DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

WORKING PAPER

THE EVOLUTION AND PERFORMANCE OF THE ZIMBABWE AGRICULTURAL RESEARCH SYSTEM - 1900 to 1980: A Case Study in Institution Building for Agricultural Development.

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Working Paper AEE 3/89

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THE EVOLUTION AND PERFORMANCE OF THE ZIMBABWE AGRICULTURAL RESEARCH SYSTEM - 1900 TO 1980: A Case Study in Institution Building for Agricultural Development

1. INTRODUCTION

The objective of this paper is to trace the historical development of agricultural research in Zimbabwe from the colonial founding of the country to 1980. Emphasis will be on identifying or highlighting the pattern of development in institution building, research policy formulation and orientation. This will be done to show the interaction between technological change, institutional reform and economic goals and policies. Such an understanding is needed to improve research resource allocation.

The paper will conclude by making an assessment of the performance and achievements of the national research system prior to 1980. This provides a basis for illustrating the task of the research system since independence and in future.

2. DEVELOPMENT PATTERN : 1900-1980

The development period can be divided into three phases closely related to the development pattern of agriculture in the country. Two of these phases, namely the Development Phase, 1903 - 1948 and the Consolidation Phase, 1948 - 1980, will be discussed in this paper. The third phase in which significant changes have taken place, is the period after 1980. This will be the subject of a subsequent paper. This is separated from the other two because since 1980 a political change took place that brought to power a black-ruled government with goals and objectives quite distinct from those of governments that have ruled since the colonial founding of the country.

In the first phase, the Department of Agriculture was responsible for all government agricultural functions including research and extension. In the second phase a separate department became responsible for research.

2.1 The Development Phase (1903 - 1948)

All agricultural research and advisory activities originated from the Department of Agriculture which was established in 1903. The key task of the Department was to foster the development of the agricultural industry in the colony. The prime concern was on increasing the export commodities, i.e. cotton, tobacco and beef

in order to create a viable agricultural base in support of the mining industry (Weinmann, 1975).

Agricultural research was given priority because of the unfamiliarity of the production environment. Research work was concerned with testing exotic crop and livestock species and with agronomic trials to determine how to grow crops and keep livestock satisfactory in the country's environment.
The period 1900 to 1948 can be characterised as an institution and infrastructure establishment era. The first agricultural research station, the Salisbury Experimental Research Station was established in 1909 (Weinmann, 1975). With increase in settler farmer population and expansion of agriculture into the various agro-ecological zones, it was felt necessary to decentralise crop and animal research activities. The idea was to cover the different soil and climatic conditions in the regions in which production or farmer population were concentrated (Weinmann, 1975). Over the period under review a network of research stations experimental farms, testing and demonstration farms and stations were established as shown in Table 1(Appendix).

The purpose of these were three-fold;

(1) to carry out agricultural investigations for crops and livestock,
(2) to demonstrate modern farming methods, and
(3) to demonstrate to the farmers in the different agro-ecological zones the crop and livestock potential of their areas.

With respect to agricultural investigations (research) the 1900-1948 period was when most research programs were initiated. New species and varieties of crops and livestock were introduced and tested at the various stations and farms for suitability to local environment. Breeding programs were initiated to develop varieties suitable for the local conditions and with high yield potential as well as other desirable agronomic characteristics. This was accompanied by studies on husbandry practices such as manure and fertilizer use, rotations, disease and pest control, animal nutrition and management, etc. The establishment of colleges offering agricultural training to apprentice farmers and that of demonstration farms was intended to have farmers adopt the improved practices (Weinmann 1975).

In the early 1920's efforts were started to extend good farming methods to peasant farmers. This was done through demonstration plots located on farmers' fields. Between 1930 and 1940 experimental farms to serve black farmers in the then African Purchase Areas were established at Marirangwe, Samenani and Makoholi. The research efforts included collecting and testing local crops throughout the country for yield potential, drought resistance and seed improvement for distribution to these farmers.

Agricultural research activities, as with other Department of Agriculture activities and general agricultural development, suffered setbacks during the Depression and the First and Second World War years. However, a firm foundation has been laid that allowed rapid recovery after the Second World War. Also, the government adopted protective measures for agriculture by declaring it a controlled industry. Prices of some agricultural commodities were controlled and producers subsidized, for example, maize, cotton and tobacco. These measures and the expansion in the settler population due to war prisoners, refugees and internees stimulated the agricultural industry (Weinmann, 1975). A consequence was expansion in the activities of the Agriculture Department necessitating re-organisation of the Department in 1948 when the Department of Research and Specialist Services (R&SS) was born. Other Departments within the newly created Agriculture and Lands Ministry were: Conservation and Extension Services, Forestry, Lands, Veterinary Services and Irrigation. Formation of R&SS ushered in a new era in agricultural research and extension.

Notable features of the Development Phase are (1) creation of the research infrastructure (2) initiation of research programs whose outcome had a bearing on research conduct in subsequent phases and (3) establishment of commercial agriculture based on modern production practices.

2.2 Consolidation Phase, 1948-1980

The Research and Specialist Services Department was formed to consolidate initial research efforts, which were mainly individual initiatives, into a national effort to ensure adequate and efficient scientific service to the farmer. This was felt necessary because of the expansion in agricultural activities brought about by increase in European farmer and consumer population. The European population increased by 65 percent, from 82,386 in 1946 to 135,596 in 1951 (Weinmann, 1975). The increase in urban population from the influx of war refugees and internees and improvement in living standards created an internal market with greater demand for agricultural commodities, namely meat, dairy, poultry and wheat products. Outside the country, post-war reconstruction in Europe created a demand for export commodities.

Farmer population increased by 49 percent from 3,424 in 1946 to 5,094 in 1951. This was mainly due to settlement of ex-service men on Government land (Weinmann 1975). Area under crops expanded from 449,678 acres in 1939/40 to around 600,000 acres in 1944/45. A diversified commercial agriculture began to emerge and required systematic agricultural research and provision of advisory services.

The new Department of Research and Specialist Services (R&SS) was organised on scientific disciplinary lines grouped into eleven branches, namely Tobacco, Chemistry, Animal Husbandry, Crop Production, Horticulture, Dairy, Poultry, Pasture Research, Botany and Plant Pathology, Entomology and Conservation and Extension. In 1950, the Conservation and Extension Branch (CONEX) became a separate Department responsible for extension in the large scale commercial farming areas.

There are three distinct features of the early years of the R&SS department. First, research activities were consolidated and organised on a more formal structure to service the growing commercial agriculture sector. Second, research programs initiated in the earlier phase began to bear fruit. Examples are the commercial production of maize hybrids, increase in crop yields and adoption on a wide scale improved animal and crop husbandry practices. The third feature is that farmers began to have a direct interest in the research conducted and its performance. There was now demand for more speedy generation of appropriate technologies.

In 1970, the Agricultural Research Council (ARC) was established to give farmers a say in planning and managing agricultural research. The ARC role will be discussed in a later section on policy formulation.

In 1974, R&SS was re-organised to improve its organisational and administrative efficiency and to effect better co-ordination and direction of research (Chigaru, 1984). This was brought about by the expanded activities of the Department as well as increased demand made on it by farmers. A significant change was the consolidation of the department into three main divisions and having research stations specialize into either crop or livestock research. Some stations assumed a disciplinary focus, e.g., cotton research at Kadoma Research Station; crop breeding and agronomy at Harare (Chigaru, 1984). This was the structure of government agricultural research at the time of independence in 1980.

3. Evolution of Independent and Semi-Independent Research Organisations

3.1 Independent Research Organisations

A number of independent and semi-independent research organisations have evolved with, and contributed to, the development of the national agricultural research system. Privately funded agricultural research that developed during the period under review are citrus, sugar, and inputs research by commercial chemical and machinery supply companies.

3.1.1 Citrus Research

Citrus research was pioneered by the British South African Company (B.S.A. Co) at its experimental station established at the Mazoe Citrus Estate in 1931. The station had a Director, chemist, plant pathologist, entomologist and a horticulturalist (Weinmann, 1975). Research on oranges and apples was focussed on pest and disease control, and prevention of storage wastage. The bulk of the citrus was for the export market.

