Consultative Group on International Agricultural Research
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Burma and the CGIAR Centers

A Study of Their Collaboration in Agricultural Research

Kyaw Zin

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At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research oganizations under its sponsorship. An Advisory Committee was appointed to oversee the study and to present the principal findings at the annual meeetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centers in selected countries. This paper is one of that series.

The judgments expressed herein are those of the author(s). They do not necessarily reflect the views of the World Bank, of affiliated organizations, including the CGIAR Secretariat, of the international agricultural research centers supported by the CGIAR, of the donors to the CGIAR, or of any individual acting on their behalf. Staff of many national and international organizations provided valued information, but neither they nor their institutions are responsible for the views expressed in this paper. Neither are the views necessarily consistent with those expressed in the main and summary reports, and they should not be attributed to the Advisory Committee or the study director.

This paper has been prepared and published informally in order to share the information with the least possible delay.

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Summary

This report on the collaboration between international agricultural research centers (IARCs) and the agricultural research system of Burma was undertaken at the request of the CGIAR impact study.

The main objectives of this report are to provide:

(1) A picture of the collaboration between CGIAR-supported IARCs and Burma;
(2) An assessment of how international inputs have contributed to national research capacity;
(3) An evaluation of the relevance and impact of the centers' training programs;
(4) A summary of the impact on food production; and
(5) A discussion of the way in which selected technologies originating in the centers have been transmitted through national programs to farmers.

Agriculture is the mainstay of the Burmese economy. In 1982-83, agricultural products accounted for 52 percent of the total exports, 38 percent of GDP. The sector employed 64 percent of the labor force. The prospects of Burma's economy hinge on the performance of the agricultural sector. The bulk of the rural population lives near the subsistence level, and improved small farm productivity is a prerequisite for meeting their basic needs.

Rice is the staple food of the people and is an important source of foreign exchange. The government is giving the highest priority to development of rice land and improved rice production. The area under rice was more than 12 million acres in 1984, and rice production was more than 689 million baskets (14 Mt).

Agricultural policy, including that for research, is set by the Burma Socialist Programme Party and Council of State. Overall responsibility for managing and implementing agricultural activities rests with the Ministry of Agriculture and Forests. Within this ministry, the Agriculture Corporation is responsible for all aspects of crop research, development and production; other government agencies coordinate water resources, provide mechanized land preparation, procure crops, provide credit and train staff. The government operates a compulsory procurement system for paddy, jute and cotton.

Locally elected functionaries of the Burma Socialist Programme Party, the Peasants and Workers Associations and the People's Councils mobilize and lead the farmers. Staff from the Agriculture Research Institute, the Applied Research Division and Extension Division were made responsible for the planning, execution and evaluation of all phases of the crop development programs.

The investment allocated for the agriculture sector was increased from 548 million kyats in 1979-80 to 920 million kyats in 1983-84.

Burma's use of external assistance has been rising steadily since 1970. With assistance from the international agriculture research centers, the agriculture research departments and other agencies under the Agriculture Corporation have greatly increased yields of rice, maize, sorghum, wheat, cotton, jute, sugarcane and food legumes in Burma.

The staff of the Agriculture Corporation currently totals about 18,000, of which 2,239 hold Agriculture Science degrees. Fifteen have PhDs, 40 have Master's degrees and the rest have BSc (Agriculture) or BAg degrees. Many internationally aided projects assisting agriculture development have recognized the

need for training, and about 15 percent of the funds have been used for training components.

Burma cooperates closely with IRRI, CIMMYT and ICRISAT as well as with other centers such as IITA, CIAT and IBPGR. From these international centers, Burma has received genetic materials, training fellowships and opportunities to establish contacts with research workers and scientists in other countries to permit the continuous exchange of ideas. Publications from most of these centers are also sent to the national research institutes.

The transmission of innovations is accomplished mainly through the Extension Division of the Agriculture Corporation. The responsibilities of this division are to: disseminate agricultural research findings; implement the annual agricultural plan; distribute essential supplies to the farmers and assist in procurement of these inputs; distribute pure seeds in coordination with the central farms and help to coordinate the agricultural activities with the village councils and township councils.

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List of Abbreviations

International Institutions

ADB	Asian Development Bank
ARFSN	Asian Rice Farming System Network
AVRDC	Asian Vegetable Research Development Center
CIAT	International Center for Tropical Agriculture, Cali, Colombia
CIMMYT	International Center for Research in Maize and Wheat, Mexico
CIP	International Center for Potatoes, Lima, Peru
DANIDA	Danish Aid Agency
GTZ	German Agency for Technical Cooperation
IARC	International Agricultural Research Center
IBPGR	International Board for Plant Genetic Resources, Rome, Italy
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics, Hyderabad, India
IITA	International Institute of Tropical Agriculture, Ibadan, Nigeria
IRRI	International Rice Research Institute, Los Baños, the Philippines
JICA	Japan International Co-Operation Agency
OPEC	Organization of Petroleum Exporting Countries
USAID	United States Agency for International Development

Local Institutions

AC	Agriculture Corporation
AFPTC	Agriculture and Farm Produce Trade Corporation
AMD	Agriculture Mechanization Department
ARD	Applied Research Division
ARI	Agriculture Research Institute
CADTC	Central Agriculture Development Training Center
ED	Extension Division
FID	Food Industries Corporation

GOB	Government of the Socialist Republic of the Union of Burma
IA	Institute of Agriculture
ID	Irrigation Department
MAB	Myanma Agriculture Bank
MOPP	Maize and Oilseed Production Project
TIC	Textile Industries Corporation

Other Abbreviations

BSPP	Burma Socialist Programme Party
FYDP	Four Year Development Plan
HYV	High Yielding Variety
NARS	National Agriculture Research System
SHYP	Special High Yield Production Program
SHYV	Special High Yielding Variety
WTCPDP	Whole Township Crop Production Development Program
WTPPDP	Whole Township Paddy Production Development Program

Currency, Weights and Measures

Currency Equivalent

(1st December 1984)

Currency Unit	= Kyat (K)
K 1.00	= 100 pyas
U.S. Dollar (US$) 1.00	= K 8.59
K 1.00	= US$0.116

Weights and Measures

Burma	Metric
Viss	1.65 kg
Basket paddy	20.86 kg
" groundnut - unshelled	11.34 kg
" maize - shelled	24.94 kg
" wheat	32.65 kg
" sorghum	28.11 kg
" gram - black and green	31.29 kg
" cowpea	32.65 kg
" lablab beans	31.29 kg
" butter beans	31.29 kg

Conversion Factors

1 kilogram (kg)	= 2.205 pounds (lbs)
1 metric ton (mt)	= 1.02 long tons
1 hectare (ha)	= 2.471 acres (ac)
1 Megaton (Mt)	= 1,000,000 mt

Contents

1 The Country

1.1 Natural setting

The Socialist Republic of the Union of Burma lies in Southeast Asia between latitudes 10°N and 28°N and longitudes 92°E and 101°E. The country is roughly 582 miles across from east to west and 1,275 miles from north to south.

