHWEST							61.2 (0.0)
GRAND TOTAL	1274 (1.0)	5669 (4.0)	4634 (3.0)	1123 (1.0)	187 (0.0)	121 (0.0)	155662
FINAL SALES TOTAL							143633

[a] Source: Zambia Seed Company, Ltd.

Table 66: Zamseed maize sales by province and variety, 1991-92[a]

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MM752	MM601	MM603	MM604	MM612	MM501	MM502	MM504
SOUTHERN	987 (2.0)	1407 (3.0)	12076 (26.0)	26805 (58.0)		20 (0.0)	69 (0.0)	610 (1.0)
EASTERN	1198 (4.0)	4600 (14.0)	14000 (43.0)	9000 (27.0)			2800 (9.0)	
LUSAKA	692 (5.0)	174 (1.0)	6804 (54.0)	2641 (21.0)				20 (0.0)
NORTHERN	2139 (20.0)		1806 (17.0)	1608 (15.0)	4890 (47.0)			
LUAPULA	7 (0.0)		1114 (52.0)	4 (0.0)	1000 (47.0)			
COPPERBELT	1515 (21.0)	208 (3.0)	3167 (43.0)	2001 (27.0)	4 (0.0)			
WESTERN		4 (0.0)	1965 (73.0)	530 (20.0)				
CENTRAL	949 (4.0)	408 (2.0)	8032 (32.0)	10103 (40.0)	3816 (15.0)			
NORTHWEST	150 (8.0)		700 (37.0)	250 (13.0)	200 (11.0)			
RETAIL	202 (4.0)	80 (2.0)	1867 (38.0)	2051 (42.0)	680 (14.0)			
GRAND TOTAL	7839 (5.0)	6881 (5.0)	51531 (35.0)	54993 (38.0)	10590 (7.0)	20 (0.0)	2869 (2.0)	630 (0.0)

[a] Source: Zambia Seed Company, Ltd.

Table 66: Zamseed maize sales by province and variety, 1991-92[a] (con't)

(50 KG BAGS)(% OF SALES IN PARENTHESES)

PROVINCE	MMV400	MMV600	ZS206	R215	R201	ZS225	BULK	GRAND TOTAL
SOUTHERN	1695 (4.0)		391 (1.0)	1787 (4.0)	289 (1.0)			46136 (32.0)
EASTERN	11 (0.0)	11 (0.0)					1148 (4.0)	32768 (22.0)
LUSAKA	379 (3.0)	366 (3.0)	1125 (9.0)	373 (3.0)	54 (0.0)			12628 (9.0)
NORTHERN								10443 (7.0)
LUAPULA								2125 (1.0)
COPPERBELT		13 (0.0)	377 (5.0)					7285 (5.0)
WESTERN	204 (8.0)							2703 (2.0)
CENTRAL	19 (0.0)		1965 (8.0)	57 (0.0)				25350 (17.0)
NORTHWEST		584 (31.0)						1884 (1.0)
RETAIL								4879 (3.0)
GRAND TOTAL	2308 (2.0)	974 (1.0)	3858 (3.0)	2217 (2.0)	343 (0.0)		1148 (1.0)	146200
FINAL SALES TOTAL								199864

[a] Source: Zambia Seed Company, Ltd.