3.1.2 Sugar Research

Sugar cane research developed in the low-veld in the 1930's following the introduction of sugar cane production by Triangle Sugar Estates (Robertson, 1954). This was made possible by construction of irrigation dams pioneered by T.M. McDougall (Robertson, 1954). In 1914 because of lack of viability, the activities of Triangle Estates were taken over by a quasi-government body, the Sugar Industry Board. The Board was aimed at having government finance and control the development of sugar cane production in the low-veld. The government invested in dam construction leading to sugar cane area expansion. Sugar cane research, which reverted back to private sector in 1954, was directed at selecting varieties that were disease resistant and with high cane and sugar yield potential. Most varieties tested were obtained from South Africa (Weinmann, 1975).

3.2 Semi-Independent Research Organisations

Semi-independent research organisations that have evolved over the period under review are that for tobacco, pig, and to some extent cotton.

3.2.1 Tobacco Research

Tobacco growers' pressure for well-funded tobacco research to improve the speed of tobacco technology development led to the formation of the Tobacco Research Board (TRB) in 1935 by a Parliamentary Act, the Tobacco Research Act (Weinmann, 1975).

The board assumed responsibility for all tobacco research. Board members were drawn from the grower representatives (two); tobacco buyers (two) and Department of Agriculture officials (two). Up to 1950 research was financed by Government and donations from the tobacco processing and marketing companies. With re-constitution of TRB in 1950, tobacco processing companies, levies charged on marketed tobacco as well as the commercial activities of the Board's research stations, that is advisory services and tobacco production.

3.2.2 Cotton Research

Cotton research started in 1925 with the establishment of the Gatooma Cotton Breeding Station by the Department of Agriculture in association with the Empire Cotton Growing Corporation (Weinmann, 1975). The latter provided technical specialists. In 1936, the Cotton Research and Industry Board took over the running of the station. The terms of the Cotton Research and industry Act was for the Board to conduct research, market cotton and run ginneries. A new Act in 1942 allowed the Board to establish textile and allied industries (Weinmann, 1975). These activities of the Board and government fixed pre-planting prices encouraged cotton production.

3.2.3 Pig Research

Pig research started as early as 1925 on government research farms and in cooperation with individual producers. The research was aimed at improving quality of pigs and husbandry practices. The Pig Industry Act of 1937 resulted in the formation of the Pig Industry Board. The Board had responsibility for marketing and grading of pig carcasses and products. It had regulatory and licensing powers over pig producers and processing factories. The Board was charged with the responsibility for developing the pig industry with an eyemark for export trade. Finance was from government grant and levies on marketed pigs (Weinmann, 1975).

3.3 Agro-industry Research Activities

Private sector companies played a role in the research and development of chemical and mechanical inputs. However, such industries developed mostly after the Second World War following the establishment of a more viable agricultural production sector. Before then, the chemicals and machinery were imported for marketing to farmers. In the early decades use of fertilizer was limited by high freight costs. Import substitution strategies adopted after the 1965 Unilateral Declaration of Independence (UDI) and the resulting international sanctions provided financial incentives that stimulated the growth of local private sector firms producing industrial inputs for agriculture. Another stimulant was increased demand for chemical and mechanical inputs following increased adoption of these technologies. The firms had research activities associated with their sales promotions. These included employment of technical field staff and on-farm field demonstrations on chemical and fertiliser application, mechanical tillage and other activities.

3.4 University's Contribution

With the establishment of the University in 1957, the Department of Agriculture played a significant role in agricultural research. Notably work was done on livestock research, particularly on the aspects of animal nutrition (R&SS, 1969). The University also contributed to development of national scientific cadre.

3.5 International Linkages in the Development of Agricultural Research

The national agricultural research system up to 1980 did not develop in isolation. From the early years there was British and South African influence. Most of the exotic material used in experimental work were acquired from South Africa which had had an agricultural research system for a number of decades. For example, the early successful maize varieties, Hickory King, Potchefstroom Pearl originated from South Africa. Original source of maize material was the United States as shown by the following varieties which were tested at Salisbury Station, Wisconsin White Dent, Iowa, Silver, Texas Hickory, Minnesota No. 132, to name a few (Weinmann 1975). Wheat material was introduced from Canada, Kenya (Kenya 13286, Kenya Governor) and from the Indian Subcontinent (Punjab, Karachi).

From these exotic materials the country was able to develop its own varieties and species suited to its agro-ecological environment. New material, however, continued to come in and to be tested or incorporated into local material needed. For example, in the 1960's wheat material was obtained from CIMMYT. However, international sanctions imposed after 1965 disrupted such linkages.

4. RESEARCH POLICY FORMULATION AND ORIENTATION

This section looks at research policy formulation and orientation during the period 1900 - 1980.

4.1 Policy Formulation and Orientation

In the first phase, the Department of Agriculture was concerned with the increase in output of agricultural export commodities (Weinmann, 1975). It took upon itself the task of establishing agricultural investigations, demonstrating the results and encouraging farmers to adopt production of the commodities using improved husbandry practices. Individuals within the Agriculture Department were the prime movers of the

investigations. The concern was on expanding output from expanded agricultural activities. New animal and crop species had to be developed and the requisite agronomic and husbandry practices established for the country's production environment. Equal emphasis was therefore put on extension through demonstration farms and agricultural instructions at agricultural colleges. This is because some of the settler farmers had not farmed before (Weinmann, 1975). Research orientation was therefore towards these farmers and for the development of a diversified commercial agriculture sector based on modern production methods. Both crops and livestock were given attention.

Research policy centered around individual crops or animals and the husbandry practices related to these (R&SS, 1969). The technical post of Director of Agriculture created in 1930 was responsible for guidance and co-ordination of the research of various branches within the Department of Agriculture (Weinmann 1975).

Formation of R&SS allowed for central policy formulation and for central planning of agricultural research. The needs of the farmers were ascertained in the Department of Conservation and Extension (CONEX) and relayed to the research organization through research liaison committees. Farmers were represented on these committees. The research orientation remained towards commercial farmers with the objective now of increased land and animal productivity, that is, higher crop yields and output per animal from beef ad dairy cattle. This is unlike during the Development Phase when the concern was expanded output agricultural activities. This is because area expansion had become limited (Weinmann, 1975). Farmers were also demanding yield-increasing and cost-reducing technologies.
The formation of the Agricultural Research Council (ARC) in 1970 was a response to farmers' demand for direct involvement in research policy formulation. It was also a tactical movement by the government to have farmers contribute towards research costs. The ARC did not operate as a statutory body according to the terms of the 1970 Agricultural Research Council Act. Initially, it played an advisory role, but in 1976 it assumed direct responsibility for agriculture within R&SS and engineering research in CONEX (ARC, 1976). This was in line with farmers' demand for an organisation that was flexible and not bound by the rules of the civil service. All expenditure on research (excluding salaries) by the Ministry of Agriculture and contributions by producer associations were to be channelled through the ARC. This enabled the producers through the ARC to influence directly the formulation of agricultural research policies and programs. Ten members of the Council were drawn from the commercial farmers' represented by the then Rhodesia National Farmer's Union (5 members), the Directors of R&SS, CONEX and TRB and representatives from the University and agro-

industry. The ARC was responsible for: (a) keeping under review agricultural research in the country with particular reference to the adequacy of such research for the needs of the country; (b) promoting all aspects of agricultural research and ensuring maximum co-ordination between persons and authorities who undertook any form of agricultural research (ARC 1976). The ARC interpreted its objective as (ARC, 1976):

(1) to strengthen the Research organization, and
(2) to improve the nutritional quality and yield of the basic food crops through breeding, plant protection and collection of genetic materials and to improve animal health and production.