Burma is the largest country on the southeast Asian mainland. Facing the Bay of Bengal and the Andaman Sea on the west and south it shares land borders with Thailand, Laos, China, India and Bangladesh.

Burma is rimmed on the north, east and west by mountain ranges with elevations up to 4,570 meters (15,000 ft) above sea level along the Chinese border and 2,400 meters (8,000 ft) along the Indian border.

The country has many varieties of rich forest. World famous Burma tea is cultivated in the deciduous monsoon forest.

1.1.1 Rivers

The four chief rivers in Burma are the Irrawaddy, the Sittang, the Chindwin and the Salween.

<u>The Irrawaddy River</u>

The 1,238 mile long Irrawaddy River is formed by the confluence of two rivers, N'mai Kha, and Mali Kha, some 273 miles north of Mandalay. The river which is nearly one mile wide at many places is navigable from its mouth to Bahmo. Before the river enters the Andaman Sea it divides into eight main branches which form the sprawling fertile delta. The Irrawaddy is the

country's economic lifeline and major transportation system, connecting Rangoon with Mandalay in the central area.

The Sittang River

The Sittang River rises in the hills southeast of Mandalay and flows to the Pegu Yoma until it empties into the Gulf of Martaban, an extension of the Andaman Sea. This river is 186 miles long.

The Chindwin River

The Chindwin River is the main tributary of the Irrawaddy and rises in the northwestern hills. It flows through 480 miles of navigable reaches until it flows into the Irrawaddy near Pakokku. This river is 691 miles long.

The Salween River

The Salween River races through gorges cut deep into the Shan Plateau. It is locally navigable but is too swift to permit navigation for any extended distance. It flows into the Gulf of Martaban.

1.1.2 The climate

Most of Burma lies within the tropics, the Tropic of Cancer passing through the country about 150 miles north of Mandalay. There are three seasons: the monsoon, winter and summer.

The monsoon is from mid-May to the end of October. During this period the southwest monsoon brings rain from the Bay of Bengal. The coastal regions receive about 500 cm of rain, the Irrawaddy delta about 250 cm, and the hilly regions about 200 cm. Central Burma, which lies within the rain shadow of the Arakan Yoma, receives about 50 to 75 cm of rain.

The cold season is from early November to late February. Temperatures in the south of the country may drop to 15.5°C and in other areas the cold is more intense.

The hot season or the summer comes before the rains. The temperatures in the south are around 30°C but those in the central plain may be as high as 33°.

1.2 Political setting

The Socialist Republic of the Union of Burma came into being on January 3, 1974, after the new socialist constitution had been passed by over 90 percent of the electorate in a referendum. It is a single party system. Under the provisions of the constitution, the nationwide elections for Pyithu Hluttaw (Parliament), People's Councils for State/Division, Township and Village tract levels are held every 4 years. The Pyithu Hluttaw includes 475 members elected from 314 townships. Candidates for these elections are approved by the Burma Socialist Programme Party (BSPP), the only political party.

The Pyithu Hluttaw is the highest organ of the State Power. It meets twice a year in March and October. When the Pyithu Hluttaw is not in session, the State Power is delegated to the Council of State. The Council of State is composed of 29 members. Fourteen represent the 14 State and Divisional territorial units, while another 14 represent the Pyithu Hluttaw as a whole. The Prime Minister is the 29th member.

The Council of Justice is the highest judicial organ of the State and the Council of People's Attorneys protects and safeguards the Socialist System as well as the rights and privileges of the working people. Under the Council of State there are the Council of Ministers (Cabinet) and the Council of People's Inspectors to implement the State policies. All members of the executive branch are elected from among the members of Pyithu Hluttaw.

The Socialist Republic of the Union of Burma comprises seven states and seven divisions, namely: the Kachin State, the Chin

State, the Kaya State, the Karen State, the Mon State, the Rakhine, and the Shan State. The seven divisions are the Rangoon Division, Mandalay Division, the Pegu Division, the Tenasserim Division, the Irrawaddy Division, the Sagaing Division and the Magwe Division. These divisions are comprised of 314 townships. The administrative control is exercised from the National Headquarters downward through a system of subordinate executive bodies. People's Councils at the levels of State/Division, Township and Village tract have government functions. A nation-wide party apparatus, through a system of party cells and committees, exercises policy control over the activities of People's Councils.

1.3 Population

Burma had a population of 35.6 million in 1984, with an annual growth rate of 2.01 percent. The male population was 17.7 million and the female population was 17.98 million. In analyzing growth by age groups, it was estimated that out of the total population, 13.36 million were under 15 years old, 19.98 million were in the working age group of 15 to 59 years, and 2.34 million were in the age group 60 years and more.

The crude birthrate was 28.3 per thousand while the crude death rate was 11.2 per thousand.

1.4 Economy

Burma is an agricultural economy in the process of modernization and appropriate industrialization. Rice and timber are the main products but other cereal crops, oilseed crops, industrial crops, minerals and petroleum are growing in importance.

Improved performance of the economy during 1983-84 has been made possible by steady growth in the main productive sectors,

namely agriculture, forestry and processing and manufacturing. According to the provisional data, the value of output of the agriculture sector in 1983-84 increased by 5.6 percent. This remarkable growth rate was the result of increase in output of principal crops. The increase in agricultural output is attributable to the introduction of high yield variety (HYV) programs of crops, improved cultural methods, and whole-township crop production programs for important selected crops. The impact of such measures is responsible for increases in yield per acre of many important crops.

According to the provisional data, the value of net output in the forestry sector increased by 5.2 percent in 1983-84. Modern methods of log transportation and extraction coupled with building of all-weather accessible roads which minimized the stock in course of extraction contributed to the increase in output of teak and hardwood during this period.

The processing and manufacturing sector showed perceptible increase in production in line with the increased production in agriculture. The adequate supply of raw materials in the agriculture sector, regular supply of foreign raw material and spare parts, mainly contributed to the increase in the value of net output of the processing and manufacturing sector by 9 percent in 1981-82. Utilization of production capacity in this sector was 72.91 percent in 1980-81; 73.60 percent in 1981-82; 71.00 percent in 1982-83 and 73.00 percent in 1983-84.