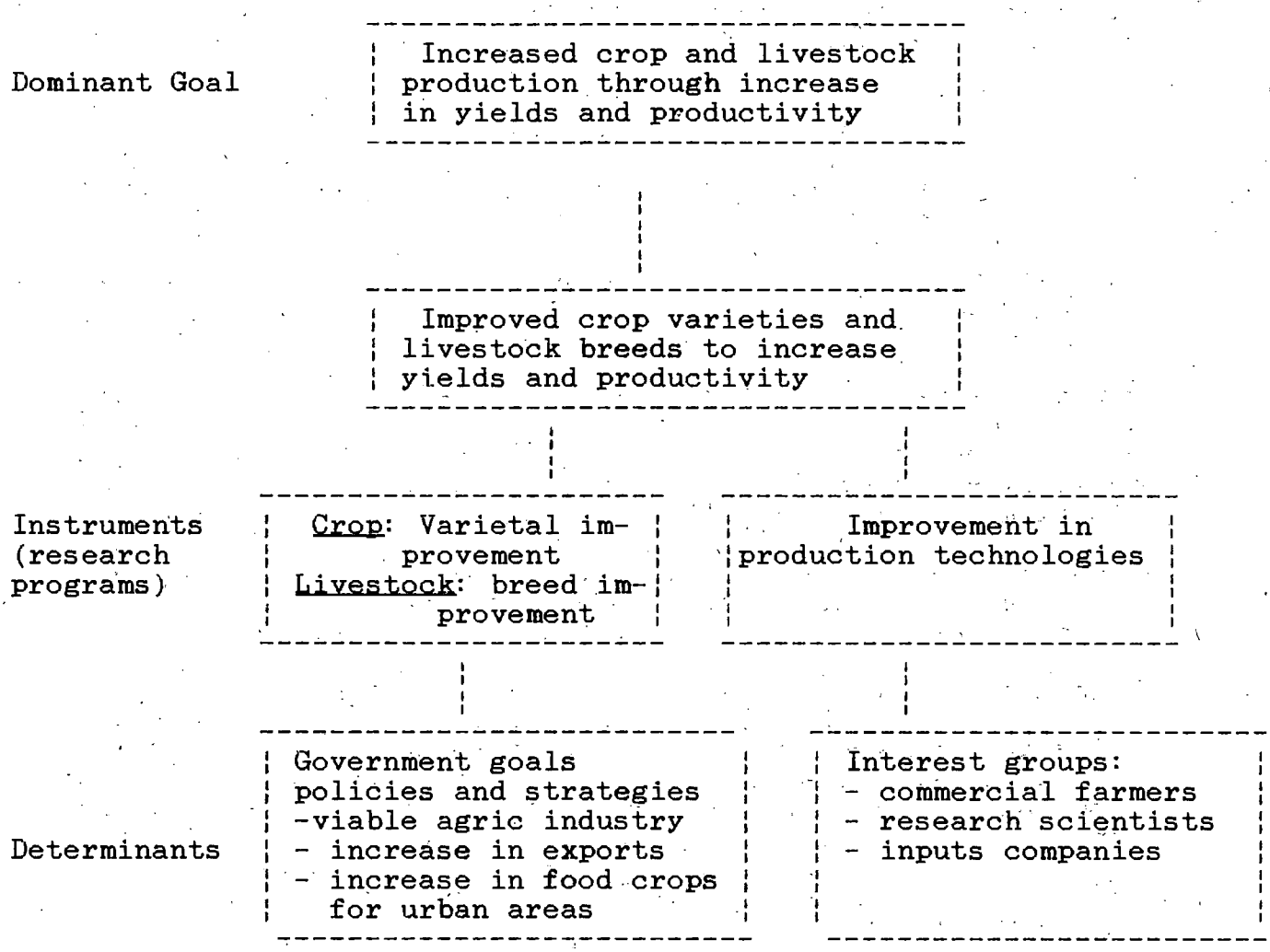
The ARC effected its functions through a number of committee. The Technical Committee was responsible for recommending to Council research policy and budgetary allocation for agricultural research. It was also responsible for setting research priorities within the R&SS departmental programs. The priorities were assessed in light of the resources available. Several commodity sub-committees of the Technical Committee had the responsibility for drawing out commodity research programs in consultation with R&SS and producer associations.

Research orientation remained towards commercial agriculture with emphasis on yield-increasing and cost-reducing technologies suited to the needs of large scale commercial farmers.

A sub-committee on communal agriculture was formed in 1973 (ARC, 1977). It was charged with the responsibility for co-ordinating agricultural research in the peasant sector. The concern was with sociological and economic aspects of food production and distribution. It was the ARC's view that these and not development of appropriate technologies were a constraint to peasant agriculture development (ARC, 1977). Emphasis was therefore put on extension and generation of knowledge about peasant farmer behaviour.

It is important to note that the activities of ARC as with those of R&SS, and CONEX were guided by the importance attached to agriculture by government. Agriculture was charged with the responsibility to produce the major food crops, maize and export commodities, cotton, tobacco and beef, for foreign exchange needs of the country. Figure 1. illustrates what has been the goals, priorities and instruments and their determinants, during the development of the agricultural research system from 1900 1980.

Figure 1: Zimbabwe: Agricultural Research Goals, Priorities, Instruments and their Determinants during the Period 1900 - 1980



(Adapted from: Barichello, R., G. Kennedy, and E.L. Anton, "Research program Development and IRRI", Agricultural Administration Vol. 19, (1985) 1-12.

4.2 Research - Extension Linkages

With regard to research - extension linkages , during the Development Phase, there was no clear distinction between research and extension activities particularly with regard to

agronomic experiments. These were also used for demonstration purposes. With the formation of R&SS and a separate extension department, linkages were effected by means of putting extension liaison officers within the research department. The extension department (CONEX) had crop and livestock extension specialists to back up field workers and liaise with research stations. The extension specialists were required to conduct applied research, produce informative reports and conduct training courses for extension workers on new production methods generated by the research system. Their role was also to review, update and disseminate research results in the form of practical extension recommendations. This narrowed the gap between scientists and farmers.

Up to 1980, these were two extension departments housed in two different ministries. One was CONEX in the Ministry of Agriculture. The other was the Department of Agricultural Development (DEVAG) housed in the Ministry of Lands. The latter department as with its parent ministry was responsible for agricultural extension in the peasant sector. Extension in the large scale and small commercial sectors were the responsibilities of CONEX. It was this department that had the closest links with research as discussed above.

4.3 Role of Farmer Organisations and Producers' Associations

Farmer organisations and livestock and crop producer associations have also played a role in the advancement of agricultural research from the early years. Table 1 shows that the pioneer farmer and producers' organisations were the Rhodesian Farmers' Union formed in 1909, the Tobacco Growers' Association formed in 1935, the Grain Producers' Association formed in 1919, and the Seed Maize Association formed in 1940. Apart from exerting pressure for more organised commodity research, in the case of tobacco, the associations encouraged adoption of improved production technologies by their members. For example, the Seed Maize Association formed in 1940 encouraged certified seed maize production by providing members with information on best production methods (Weinmann, 1975). It also promoted certified seed use by maize growers. Producer levies charged on such marketed commodities like cotton, tobacco, poultry, maize and pigs were used in part to finance agricultural research of the respective commodities.

5. AN ASSESSMENT OF THE PERFORMANCE OF THE AGRICULTURAL RESEARCH SYSTEM PRIOR TO 1980

This section reviews the performance of the agricultural research system over the period 1900-1980. The focus is on how research has contributed to increased agricultural output and development of the country. An attempt will be made to identify the factors contributing to the performance and draw lessons for the future agricultural research planning and implementation.

A literature search revealed that no study has been done to assess quantitatively research impact on the various sectors of the Zimbabwe economy and population (producers and consumers). This will not be attempted in this study but aspects that need to be looked at by a more detailed study will be highlighted.

The success of basic and applied research conducted up to 1980 can be measured in terms of research programs and their impact on agricultural development. Successful research program outcome would include the types of available and applicable technologies generated and adopted by farmers, positive trends in productivity and quality of agricultural commodities.