Out of over 5.8 million students, 0.17 million were studying higher education. Over 33,000 academic and professional degrees were awarded in 1983-84.

During 1982-83, the export value of K 3,036.3 million was realized. Export by type of commodity is presented in Table 1.1.

The allocation of capital and current expenditure for the State Administrative Organizations, the State Economic Enterprises and the Town and City Development Committees for 1984-85 is shown by sector in Table 1.2.

Table 1.1 Exports by Type of Commodity, 1982-83

Type of Commodity	Kyats in Million
Agricultural Products	1,566.8
Animal and Marine Products	152.1
Forest Products	813.6
Minerals and Gems	398.5
Others	72.3
Re-export	33.0
Total	3,036.3

Table 1.2 Allocation of Capital and Current Expenditure by Sector for 1984-85

Sector	Capital Kyats (million)	Capital %	Current Kyats (million)	Current %
Agriculture	1,130	13.1	1,630	5.5
Livestock and Fishery	250	3.2	640	2.2
Forestry	240	3.1	1,070	3.6
Mining	240	3.1	1,450	4.9
Processing and Manufacturing	2,480	31.6	9,010	30.3
Power	1,840	13.3	410	1.4
Construction	320	4.1	1,520	5.1
Transportation and Communications	840	10.7	1,480	5.0
Trade	350	4.5	6,500	21.8
Social Services	550	7.0	1,710	5.7
Financial Institutions	20	0.2	1,260	4.2
Administrative Organizations	350	4.5	2,800	9.4
Town and City Development Committees	130	1.6	190	0.6
Reserve Fund	-	-	100	0.3
Total	8,740	100.0	29,770	100.0

2 The Agriculture Sector

The prospects of Burma's economy hinge on the performance of the agriculture sector. The bulk of the rural population lives near the subsistence level and improved small farm productivity is a prerequisite for meeting their basic needs. About 85 percent of the population lives in rural areas and two-thirds of employment is in agriculture.

Burma is richly endowed with natural resources. It has a substantial area of arable land which could be brought under cultivation and significant water resources. Official data indicates 21 million acres of cultivable wasteland. Of the total land area of 261,228 square miles, half is in forest and about 72,000 square miles is considered suitable for cultivation. However, only 45 percent of this area is under cultivation, due to limited availability of water. In 1983-84, 34,000 acres of cultivable land was brought under cultivation. The utilization of land is shown in Table 2.1.

Table 2.1 Land Utilization

Particulars	Acres (000)
Net Sown Area	19,957
Fallow Area	4,942
Cultivable Wasteland	21,087
Reserved Forest	24,578
Other Forest Area	54,849
Other Lands	41,773
Total	167,186

Land is owned by the State and only the actual tillers are given the right to till the land. Thus the number of small landholders has increased substantially while the farmers with large holdings has declined. The land area occupied by peasant families in 1983-84 is shown in Table 2.2.

Table 2.2 Position of Peasant Families and Land Occupied

Size of Holding	% of Acreage	% of Peasant Families
Under 5 Acres	25.1	61.36
5 to 10 Acres	30.9	24.25
10 to 20 Acres	29.2	11.73
20 to 50 Acres	12.4	2.50
50 to 100 Acres	0.5	0.05
Over 100 Acres	1.9	0.02

From the above table it can be seen that holdings of 10 acres or less take up 55 percent of the total acreage and are held by 85 percent of the population. The remaining 45 percent of land in farms of 10 acres or more are held by 12 percent of the farmers. Less than 3 percent of the farmers have holdings of 20 acres or more.

Burma has vast irrigation potential but irrigated area comprises only about 13 percent of the total area sown to agricultural crops. It has been recognized that the lack of flood control, drainage and development of irrigation is one of the major factors contributing to low yields and the inability to produce crops during the dry season. Attempts have been made to correct these conditions. The main sources of irrigation water are river diversion schemes (serving a total irrigable area of at

least 1.6 million acres), dams and reservoirs (serving around 190,000 acres) and pump schemes (serving about 380,000 acres) and others about 430,000 acres. At present only 2.6 million acres is under irrigation. During the last few years, operations of the Irrigation Department (ID) have expanded rapidly. Authorized staff positions increased from 6,800 in 1973 to about 20,000 in 1982, and the number of projects under implementation increased from 8 to 17. However, it was found that only 12.5 percent of the irrigated area is double cropped.

Attempts to provide farm inputs such as fertilizers, and pesticides have been quite successful.

Rice is the staple food of the people and is an important foreign exchange earner. The Government is giving highest priority for rice land development and improvement of its production.

Rice is presently grown in about 12.06 million acres. There had been a gradual decrease in rice acreage from 12.6 million acres in 1965 to 12.0 million acres in 1973. From 1974 onwards the area increased substantially as shown in Figure 2.1.

During the 10-year period 1963-73, annual production fluctuated. Since then production increased substantially from 7.4 Mt in 1973 to 14.4 Mt in 1982-83.

Prior to 1974 rice yields were low. Yields per acre fluctuated between 29 and 32 baskets. After 1974, a gradual yield increase was obtained and in the year 1983, average yield per acre reached 61 baskets.

Total domestic consumption of paddy gradually increased from 5.5 Mt in 1978-79 to 6.1 Mt in 1982-83. The exportable surplus in 1978-79 was 1.6 Mt and in the year 1982-83 it was about 0.59 Mt.

The agriculture sector accounts for 38 percent of gross domestic product and employs 64 percent of the country's labor force. In 1982-83, the sector accounted for 52 percent of the foreign exchange earnings.

2.1 Structure

Overall responsibility for managing and implementing agricultural activities rests with the Ministry of Agriculture and Forests, which consists of seven Departments and three Corporations as shown in Table 2.3. The Agriculture Corporation, under its Managing Director, is responsible for all aspects of crop research, development and production. Forestry activities fall under separate departments or corporations.

The organizational structure of the Agriculture Corporation is depicted in Table 2.4.

2.2 Infrastructure

Agricultural support services are organized through the relevant departments and corporations concerned with the development and establishment of agricultural and rural development projects.