5.1 Major Crop Research Programs

Over the period under review, crop research had been concentrated on the following aspects that have a limiting effect on yield, (1) varietal improvement, (2) soil fertility, (3) moisture availability, (4) weed control, (5) insect and disease control, and (6) crop husbandry practices (R&SS, 1969). On varietal improvement there has been continuous introduction, evaluation and selection of varieties obtained locally and from other parts of the world. The objective was to develop suitable crop varieties for the agro-ecological conditions in the country. The work involved plant breeders working in collaboration with the agronomists, plant pathologists, entomologists and soil scientists.

A large number of crop varieties with one or more of the following characteristics have been developed: high-yielding, fertilizer-responsive, disease resistant and drought tolerant. Other acceptable characteristics were low plants for easy harvesting, high grain quality, adaptability to storage and resistance to wind lodging. Knowledge has also been accumulated on the ideal husbandry practices. Such knowledge include fertilizer application rates and timing to address soil fertility problems; planting dates for maximum use of effective rainfall in the high and low altitude areas; optimum plant population spacing for the different crop varieties; effective mechanical and chemical weed control; tillage methods to conserve soil moisture; and pest and disease control techniques. All these were aimed at

exploiting to the maximum the yield potential of the different crop varieties (R&SS,1969).

Dissemination and adoption of improved crop varieties and production technologies facilitated growth in areas grown to most crops as it became profitable to grow them.

Notable crop research programs that have had considerable impact on the agricultural development of the country are maize, cotton, tobacco and to some extent wheat and sugar.

5.1.1 Maize Research

Maize research has been under way since the 1900's. Earlier efforts were on variety evaluation and improvement using local varieties and those obtained from South Africa and America. By 1924, four open-pollinated white dent varieties, Salisbury White, Hickory King, Louisiana Hickory and Potchefstroom Pearl had been tested and established as superior to all other varieties (Weinmann, 1975). Maize breeding started in 1932 with the objective of hybrid development. The first hybrids - double hybrids - were released for commercial production seventeen years later, in 1949. The country was second after the USA to grow maize in hybrids from its own breeding program (R&SS, 1969). A single hybrid variety, SR52, released in 1961/62 revolutionalized maize production in the high rainfall areas. This is because of its high yield potential which was found to be 46 percent higher than that of open-pollinated and double hybrids (Weinmann, 1975). A later development of equal importance was the development of an SR52 variety with high lysine protein content. Lysine is an essential protein in human diet. By 1975, maize varieties R200, R201, R215 have been developed to suit the short crop growing season and withstand the mid-season drought experienced in agro-ecological regions 111 and 1V.
It is estimated that by 1980 improved maize varieties were universally used by both the commercial and communal farmers (personal communication from R&SS and AGRITEX personnel). Recommended production practices such as row planting, high population density, timely fertilizer application were widely adopted although at different intensity levels.

Table 2 shows what has been the impact of the maize research program on yield and total output in the large scale commercial farm sub-sector. The yield levels for the 1976-80 period were 235 percent higher than 1951-55 yield levels. Nitrogen was responsible for 200 percent of this maize yield increase (Table 3).

Table 2 Five-year Average Area and Yield of the Major Crops in the Large Scale Commercial Farming Areas, Zimbabwe, 1926/30 to 1976/80.

('000')

	Maize		Cotton		Flue-cured		Wheat	
Years	Area (ha)	Yield (kg/ha)	Area (ha)	Yield (kg/ha)	Area (ha)	Yield (kg/ha)	Area (ha)	Yield (kg/ha)
1926/30	121.0	1.3	6.8	0.1	9.3	0.2	2.4	0.6
1931/35	109.4	1.3	1.8	0.1	12.4	0.2	6.6	0.5
1936/40	112.9	1.4	0.6	0.2	20.1	0.2	8.7	0.6
1941/45	98.2	1.3	1.9	0.8	26.9	0.3	7.0	0.6
1946/50	117.7	1.1	1.8	0.6	45.0	0.3	2.0	0.7
1951/55	145.1	1.4	5.1	0.3	70.8	0.9	0.8	1.4
1956/60	143.3	2.3	0.5	0.7	77.5	1.0	0.8	1.2
1961/65	162.0	2.8	4.6	1.2	88.7	1.2	1.0	2.0
1966/70	224.2	3.6	43.8	1.4	53.9	1.3	8.4	3.1
1971/75	270.3	4.9	70.6	1.7	49.9	1.4	24.0	3.9
1976/80	212.5	4.7	74.1	1.74	47.9	1.6	37.3	4.3

Source: Muir-Leresche, K.A. "Crop Price and Wage Policy in Light of Zimbabwe's Goals". D. Phil, Thesis, University of Zimbabwe.

Table 3: Estimated Percentage Contribution to Increase in Maize Yield by Improved Maize Technologies Since 1950, Zimbabwe

Factor	% Increase in yield in yield
Nitrogenous fertiliser	200
Hybrids	45
Increase in plant populations	20
Early planting	15
Weed control	30
Pest control	10
Early reaping	5
Total	325

Source: Adapted from Agricultural Research Council, 1981. Annual Report and Accounts, 1981. A.R.C. Harare.

In the communal sub-sector, adoption of improved maize technologies have led to expansion of area grown to maize. This has been at the expense of traditional crops (pearl and finger millet, round nuts, cowpeas, white sorghum) for which there was little research (Billing, 1985; Mugabe, 1984). By 1980 maize had become a dominant cash and food crop for the communal farmers in all natural regions. Table 4 illustrates the yields trends of major crops grown by the communal and large scale commercial farmers. The 1976/80 crop yields in the large scale commercial farming area were on average three to four times higher than 1951/55 crop yields, while those in the communal areas had increased two-fold.

Table 4: Trend in Yields of Major Crops Grown by Communal and Commercial Farmers, 1946/50 to 1976/80, Zimbabwe

(1951/55 = 100)

(a) Commercial Sector

Period	Maize	Sorgum	Wheat	Barley	Sugar	G/Nuts	Soy bean	Cotton	Mhunga	Rapoko	Edible beans
1946/50	81	130	53	124	83	151	95	118	-	-	112
1951/55	100	100	100	100	100	100	100	100	-	-	100
1956/60	162	140	96	133	114	107	145	261	-	-	121
1961/65	200	167	164	208	171	130	138	453	-	-	146
1966/70	254	203	252	245	286	173	194	562	-	-	166
1971/75	345	271	313	273	286	270	367	666	-	-	140
1976/80	333	440	356	408	294	417	494	618	-	-	143

(b) Communal Sector

Period	Maize	Sorgum	Wheat	Barley	Sugar	G/Nuts	Soy bean	Cotton	Mhunga	Rapoko	Edible beans
1946/50	62	132	-	-	-	71	-	-	96	102	119
1951/55	100	100	-	-	-	100	-	-	100	100	100
1956/60	130	93	-	-	-	205	-	-	111	101	121
1961/65	159	131	-	-	-	192	-	-	87	74	65
1966/70	190	140	-	-	-	241	-	-	75	-	121
1971/75	189	171	-	-	-	270	-	-	82	83	114
1976/80	203	161	-	-	-	186	-	-	73	80	97

Notes: (i) Blank (-) indicates either not grown or data not available
(ii) Mhunga is pearl millet; Rapoko is finger millet

Source: Tattersfield, J.R. 1982. "The Role of Research in Increasing Food Crop Potential in Zimbabwe". Zimbabwe Science News 16(1) : 8-10

5.1.2 Cotton Research

Until the establishment of the Gatooma Cotton Research Station in 1924, cotton production had been unsuccessful. As with maize the emphasis was on varietal testing, selection and breeding using materials from various parts of the world. Breakthrough in cotton research and production occurred forty years later around 1964 -65 with the evolution of effective pest and disease control methods. The major disease and pest problems were those related to jassid attacks and cotton lint staining caused by bollworms.

The breakthrough in cotton research allowed successful and profitable cotton production. This is illustrated by a 150 percent expansion in area and a 45 percent increase in yields since 1961/65 (Table 2) in the large scale commercial sub-sector. Cotton production has also expanded considerably in the communal sub-sector, notably in Guruve and Gokwe. This is attributed to the successful adoption of improve cotton varieties and technologies, particularly pest control management.