2.2.1 Agriculture Corporation (AC)

The Agriculture Corporation of the Ministry of Agriculture and Forests is responsible for agricultural extension and research, the coordination of fertilizer and agricultural chemical distribution, and seed multiplication and distribution. Within the AC, there are two research divisions: the Applied Research Division (ARD) at Gyogon (Rangoon) and the Agricultural Research Institute (ARI) at Yezin. The Extension Division is also located at Rangoon. ARD administers 20 seed farms and 20 central farms scattered throughout the country. Its objectives are to multiply and produce high quality seeds. The central

Figure 2.1 Paddy Sown Area

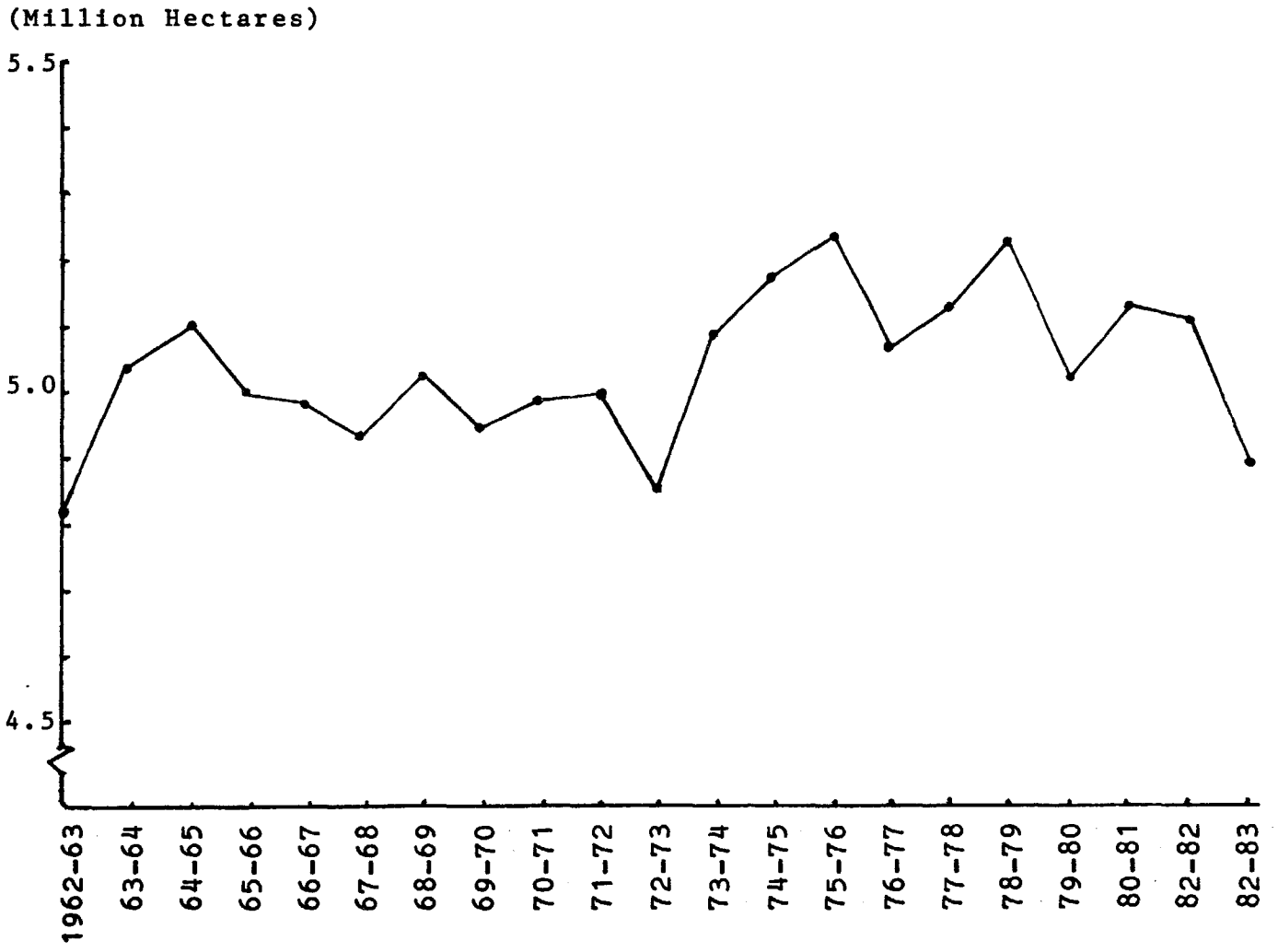


Table 2.3 Organization of the Ministry of Agriculture and Forests

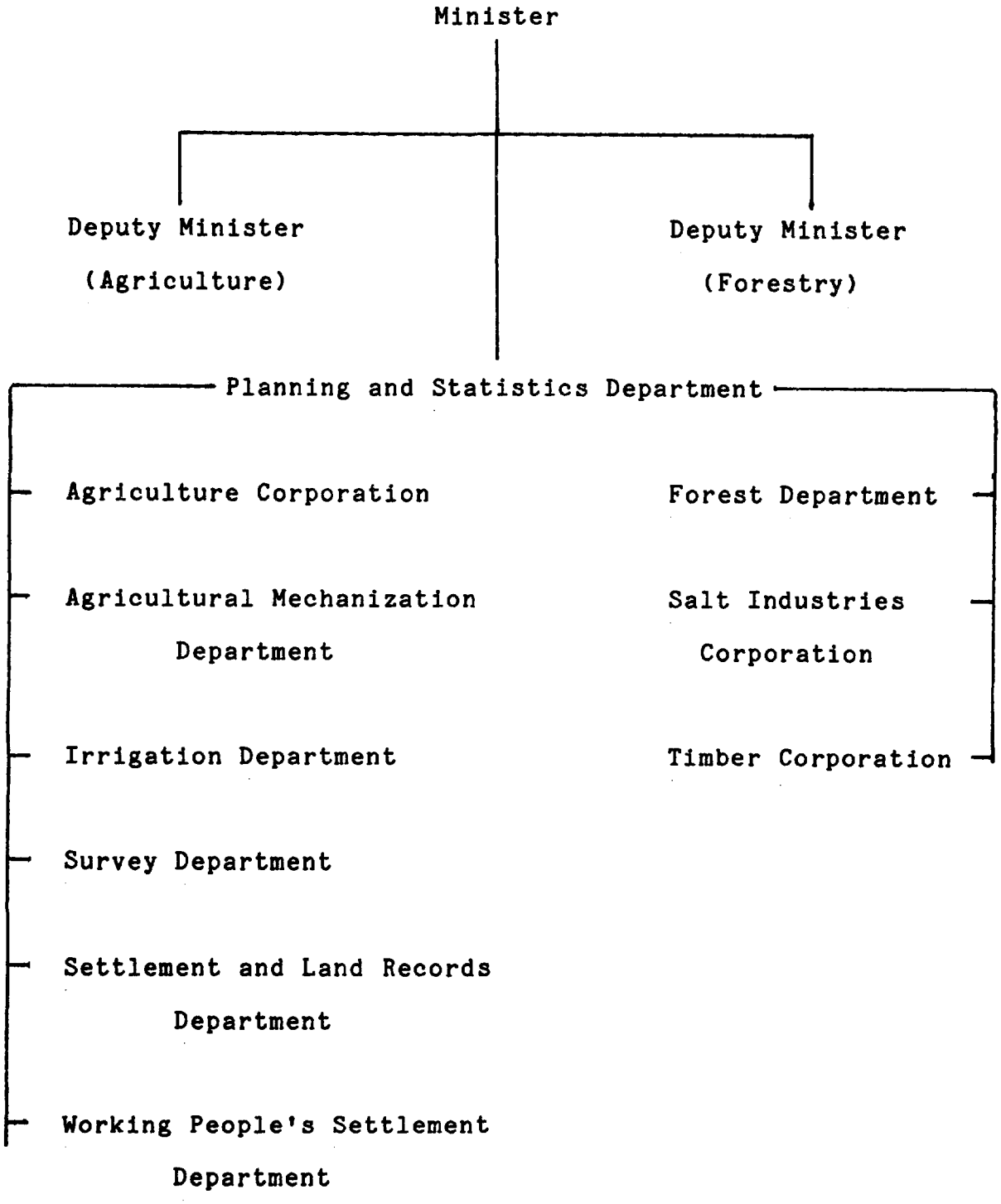


Table 2.4 Organization of the Agriculture Corporation (AC)

Managing Director

Agricultural Research Institute	G.M.
Applied Research	G.M.
Extension	G.M.
Land Use	Dy. G.M.
Plantation Crops	G.M.
Accounts	G.M.
Administration	G.M.
Export	Dy. G.M.
Planning and Projects	G.M.
Procurement and Distribution	G.M.

farms are responsible for plant breeding, crop selection, yield testing, cultural and fertilizer experiments and extension manager training.

The research activities of ARI are similar to those of ARD. Germplasm collection and evaluation, selection and varietal improvement, crop culture techniques, seed production, crop response to fertilizers, control of crop pests and diseases, and various other miscellaneous studies and activities are carried out by ARI.

The extension department has responsibility for implementing agricultural plans, procuring and distributing agricultural supplies and disseminating research information to farmers. The Whole Township Programs are now the main vehicle for extension activities.

2.2.2 Irrigation Department (ID)

The prime function of the Irrigation Department is to plan, design and implement coordinated water resources development, including irrigation, drainage and flood control.

The ID has considerable experience in executing major internationally funded projects, including the Sedawgyi Dam and the Ngalaik Dam, both financed by the Asian Development Bank. The Kinda Dam Project and the Lower Burma Paddy Land Development Projects are assisted by the World Bank.

Between 1962 and 1980, the ID completed eight major projects with a total irrigable area of 137,000 ha. The department also completed four major flood protection projects providing protection for over 50,000 ha.

2.2.3 Agricultural Mechanization Department (AMD)

The AMD is charged with the responsibility of assisting the farmers with timely land preparation. They provide tractors,

sprayers, pumps, power tillers, threshers and other farm implements for sale and hire to farmers and village cooperatives. This department does land preparation on about 700,000 acres annually.

The AMD is not only charged with the above responsibilities, but they also have to carry out production of innovative equipment like the manual rice transplanter, and maintenance and repair of department-owned and cooperatively owned agricultural machinery. Another function is the training of operator and repair technicians.

2.2.4 Food Industries Corporation (FIC)

FIC under the Ministry of Industry No. 1 is responsible through its Tobacco Division and Sugarcane Division for the procurement, processing and marketing of Virginia tobacco and sugarcane. The tobacco division also provides cultural advice, initial multiplication of improved seed and research. It has established a number of state farms and experimental stations situated in Middle and Upper Burma.