5.1.3 Flue-cured Tobacco Research

Flue-cured tobacco has been and still is the most important foreign exchange earner among all export crops. The breeding program, started in 1935, was centered on variety improvement for a high quality export leaf and for disease and pest resistance. The most significant research outcome has been on agronomic trials; namely fertilizer trials, rotations, insect control, disease control, root nematode control, topping and suckering as well as curing techniques (Weinmann, 1975). Tobacco production has become very specialised as a result of these recommendations. Because of this, Zimbabwe produces high quality tobacco with high demand on the export market (Manager, Commercial Tobacco, Kutsaga Research Station - personal communication).

Tobacco market availability and the high price obtainable have played a role in promoting tobacco growing and adoption of improved technologies. To this day, the foreign exchange earning capacity has made tobacco an important contributor to the agricultural and economic development of the country. This will be discussed in a later section.

There has been a 70-80 percent increase in tobacco yields since the early 1950's (Table 2).

5.1.4 Sugar and Wheat Research

Breakthroughs in sugar and wheat production and research were only possible with infrastructure development. For sugar it was the construction of irrigation dams in the low-veld, while for

wheat it was the development of irrigation facilities to allow winter production. By the mid-seventies the country had become self-sufficient in wheat. Zimbabwe wheat yields are the fourth highest in the world after the United Kingdom, Egypt and Mexico (CIMMYT, 1985).

5.1.5 Seed Improvement Program

A notable research-related program that deserves special mention in the seed improvement program under the Research Services Division of R&SS. Seed Services monitors the production and distribution of improved crop seeds. This includes testing and quality control of released planting materials by both R&SS and private sector seed companies. Through this program the country has an assured seed service. This coupled with commercial seed production by farmers have played a role in dissemination and adoption of improved seeds, particularly maize.

In summary, the output effect of crop research has, therefore, come from two sources namely expansion in area and increase in yield.
Area expansion resulted from: (i) development of adaptive varieties; (ii) growing of crops in environments not cropped before through use of fertilizers, irrigation and varieties bred for those conditions; and (iii) increase in land and labour productivity allowing farming of large units in the commercial subsector.

Increase in yield came from: (i) new varieties better able to exploit the environment, e.g., short season maize varieties for agro-ecological zone III; and (ii) improvement in management and other crop husbandry practices, e.g. fertilizer application and timing; planting dates, plant population, weed control, etc.

5.2 Livestock Research Programs

Livestock research started as early as 1916 and was oriented towards genetic improvement, feeding and management of beef and dairy cattle (R&SS, 1969). For beef cattle, genetic improvement was aimed at producing a carcass of suitable conformation acceptable on the export market. The export market was crucial because local beef consumption was small. Initially pedigree bulls of various breeds were imported. But increased exotic material, for example Hereford blood, in the progeny led to degeneration as indicated by high mortality rate and low cow productivity. A significant achievement of beef cattle research was therefore development of a hardy beef cattle adapted to the country's ranges and climatic conditions. This was achieved by

crossing local livestock with exotic breeds to improve productivity and disease resistance (R&SS, 1969).

The motive in animal nutrition and feeding trials was to investigate ways of increasing weight gain or minimise weight loss of beef cattle during the dry winter months when grass quality is poor in nutrition. Knowledge generated on the protein, energy and supplementary feed requirements during the winter period has helped build up a thriving beef industry in terms of herd size and productivity. For example, in 1948 the average weaning percentage was 49 percent, by the 1960's it had gone up to 60 percent; and is currently estimated at 90 percent (R&SS, 1969; CFU, 1985). Between 1948 and 1970, production of beef per unit of cattle population increased from 13kg to 20 kg (R&SS, 1969).

Research related to dairy cattle is credited with raising average milk production per cow of recorded herds from 580 gallons (2,637 litres) to 740 gallons (3,364 litres) between 1948 and 1969 (R&SS, 1969). Such research includes herd management, winter supplementary feeding, use of concentrates, and introduction of pedigree dairy stock (Weinmann, 1975).

Another notable achievement in livestock research is tsetse fly research and control by the Veterinary Department. This has led to eradication of tsetse fly in large areas in the low altitude zones. This has contributed to expansion of livestock numbers, particularly cattle, into these areas.

5.3 Other Research Impacts

This section will make a limited assessment of the foreign exchange, employment, food security, multplier, and institutional effects of agricultural research up to 1980. The purpose of this section's discussion is to point out areas that need to be studied in evaluating impact of the agricultural research system.

5.3.1 Foreign Exchange Earning Effects

Foreign exchange impact arises from the ability to produce enough for export of the following agricultural commodities: tobacco, cotton, beef, coffee, sugar and to some extent maize. These contribute significantly to foreign exchange earnings and trade balance in Zimbabwe. In 1984, flue-cured tobacco exports generated the most foreign exchange earnings of all agricultural and non-agricultural exports. Out of a total export value of Z$347.1 million, Z$67.7 million (19.5%) was from tobacco, Z$40.3 million (12%) from cotton, Z$16.3 million (5%) from sugar and Z$9.4 million from beef. This compares with Z$39.5 million from

ferro-alloy exports, Z$24 million from gold and Z$9.8 million from nickel (Zimbabwe Reserve Bank, 1985).

As discussed earlier, the history of research shows that development of technologies was earmarked at producing commodities of high export quality, particularly cotton, tobacco, and beef.

5.3.2 Employment Effects

The agricultural sector is the largest employer in the country. This refers to employment of own-farm labour in the communal sub-sector and wage-earning labor in the commercial sub-sector as well as agro-based industries. Labour employment in the large scale commercial farming sub-sector varied between 298,000 in 1970 to 356,000 in 1976 and 287,000 in 1981 (CSO, 1984). Wage employment in this sub-sector has grown with increase in agricultural production, in terms of area. Agricultural research did play a role in the expansion of the agricultural base which has resulted in employment of such a large labour force and those in agro-based industries, e.g. inputs suppliers.

5.3.3 Food Security Effect

Agricultural research influences food security in several ways. First, it facilitates expansion in food production. In Zimbabwe, agricultural research has increased the country's capacity to produce and feed itself. Secondly, research by facilitating communal area production of cash crops (e.g. cotton, surplus maize, sunflowers, soybeans, surplus groundnuts) food security is enhanced in that the producers will have cash to purchase food items that are available on the market, e.g. bread, milk, meat, etc. Third, on the nutritional aspect of food security the development of SR52 with high lysine protein content has contributed to improved nutrition.

5.3.4 Industrial Linkages

Other research effects include development of an inputs industry for supplying seeds, fertilizers, pesticides, herbicides, fungicides, machinery credit, advisory and other services to the agricultural producer's sectors. As was discussed earlier on, this was stimulated by increased adoption of improved production methods in both large scale and communal sub-sectors.

5.3.5 Institutional Effects

On institutional effect, it has been shown that as agricultural research overcame production constraints leading to increased agricultural activities, for example expansion in area and number of farmers, new institutions were created to service agriculture.

Examples are, creation and improvement of the government and private sector agricultural research infrastructure, development of parastatals; and creation of the extension department; establishment of agricultural colleges; establishment of agricultural marketing boards and improvement in rail and road communication networks. All these came into existence with the development of a viable agricultural sector for which agricultural research played a part. Thus, there has been a direct relationship between technology generation and adoption, and institutional development.

6 FACTORS ATTRIBUTED TO SUCCESS OF ABOVE PROGRAMS

6.1 Research Continuity

Several factors are attributed to the success of the research system over the period under reviewed. The first factor is that of constancy. Research programs were maintained with little disruption for an extended period of time. For example, maize breeding work stretched over nearly two decades ending in production of hybrid varieties. Since the initiation of maize breeding research in the 1930's up to 1980, R&SS has had only four maize breeders, namely D.E. Mcloughlin, H.C. Arnold, A.G.H Rattray and Rob Olver (Fenner, Assistant Director R&SS-personal communication).

Also persistent cotton and tobacco agronomic trials led to overcoming pest and disease problems. These reflect continuity in research programs.

Related to the above, is the fact that over the time period an institutional research infrastructure capable of responding to the needs of the country and farmers became established. This in itself contributed to research stability and continuity.

6.2 Farmer Response

Farmer pressure for more organized and appropriate research as well as their preparedness to pay for it are other factors that contributed to success of the research system. During the Development Phase, research outcome was a catalyst in expansion of agricultural activities. Once a viable agriculture sector had been established, farmers became the catalysts for technology generation. Tobacco, cotton and maize research programs owe their success in part to grower interest and finance. For maize, the activities of the Maize Seed Association in promoting commercial production of hybrid seed and its use by maize growers illustrate this point.

6.3 Financial and Manpower Resource Allocation

Data on financial and manpower resources allocation is readily available for government, Tobacco Research Board and Pig Industry board. The share of government agricultural research expenditure, expressed as a proportion of total government expenditure for the agricultural sector, averaged 41 percent per annum, over the period 1964-85 (Table 5). Over the same period allocation to R&SS alone averaged approximately 19 percent of Ministry of Agriculture annual budget. Thus, government allocation to agricultural research has been reasonable and stable. However, government annual research expenditure and its allocation to R&SS and Veterinary Services Department as a share of total government expenditure exhibit downward trends since 1971/72. Government research allocation had not been reduced but rather there has been an expansion in government total expenditure and allocations to other non-agricultural sectors. Index of real research expenditure by government, the Tobacco Research Board and the Pig Industry Board shows that research investment grew by a factor of two over the period 1964/65 to 1979/80 (Table 6).

Table 5. Analysis of Government Research Expenditure as percentage of Total Government Expenditure and Allocation to Ministry of Agriculture, 1984 - 1985, Zimbabwe.

Year	Allocation MOA as % of Total Govt. Expenditure	Research Allocation as % of MOA Budget				Research Allocation as % of Total Government Expenditure		
		R&SS	Vet.	TRB	Total	R&SS	Vet.	Total
64/65	5.6	18.6	22.9	2.0	43.6	1.0	1.3	2.4
65/66	6.3	15.7	19,5	1.6	36.8	1.0	1.2	2.3
66/67	8.8	15.3	13.4	1.0	25.8	1.0	1.2	2.3
67/68	11.0	8.8	10.0	0.8	19.5	0.9	1.1	2.1
68/69	16.9	5.5	5.9	0.4	11.8	1.1	1.0	2.0
69/70	6.8	15.7	16.4	1.1	33.2	1.1	1.1	2.3
70/71	8.5	12.7	12.6	0.1	26.2	1.1	1.1	2.2
71/72	5.4	20.8	20.4	1.4	42.6	0.9	1.1	2.3
72/73	5.0	18.1	18.4	1.0	37.6	0.7	0.9	1.9
73/74	4.1	17.7	20.3	1.0	40.4	1.7	0.8	1.7
74/75	4.2	17.4	16.7	1.2	35.3	0.7	0.7	1.5
75/76	3.1	28.9	24.4	1.6	54.9	0.6	0.8	1.7
76/77	2.9	28.1	25.9	1.5	55.5	0.5	0.8	1.6
77/78	2.1	33.7	24.5	1.8	60.0	0.6	0.5	1.3
78/79	2.1	33.3	27.4	2.1	62.8	0.5	0.6	1.3
79/80	2.8	22.6	18.7	1.4	42.7	0.5	0.5	1.2
80/81	1.9	30.7	25.7	1.8	58.0	0.5	0.5	1.1
82/83	2.6	16.7	35.0	1.0	52.7	0.4	0.9	1.4
83/84	3.1	12.0	25.1	0.8	37.9	0.3	0.8	1.2
84/85	2.8	12.2	23.8	0.8	38.9	0.3	0.7	1.1

Source (a) Billing K.J., 1985, Zimbabwe and the CGIAR Centres World Bank, Washington, D.C. 1985

(b) R&SS Estimates of Expenditures Files

Table 6: Zimbabwe: Index of Real Research Expenditure, 1964/65-1984/8

(1964/65 = 100)

Year	Ministry of Agriculture		(b)	
	Allocation to R&SS	Total Research Expenditure (a)	TRB, PIB Total Research Expenditure	Min. of Agric TRB and PIB Total research Expenditure
1964/65	100	100	100	100
1965/66	105	105	121	107
1966/67	112	109	129	111
1967/68	121	115	105	115
1968/69	136	126	123	125
1969/70	146	132	129	132
1970/71	160	141	135	140
1971/72	173	152	161	153
1972/73	190	167	176	169
1973/74	192	189	186	189
1974/75	207	181	186	181
1975/76	204	216	194	214
1976/77	193	229	196	227
1977/78	190	188	180	187
1978/79	195	200	196	200
1979/80	195	200	208	200
1980/81	229	220	206	219
1981/82	187	304	194	296
1982/83	196	301	186	292
1983/84	182	301	202	293

Notes: (a) Ministry of Agriculture allocation to R&SS, PIB and TRB
(b) Total research expenditure by PIB and TRB
(c) Summation of R&SS, PIB and TRB research expenditures

Government investment in agricultural research as a percentage of agricultural gross domestic product has averaged 3.6 percent per year (Table 7). Allocation to R&SS averaged 1.4 percent of agricultural GDP, while total national expenditure on agricultural research (excluding private sector tea, sugar, poultry and inputs research) as the proportion of agricultural GDP has been around 3.6 percent per year, during the period 1964-85. These levels of investment in agricultural expenditure are in line with the target of one percent of agricultural GDP recommended by the World Food Conference in 1974 (FAO, 1981). They also compare favorably with an annual investment of 2 percent of agricultural GDP recommended by the World Bank (1981a).

Table 8 shows that, over the five year period 1975-76 to 1979-80, the percentage of R&SS research expenditure (excluding salaries and wages) allocated to recurrent operating expenses averaged 79% per annum. This suggests sufficient allocation for financing and maintaining on-going research programs compared to allocation for administration and development of new programs. This allows on-going flow of current programs without interruptions.

Table 7: Analysis of Agriculture Research Expenditure as Percentage of GDP, Agricultural GDP and Commodity Gross Value, 1964/65-1984/85, Zimbabwe.

(Percent)

Year	Total Govt. Research Exp. as % Agric GDP	R&SS Exp. as % of Agric. GDP	National Research Exp. as % Agric GDP (a)	Agric. Research as % Agric Adjusted GDP (b)	Tobacco Research Exp. as % Tobacco Gross Value	Pig Research as % Pig Gross value
64/65	2.6	1.1	2.8	3.2	0.6	2.7
65/66	3.0	1.3	3.3	3.6	0.6	3.8
66/67	2.7	1.2	3.0	3.2	0.8	3.9
67/68	2.6	1.2	2.8	3.1	0.8	3.4
68/69	3.6	1.7	3.9	4.3	1.4	4.1
69/70	2.8	1.3	3.1	3.3	1.7	3.4
70/71	3.5	1.7	3.7	4.0	1.9	4.1
71/72	2.9	1.4	3.2	3.5	1.8	4.3
72/73	2.9	1.4	3.2	3.5	1.9	3.3
73/74	3.7	1.6	4.0	4.5	1.7	3.8
74/75	2.6	1.3	2.8	3.1	1.4	3.6
75/76	3.3	1.3	3.5	4.1	1.5	3.5
76/77	3.4	1.3	3.7	4.3	1.2	3.6
77/78	3.3	1.4	3.6	4.6	1.5	3.8
78/79	4.5	1.9	4.9	4.9	1.6	4.0
79/80	4.5	1.7	4.8	3.8	1.6	4.4
80/81	4.0	1.8	4.2	5.4	1.6	4.3
81/82	4.5	1.2	4.8	5.5	1.3	3.9
82/83	5.0	1.2	5.3	6.0	1.3	3.7
83/84	6.0	1.6	6.3	7.6	1.3	3.9
84/85	4.8	1.4	5.1	5.9	1.1	4.6

Notes (a) National Research Expenditure = Govt. Research Expenditure + Research Boards Expenditure (excluding sugar research expenditure)
(b) Agricultural GDP less Sugar Gross Value
(c) The Agricultural GDP, crop gross values and research expenditures are at current prices.