2.2.5 Textile Industries Corporation (TIC)

TIC is responsible for the purchase of jute and long staple cotton directly from the farmers and subsequent processing, storage and transportation. In the case of cotton, the seeds are stored and distributed back to the farmers. The above activities are carried out by the Cotton Textile Division and the Jute Production Division.

2.2.6 Department of Cooperatives

There are many cooperative organizations. In each township there is a township cooperative society to which varying numbers of other cooperatives are affiliated. One of the major cooperative activities in every township is crop procurement and distribution. Crops are often produced on a forward sales basis. A cooperative aims to buy a specific quota of various crops. The

farmer is paid up to 70 percent of crop value in advance. A second major function of cooperatives is the distribution of various rationed goods, on a quota basis, which are sold through the village tract and township consumer cooperatives. At the village level the village tract cooperative undertakes the distribution of fertilizers. A cooperative advances fertilizers to farmers, who then pay at harvest. A cooperative borrows from the Myanma Agricultural Bank to finance fertilizer purchase, and farmers pay a financing charge in addition to the normal transport and handling charges.

2.2.7 Agricultural and Farm Produce Trade Corporation (AFPTC)

AFPTC is the main agency responsible for paddy procurement on a national basis. It is also responsible for the Government's butter bean and mung bean procurement policies. It also operates an advance scheme for some non-paddy crops such as maize and oil seed cake.

2.3 Institutional support

Under the Ministry of Education, there are two departments connected with agricultural training: the Higher Education Department and the Technical, Agricultural and Vocational Education Department.

The Institute of Agriculture, which is the sole institution giving training in Agriculture Science at university level falls under the Higher Education Department. It accepts about 300 successful candidates of the Basic Education High School Examination each year, for a 5-year course leading to the degree of Bachelor of Agriculture (BAg). At present, postgraduate courses are also offered in five subjects.

The Technical, Agricultural and Vocational Education Department is responsible for the running of Agricultural High Schools and Diploma level teaching at the State Institute of Agriculture.

The Agricultural High Schools accept students who have passed their Basic Education Middle School Examination for a 2-year course in agriculture training. There are nine such schools with a total student body of 1,550.

The State Institute of Agriculture accepts the successful candidates of the Basic Education High School Examination, for a 3-year course leading to a Diploma in Agriculture. There are six such institutes with a total enrollment of about 1,150.

Agriculture technicians at all three levels per year total about 1,400. The majority of the BAg and Diploma graduates are absorbed by the AC.

Central Agriculture Development Training Center (CADTC)

The CADTC holds its position as one of the executing divisions within the AC, having its advisory board with the Training Implementation Committee. The Managing Director is chairman, the Project Manager of the CADTC is secretary and the Division Managers of the AC are committee members.

The CADTC has a Training Section responsible for execution of training and improvement of teaching materials, a Field Section for control and operation of the demonstration farm, a Publication Section for compilation and printing of training materials, an Audio-Visual Section for operation and maintenance of training aids and a Project Manager's Office for training planning, administration and management of the CADTC.

The yearly training programs are planned by the Project Manager's Office of the CADTC and are approved by the Training Implementation Committee. The CADTC provides the following training as the primary training programs for the extension staff.

Pre-Service Training. This training provides for new graduates from the Institute of Agriculture, Agricultural Institutes and Agricultural High Schools, for a period of 2 months, to cultivate the responsi-bility of the extension staff and the ideology of agricultural extension activities. The curriculum is based mainly upon theoretical education.

On-the-Job Training. This training serves to improve technical skill of extension staff from state, division, township, village tract and village levels. The training period covers 1 to 2 weeks. The curriculum applies to any varied level of trainees and provides mainly theoretical and laboratory exercise training.

In-Service Training. This training program consists of four courses for extension staff and specialists in every field, such as Subject Matter Specialist Course (S.M.S.), Specialist Comprehensive Course, General Agriculture and Extension Course and Planning and Analysis Course. The training period is 3 to 6 months.

2.4 Pricing

The marketing and pricing of agricultural products is carried out through both state and private systems. The government exercises considerable influence over farmers' incentives through its compulsory procurement monopoly purchase system which operates for paddy, jute, cotton, and to some extent sugarcane, pulses, tobacco and maize. For most of these crops including paddy, compulsory delivery quotas, enforced by local authorities, are imposed at fixed prices.

Paddy is divided by quality into six groups, namely Ngasein, Meedon, Emata, Ngakwe, Kauknyin and Special Emata. The highest quality, Ngakwe, has a 20 percent higher price than Ngasein.

Table 2.5 Purchase Prices of Ngasein Paddy by Grade, 1962-63 to 1983-84
(kyats per 100 baskets)

Grade	1962/63 to 1965/66	1966/67	1967/68 to 1972/73	1973/74	1974/75 to 1976/77	1977/78 to 1979/80	1980/81 to 1983/84
Ordinary	310	340	358	600	900	900	900
Quality Seed	325	355	373	615	920	940	990
First Grade Quality Seed	330	360	378	620	930	970	1,060

Each group is again divided into three grades: ordinary, quality seeds and first grade quality seeds. The purchase prices for paddy is fixed according to its quality and variety.

The annual purchase prices of Ngasein paddy paid by AFPTC are shown in Table 2.5 and prices of agricultural products other than paddy are shown in Table 2.6.

In the case of groundnuts, farmers are organized to sell about half of the produce to cooperatives at controlled prices and the remainder can be sold at open market.

For government controlled farm products, target quotas are determined at the national level and these are eventually allocated to townships. The townships then further subdivide the required quotas among the village tracts where, after consultation with the farmers concerned, targets are set for each farmer.

The government has promoted the extensive cultivation of HYVs because the production cost per basket for HYV paddy is considerably lower. As a general rule, farmers participating in HYV special programs are allocated a higher target. Fertilizers, improved seeds and pesticides are included as a package in order to raise production.

Farmers growing controlled crops receive priority to buy fertilizers and insecticides at a subsidized price. Nitrogen fertilizers are more readily available than phosphate and potash fertilizers because of the two urea plants in Burma. Nitrogen costs are partially subsidized and a mechanism for distribution has been established by the Agriculture Corporation. Rice farmers were alloted 50 kg of urea fertilizer per acre for HYV and 25 kg of urea fertilizer per acre for local improved varieties.

Table 2.6 Prices of Agricultural Produce Fixed by the State 1983-84

Commodity	Price	Per Unit
Jute (first class)	K 3.55	per viss
Cotton (long staple)	K 7.00	per viss
Sugarcane	K 100	per long ton
Pulses	K 20-50	per basket of 72 lbs
Virginia Tobacco Leaf (green)	K 1.40	per viss
Maize	K 20	per basket of 55 lbs

At the township fertilizer depots, the cost of urea fertilizer is K 9 per 25 kg, 50 kg of triple superphosphate (TSP) at K 62 and murate of potash at K 29.90.

The farmer is required to pay cash, although in some instances the MAB does provide credit or AFPTC supplies some advance purchase funds.

As the basic commodities are sold to the public at controlled prices, the consumer price index in Burma increases only at a very small rate. Based on the price of consumer goods at 100 for 1978, the price index for 1983 is 118.20, an increase of 18.2 percent for the last 6 years or an annual increase of 3 percent.

Regarding price policy, the AC of the Ministry of Agriculture and Forests prepares farm budgets to be used for analytical purposes in procurement prices. The government sets these prices for inputs and outputs so as to encourage production and not cause undue inflation for food in the country.

A statistically acceptable sample survey of cost of production for farms is collected and analyzed each year. The samples cover crops which are to be purchased by the government in the following marketing year. The sample is further stratified for each crop by agroclimatic region and by season of production. The monopoly purchase prices are then set to cover the cost of a predetermined portion of the farm production. The government pays great consideration to narrowing down the margin between procurement prices for crops under the monopoly purchase system.

2.5 Past and present performance

2.5.1 Sector contribution

The development of agriculture constitutes a major goal in the national economic development programs of Burma. A series of Four Year Plans (FYP) are being implemented by the Government of Burma within the framework of a 20-year, long-term perspective plan ending 1989-90 (fifth FYP) with the following objectives set for the agricultural sector: (1) attain self-sufficiency in all food crops; (2) produce adequate raw materials for the agro-based national industries; and (3) promote the export potential of the various agricultural products.

During the third FYP, targets of the agriculture sector were exceeded. From 1976-77 to 1979-80, agricultural output including livestock, fisheries and forestry grew at an average annual rate of 7.7 percent compared to 1.3 percent per annum in the previous 10 years. From 1979-80 to 1980-81, the rate of increase was 11.3 percent and accounted for two-thirds of the growth of GDP. It also accounted for about 67 percent of total employment and 80 percent of total exports. The increase in agricultural output was 9.2 percent in 1981-82, 8.9 percent in 1982-83, and 4.8 percent in 1983-84. The decline in 1983-84 was due to the unfavorable weather conditions.