Source: Billing, K.J. 1985. Zimbabwe and the CGIAR Centres. World Bank, Washington D.C.
R&SS Estimates of Expenditure files

Table 8: R&SS Research Allocation to Administration, Operating and Developm Expenses by Division 1975/76 to 1980/81

(Z$ '000)

	75/76		76/77		77/78		78/79		79/80		80/81	
Expenses	$	%	$	%	$	%	$	%	$	%	$	%
ADMINISTRATION	34	2.3	33	2.1	37	2.1	42	2.3	40	2.0	52	2.9
RESEARCH OPERATING												
Crops Division	489	33.7	561	36.2	567	32.8	604	32.8	692	35.4	534	24
Livestock Div.	525	36.1	535	34.5	611	35.3	649	35.2	720	36.9	642	35
Res. Services	133	9.2	140	9.0	164	9.5	198	10.7	208	10.7	222	12
	1,147	79.0	1,236	79.7	1,342	77.6	1,451	78.7	1,620	83.0	1,398	77
RESEARCH DEVELOPMENT												
Crops Division	75	5.2	101	6.5	146	8.4	76	4.1	39	2.0	66	3.7
Livestock Div.	56	3.9	52	3.4	48	2.8	72	3.9	58	3.0	43	2.4
Res. Services	44	3.4	9	0.6	22	1.3	24	1.3	41	2.1	21	1.2
	180	12.5	162	10.5	216	12.5	172	9.3	138	7.1	130	7.3
GRANTS & OTHER EXP.	92	6.3	118	7.6	134	7.8	178	9.7	155	7.9	126	12.0
TOTAL	1,453	100.0	1,549	100.0	1,729	100	1,843	100	1,953	100.0	1,796	100

Source: Agric. Research Council (ARC), Annual Reports & Accounts, 1976 to 1981

Table 8: R&SS Research Allocation to Administration, Operating and Development Expenses by Division 1975/76 to 1980/81

(£'000)

	75/76		76/77		77/78		78/79		79/80		80/81	
Expenses	$	%	$	%	$	%	$	%	$	%	$	%
ADMINISTRATION	34	2.3	33	2.1	37	2.1	42	2.3	40	2.0	52	2.9
RESEARCH OPERATING												
Crops Division	489	33.7	561	36.2	567	32.8	604	32.8	692	35.4	534	24.7
Livestock Div.	525	36.1	535	34.5	611	35.3	649	35.2	720	36.9	642	35.7
Res. Services	133	9.2	140	9.0	164	9.5	198	10.7	208	10.7	222	12.4
	1,147	79.0	1,236	79.7	1,342	77.6	1,451	78.7	1,620	83.0	1,398	77.8
RESEARCH DEVELOPMENT												
Crops Division	75	5.2	101	6.5	146	8.4	76	4.1	39	2.0	66	3.7
Livestock Div.	56	3.9	52	3.4	48	2.8	72	3.9	58	3.0	43	2.4
Res. Services	44	3.4	9	0.6	22	1.3	24	1.3	41	2.1	21	1.2
	180	12.5	162	10.5	216	12.5	172	9.3	138	7.1	130	7.3
GRANTS & OTHER EXP.	92	6.3	118	7.6	134	7.8	178	9.7	155	7.9	126	12.0
TOTAL	1,453	100.0	1,549	100.0	1,729	100	1,843	100	1,953	100.0	1,796	100

Source: Agric. Research Council (ARC), Annual Reports & Accounts, 1976 to 1981

6.4 Effective - Research Extension Linkages

It seems like research programs have been effective because of the detailed knowledge of the farming problems and the socio-economic priorities of the target group, namely the large scale commercial farmers. Applicable technologies geared to solving identified problems were thus generated. This can be attributed to the close relationship between extension and research during the period under review. Use of demonstration farm in the earlier phase and having extension liaison officer within R&SS and commodity extension specialists within the extension department, provided a mechanism for quick dissemination of research results. It also provided a means by which researchers would know production problems and the needed technologies.

6.5 Incentives for Farmers

Market availability and incentives given to farmers also contributed to the success of the research programs. These encouraged adoption of improved technologies. Examples include the export market and high prices received for tobacco; internal market for maize; and schemes such as the Maize and Wheat Bonus Schemes of the 1940's. These schemes assured guaranteed prices and bonuses for maize and wheat provided the crops were grown according to recommended practices. A similar scheme was the Dairy Bonus Scheme that encouraged adoption of hygienic milk production practices. The Livestock Improvement Scheme, adopted in 1935, made grants to farmers to enable them to import or purchase locally improved bulls, rams or boars (Weinmann,1975).

Creation of statutory boards like the Pig Industry Board, Sugar Industry Board, Cold Storage Commission, Dairy Marketing Board and others helped the development of organized markets for agricultural commodities. Such markets gave incentives to farmers to adopt improved technologies as they provided markets for increased output.

Related to the above is the development of a viable input supply industry and well developed communication networks (roads, railways, telephones, farmer magazines, etc). The latter provided easy access to inputs and output markets. On the spot advice by input suppliers field representatives provided incentives for, and facilitated technology adoption by communicating the technologies to farmers as well as providing the input suppliers with knowledge of farmers production constraints and needed technologies.

7. CRITIQUE OF THE RESEARCH CONDUCTED UP TO 1980

A criticism of the research conducted up to 1980 is on its orientation toward the large scale commercial sub-sector. Major breakthroughs in crop and livestock research were created from solving problems on commercial farms. Most of these are located in the favourable agro-ecological zones II and III.

Little research was done on millet, sorghum and other food crops (round nuts, cowpeas, sweet potatoes, green leaf vegetables) grown and consumed by communal farmers. Some of these crops, e.g. the millet, were crops traditionally grown in the marginal agro-ecological zones. A consequence of this neglect is a decline in these crops' yields (Table 4) and their share of arable area grown to crops in the communal areas. More area is now grown to maize whose yield, due to improved technologies, makes return to labour and land from growing maize greater than the return from the crops in question.

Emergence of a monocropping farming system based on maize has contributed to environmental degradation in some communal areas (Elwell, 1982). This is a result of intensive cropping in fragile soils resulting in loss of top soil due to soil erosion.

Livestock research programs concentrated on breeding using exotic breeds, and research on pasture management and improvement that involved rotational grazing in fenced paddocks (Billing, 1985). Such conditions are not obtained nor implementable in communal areas where grazing land is a "common" resource. Potential productivity of improved breeds have not therefore been realised. Little research was done on developing off-season feeding systems for the communal areas in marginal areas. For example, calving percentage is below 50 percent; calving intervals range from 3 to 4 years compared to 1 to 1,5 years in the large scale commercial sector (Agritex, Animal Production Branch - personal communication).

Crop and livestock research conducted up to 1980 did not give much attention to the socio-economic conditions and the nature of farming systems in the communal farming sector. The technologies developed were not appropriate for the sector. However, the sector benefited mainly through a "spill-over effect" resulting from (1) visual demonstration of effect of improved technologies on commercial farms; (2) extension of these technologies in the absence of appropriate ones by the extension system; and (3) availability of new inputs on the market.

Most of the technologies became extendable to communal areas by a process of scaling down. An example is maize varieties. In retail marketing the seed could be sold in divisible units of one, two, five, ten kilograms and up by retail traders of any size. This made the seed available to all farmers, large or

small, throughout the country at affordable prices or quantities. Since hybrid seed varieties like R200, R201 and R215 had been bred for a short crop growing season, they could be used by communal farmers whose environment matched the agronomic characteristics of these varieties.