In 1977-78, the total sown acreage was 23.58 million acres which comprised 20.04 million acres of net sown and 3.54 million acres of multiple and mixed cropping. By 1981-82, the total sown acreage amounted to 25.49 million acres, of which the net sown was 20.89 million acres and that of multiple and mixed cropping was 4.6 million acres. In assessing the achievements against the plan targets, it was found that while the net area sown decreased by 7,000 acres, the multiple and mixed cropping areas increased by about 315,000 acres -- an increase of approximately 308,000 acres in total sown acreage over that of the plan target. There had been a yearly increase in total sown acreage, net areas sown and multiple and mixed cropping area during the third FYP. In 1982-83, the net sown area increased to 24.5 million acres. The provisional data for 1983-84 is 25 million acres.

Beginning in 1970, the government has given high priority to investments to obtain a more intensive cultivation of existing land under rainfed conditions, particularly in lower and central Burma. Relatively lower priority has been given to investments to extend irrigation, for drainage and flood control, or for extension of the cultivation area. Consequently, the net cultivated area increased by only 878,000 acres in 1971-72 to 1980-81; the irrigated area increased from 2,073,000 to 2,651,000 acres during the same period. The progress in irrigated area from 1970-71 to 1983-84 is given in Table 2.7.

The policy in the late 1970s was to introduce intensive measures to promote increased production of paddy in order to meet domestic demand and to provide an increasing surplus for export. It therefore introduced a selective and concentrated strategy which involved the adoption of proven technology, the leadership of local level political bodies, selective and concentrated use of land and technicians and promotion of mass participation.

Table 2.7 Progress in Irrigated Area (000 acres)

Year	Net Sown Area	Irrigated Area
1970-71	19,512	2,073
1971-72	19,674	2,199
1972-73	19,482	2,198
1973-74	19,927	2,400
1974-75	20,023	2,412
1975-76	20,088	2,432
1976-77	19,838	2,318
1977-78	20,041	2,422
1978-79	20,390	2,579
1979-80	19,908	2,468
1980-81	20,552	2,651
1981-82	20,789	2,579
1982-83	20,337	2,497
1983-84	20,438	2,622

Following the intensive pilot program in 1975-77, the Whole Township Paddy Production Development Program (WTPPDP) was introduced in two townships in southern Burma in the 1977-78 crop season. The main features of WTPPDP include more intensive use of exotic and locally bred HYVs, the introduction of improved cultivation practices, and the application of recommended rate of fertilizer. WTPPDP was extended to cover 78 townships in 1981-82, involving 6,426,000 acres or about 48 percent of the area sown to paddy. In 1982-83, the sown area increased to 6,445,000 acres and 82 townships.

Apart from paddy, 19 crops (wheat, maize seed, matpe, butter beans, sultapya, gram, pesingon, monsoon groundnut, winter groundnut, early sesamum, sunflower, wagyi, Mahlaing 5/6 cotton,

early long staple cotton, late long staple cotton, jute, sugarcane, potatoes and sorghum) were put on township special high yield programs in 43 townships in 1980-81 and further extended to 61 townships in 1981-82. In 1983-84, it increased to 86 townships.

The AFPTC procures paddy and other crops from farmers, distributes rice from surplus areas to deficient areas, and exports the surplus. AFPTC procures about 35 percent of the total paddy crop and the amount procured increased from 2.2 Mt in 1977 to 4.0 Mt in 1983. AFPTC maintains over 800 procurement centers, each serving 20 to 30 villages. The procurement quota for each farm is based on total production less the amount for domestic consumption, for payments in kind, and for sale on the free market. Incentives are offered to farmers who sell all their produce to AFPTC, as well as for rice varieties popular on international markets.

Prices for all varieties of paddy were increased by 51 percent between 1971 and 1974 and by 1984 the price of high quality paddy was increased by a further 15 percent. Paddy is graded by AFPTC at procurement centers, each variety being classified into three main grades as previously described. Procurement prices range from K 900 to K 1,300 per 100 baskets depending on the variety and quality. Price differentials have recently been increased in favor of internationally preferred premium grades.

Changes in government policies over the past decade have enabled it to introduce new technological and agronomic techniques with the active participation of farmers. These efforts have resulted in substantial increases in production and yields, which have been of considerable benefit both to the farmers and the country.

Paddy production increased from 7.6 Mt in 1962-63 to 14.4 Mt in 1982-83. Production of other crops has also markedly increased.

The introduction of WTPPDP has led to some dramatic changes in farming practices, including the introduction of HYVs and the relatively high application rates of chemical fertilizer to realize HYV yield potential in shorter growing periods. From 1970-71 to 1977-78, the use of fertilizer increased from 34,000 to 141,000 t and during the next 3 years, with the increase in townships involved in WTPPDP, fertilizer use increased to 241,000 t. An increase in fertilizer use to 345,000 t in 1982-83 was reported. A further increase in fertilizer use to 372,000 t by 1983-84 is projected.

The fourth FYP which covers the period from 1982-83 through 1985-86 is being implemented and the agriculture sector is mainly responsible for meeting the food requirements of the people, supplying raw materials to the local processing and manufacturing sector and accounting for the major share of foreign exchange earnings capital investment.

2.5.2 Production by commodity

In 1981-82, the final year of the third FYP, paddy production was targeted at 11.04 Mt, while the actual production was 13.92 Mt, an excess of 2.88 Mt. Similarly, the production of maize seed was targeted at 0.154 Mt while actual production was 0.228 Mt and the production of pulses was targeted at 0.44 Mt while production was 0.5 Mt. Production of sunflower and Virginia tobacco also exceeded their targets during 1981-82, while wheat, groundnut, sesamum, cotton, jute and sugarcane production fell short of the targets. Reviewing the overall performance of agriculture during the third FYP, it was found that agricultural production recorded significant increase mainly due to increases in yield per acre of principal crops. Produc-

tion of cereal crops such as paddy, maize and others was found to be satisfactory.

In 1983-84, during the fourth FYP, the targeted production of paddy was 7,095 million baskets while the actual production was 6,897 million. Compared with the production of the previous year, an increase of 8 million baskets was achieved. In the case of wheat, maize, pulses, sunflower, sugarcane and tobacco, it was found that the production exceeded the previous year and also that of the target. Groundnut, sesamum and cotton fell short of the targets but exceeded the previous year's production.

2.5.3 Exports

Agriculture is the mainstay of Burma's economy, producing staple food for domestic consumption as well as raw materials for the industrial sector. In addition, it is also responsible for earning foreign exchange needed for the development of the country by export of surplus agricultural products. Export of agricultural products increased yearly, the value of export having increased from K 1,069.7 million in 1977-78 to K 1,951.7 million in 1981-82. The export value of agriculture products in 1982-83 was K 1,566.8 million. This reduction in the export value was due to the reduced export prices for rice and maize.