Chemical technologies could also be scaled down for retail marketing. An example is cotton pesticides. Even with mechanical technologies, attempts were made to scale them down for communal area application. Examples include ox-drawn ploughs, row planters, cultivators, chemical applicators (e.g. the ultra-low volume, ULV, sprayer for cotton), maize and groundnuts shellers.

The large scale farmers benefited more than their counterparts because they were able to adopt and utilize the technologies better than their counterparts. This was because apart from being located in the most favourable agro-ecological zones for crops production regions IIa and IIb, the large scale commercial farmers had:

(i) greater access to information on new technologies through greater access to extension

(ii) available financial resources or easier access to credit to finance input purchases,

(iii) relatively more developed transport networks serving commercial farming areas making easy access to input and output markets,

(iv) influence over institutions including the research department

Because of the above factors, commercial farmers have performed better than their counterparts in the communal sub-sector. This is illustrated by differences in crop and livestock productivity between the two sub-sectors. The divergence in crop yields between communal and commercial farmers in a given agro-ecological zone can be explained by (1) inadequate and inappropriate fertilizer application (due to little soil analysis), (2) differences between recommended practices and those actually followed by communal farmers (due to lack of adequate inputs, labour bottlenecks etc), and (3) inability to control environment as done by commercial farmers (e.g. through water-planting, supplementary irrigation, effective tillage methods, etc.). All these indicate lack of appropriate technologies for the prevailing socio-economic conditions in the peasant sector.

The task of the government research system after independence was therefore to re-orient research focus to include development of appropriate technologies for the communal area sub-sector.

8. SUMMARY, CONCLUSIONS AND LESSONS

Agricultural research has been an instrument in agricultural transformation in the country. It played a significant role in the growth and establishment of a commercial agriculture sub-sector and has contributed to the expansion of the peasant sub-sector. Generation and dissemination of improved technologies facilitated growth in output and productivity of crops and livestock. These in turn stimulated the development of agro-industries to service the agricultural sector. There has been a direct linkage between technology development and creation of institutions to facilitate adoption of the technology such as the establishment of an extension department and marketing parastatals, infrastructure (low-veld dams) and credit (Land Bank which later became the Agricultural Finance Corporation).

Investment in agricultural research has therefore been productive. The history of expenditure on research presented in this paper indicates that investment in agricultural research as a percentage of agricultural gross domestic product averaged 3.6 percent per annum over the period 1964-1985. This is higher than the target level of 2 percent of agricultural gross domestic products proposed by the World Bank in 1981.
One weakness of the research conducted up to 1980 is that it was oriented towards the commercial farming sub-sector with little consideration for generation of technologies appropriated for the socio-economic and physical conditions found in the peasant sub-sector. The latter benefited mainly through a "spill-over" effect.

Another weakness was lack of linkages and collaboration with other research institutions within the East and Central African regions.

The shortcoming notwithstanding, by 1980, Zimbabwe had a well-established national research system with a proven track record of successful research programs that have had positive impact on agricultural and economic development. The research system had a capability to carry out basic and adoptive research.

Lessons

The history of agricultural research development in Zimbabwe highlights the importance of the following features of successful research system:

1) Creation of a stable centralised research infrastructure well supported with human, financial and physical resources to undertake technology generation relevant to farmer problems,

2) Well defined agricultural research goals with effort focussed on few commodities,

3) Political and institutional support for continued investment in agricultural research,

4) Existence of a farmer clientele with demand and support for new technologies,

5) Investment in agricultural education of farmers to facilitate their understanding and adoption of new technologies,

6) Creation of new institutions in support of agricultural development, e.g., marketing structures, extension services, credit, etc,

7) Government continued commitment to agricultural transformation.

Table 1 : Evolution Pattern of Institutions for Agricultural Research and Extension and Development in Zimbabwe 1900 - 1985.

Institution or Station	Date Established	Major Function or Research Focus
Department of Agriculture	1909	Administration of all aspects related to agriculture : agricultural research and extension
Salisbury Agricultural Experiment Station	1909	Introduction and testing of new crop species and varieties; agronomic experiments
Gwebi Demonstration Farm	1909	Experimental and demonstration farm for crops, cattle pigs and sheep
Matopo Demonstration Farm	1917	Experimental and demonstration; pasture research
Bulawayo Demonstration Farm	1921-31	Crop research trials; demonstration of crop production potential
Gwebi Demonstration Farm	1923-33	Crop experiments and demonstrations
Gatooma Demonstration Farm	1924	Crop experiments and demonstration; cotton research
Hillside Tobacco Experimental Station	1924	Tobacco breeding and agronomic research; tobacco husbandry training
Domboshawa Training Centre	1924	Training of African agricultural demonstrators
Marondera Research Farm	1930-31	Tobacco research; pasture and grass research
Maize Control Board	1931	Maize marketing
Trelawney Tobacco Station	1934	Tobacco breeding and agronomic research

Institution or Station	Date Established	Major Function or Research Focus
Marirangwe and Semenani Experimental farms	1935	Seed improvement and distribution to African farmers
Tobacco Research Board	1935	Tobacco research responsibilities
Cotton Research and Industry Board	1936	Cotton research, market and industry development
Rusape Demonstration Farm	1936	Indigenous and exotic grass trials
Cold Storage Commission	1937	Livestock marketing and development.
Pig Industry Board	1937	Pig research, market and industry development
Mazoe Valley Demonstration Farm	1939	Weed control methods demonstration
Msengezi Demonstration Station (African farmer oriented)	1939	Pasture improvement methods for peasant farmers; Indigenous cattle breeding
Seed Maize Association	1940	Promotion of production and adoption of improved seed
Makoholi Experimental Farm (African farmer oriented)	1942	Veld management trials; rice, sorghum, cowpeas and sunflower rotations, and variety trials; indigenous cattle breed
Umshandige Demonstration Farm	1943	Irrigation trials on wheat, lucern, vegetables; training centre for ex-service men at Umshandege Irrigation Scheme
Sugar Industry Board	1944	Sugar research and industry development
Matopo Experimental Station	1945	Veld and pasture research
Karoi Demonstration Farm	1946	Mixed farming demonstrations

Institution or Station	Date Established	Major Function or Research Focus
Henderson Research Station	1947	Hybrid seed production; pasture and legume research
Research and Specialists Services Department	1948	Government Agricultural Research headquarters; Crop breeding.
Chipinge Experiment Farm	1949	Breeding and distribution of acclimatized livestock
Gwebi Agricultural College	1950	Two-year agricultural diploma courses
Department of Extension and Conservation (Conex)	1950	Agricultural extension in "European" commercial agriculture sector
Dairy Maketing Board	1952	Milk processing and marketing.
University College of Rhodesia and Nyasaland	1957	University training including Agriculture
Mlezu Agricultural Institute	1957	Certificate training for African extension workers
Chibero Agricultural College	1961	Three-year agricultural diploma for African extension personnel.
Zimbabwe Sugar Association Experimentation Station	1966	Sugar cane breeding, agronomic research and variety testing
Agricultural Assistance Board	1967	Agricultural finance
Esigodini Agricultural Institute	1969	Certificate training for African extension workers
Agricultural Research Council	1970	Management of Agricultural research
Agricultural Finance Corp.	1971	Agricultural finance
Rattray Arnold Research Station	1974	Testing of R & SS-bred varieties; Plant breeding; crop variety trials for seed testing.
Faculty of Agriculture, University of Zimbabwe	1980	Agricultural degrees, research and teaching

Institution or Station	Date Established	Major Function or Research Focus
AGRITEX, Department of Agricultural, Technical, and Extension Services	1981	Unified extension services for all agricultural sectors
Agricultural Research Trust	1981	Private sector agricultural research, mainly agronomic and adaption trials
Kushinga Phikelela Agricultural Institute	1981	Certificate agricultural extension training
Farming System Research Unit	1982	Communal area on-farm research trial
Rio Tinto Agricultural Institute	1983	Certificate agricultural extension training
CIMMYT/IITA/UZ Mid-Altitude Station	1985	Maize trials under mid-altitude conditions, maize streak virus research.

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