2.5.4 Imports

As more consumer goods, capital goods, spare parts and raw materials have to be imported according to economic and social needs of the country, the import value is more than the foreign exchange earnings from exports resulting in a deficit in external trade. Accordingly, imports of investment goods which are indispensable for national requirements are financed by foreign loans and aid. The import value was K 2,086 million in 1977-78 and in the successive years an acceleration of imports is noted. In the year 1982-83 they were K 6,566.8 million. Foodstuff import was only about 2 percent of the total import.

2.6 Policy issues

Since 1964, the Government of the Union of Burma has placed great emphasis on the need for self-sufficiency, notwithstanding the requirement for increasing economic growth. In 1972, national guidelines were laid down in the Twenty Year Plan which incorporated the policies of the Burma Socialist Programme Party. This plan is divided into five FYPs, each subject to annual review.

The policies formulated by the government in the development of the agricultural sector are the roles played by the local organs of the Burma Socialist Programme Party, the Peasants and Workers Associations and the People's Council. With the active involvement and the consequent advantages of local knowledge of the prevailing economic and social conditions in their respective areas, locally elected functionaries are able to mobilize and lead the farmers. Thus they are able to make a significant contribution to implementing and monitoring the development plans established by the government.

During planting and harvesting time, the People's Councils and Associations organize voluntary labor. The urban workers, the Armed Forces and members of the Lanzin Youth Organization supplement labor during the times of shortage. The advantages of the active participation of volunteer labor are: (1) it reduces the cost of production; (2) it eases the seasonal shortage of labor; and (3) it promotes better understanding between farmers and the local institutions and Armed Forces.

This approach was used in the implementation of the Whole Township Special High Yield Paddy Production Program.

Development of the agricultural sector is largely due to this program. With the active involvement of the local organs of the Burma Socialist Programme Party, the Peasant and Worker

Associations and the People's Councils, the program is a success. The program involves a package of improved practices including varieties, fertilizers, pest control, recommended transplanting time, weeding, etc.

This program receives the popular participation of farmers. Annual plans and targets for cropping pattern, sown area and production goals are subjected to the close scrutiny of the People's Councils. Moreover, the People's Councils participate actively in the coordination of production and procurement. The program is carried out with a campaign type approach; mobilization of the community to provide extra labor; and the priority provision of consumer goods to the project area to complement incomes.

The Whole Township Special High Yield Paddy Production Program covers over half of all the country's area under paddy. The production has increased by a remarkable 65 percent from 1974-75 to 1982, with a national yield raised from 1.65 t/ha to almost 3 t/ha.

There is also a policy to stimulate and encourage the initiative of the farmer by organizing yield competitions. The results have been very encouraging with the number of farmers who were able to produce 100 baskets or more of paddy from an acre.

The AC also runs formal training for farmers at production camps located in the rural areas. Ten to twelve village extension workers live together at the camp to benefit from the interchange of ideas. The camps are provided with facilities for staging of seminars and meetings. Technicians and other agricultural specialists regularly visit these camps to support and complement the work of the extension staff.

This form of extension strategy using production camps and core-team extension workers is known as the selective-

concentrative strategy. Selectivity and concentration are applied in terms of location, crop variety and extension service personnel. The program was started on an operational basis during the 1979-80 fiscal year and extended to cover about 2.4 million ha (6 million acres) in 1981-82 and involved 78 townships. At present the SHYV program for paddy covers 82 townships.

This method of selective-concentrative strategy is also being utilized to improve the production of other crops. During 1980, Whole Township High Yield Variety Special Programs were launched for maize, groundnut, sunflower, cotton, wheat, sorghum, jute, potato and pulses. The following are the whole township programs now in operation: maize in 9 townships; monsoon groundnut in 4; winter groundnut in 11; sunflower in 6; cotton in 12; wheat in 14; sugarcane in 5; sorghum in 2; jute in 1; potato in 3; and 15 townships growing various pulses.

These programs have already produced significant yield increases in cotton, maize, wheat, groundnut and sugarcane and in the townships promoting the special HYV programs, average yields are two to three times the national figures.

3 The National Agricultural Research System (NARS)

Overall responsibility for managing and implementing agricultural activities rests with the Ministry of Agriculture and Forests, which consists of seven Departments and three Corporations. The Agriculture Corporation, under its Managing Director, is responsible for all aspects of crop research, development and production.

Research needs are ensured by two separate but very similar bodies, the Agriculture Research Institute (ARI) and the Applied Research Division (ARD) both headed by General Managers.

During the third FYP period (1978-79 to 1981-82) an average annual growth rate of 5.8 percent for the agricultural sector was targeted by the government while setting up specific targets for increasing the yield per unit area and total production of important field food crops and industrial raw material crops.

Recognizing the need for accelerating crop improvement research which would lead to increased production, the government initiated a program to strengthen the crop improvement research programs.

The ultimate objective of the crop development activities was to evolve high yielding, management responsive varieties and improved cultural practices for many different crops and to extend these to the farmers' fields, in order to enhance their production in the country. In each case, the program started with survey travels and discussions with the national staff to assess the existing situation and requirements. The spectra of land varieties and the prevailing production practices were particularly observed and as a result, the productivity constraints for various crops were identified. Varietal improvement and agronomic research programs were then formulated for each of the crops and are now at various stages of their

execution. For crops like maize, jute, wheat and sorghum, these efforts have already resulted in the release of HYVs. These varieties with their impressive yield superiority over the existing cultivars have already spread over several hundred to several thousand acres of farmers' land and have been enthusiastically received by farmers as well as extension workers.

Simultaneously with the varietal improvement program, a number of agronomic experiments were conducted as part of the project program implementation to develop an appropriate production technology commensurate with high yield. Based on the results from these experiments, specific recommendations and production guidelines have been developed for various crops and in most cases these have already been adopted by the farmers along with the new varieties, with a noticeable impact on yield.

In planning crop improvement programs the objective of a rapid transfer of technology was always foremost. In order to make the line of communication between the researcher and the farmer more effective, working groups comprising staff from ARI, ARD and extension division were constituted for each of the project crops and these were made responsible for the planning, execution and evaluation of all phases of the crop development programs. Apart from utilizing the facilities at the experiment stations, regional tests for varieties and proposed production practices were also conducted on the farmers' fields in collaboration with the extension staff, resulting in their direct involvement in this process. This association has contributed towards a faster spread of the improved varieties and agronomic practices.

3.1 Institutional structure

3.1.1 The Agriculture Research Institute (ARI)

This institute is situated in Yezin, some 250 miles north of Rangoon. It is responsible for basic programs connected with plant improvement, plant protection and crop husbandry and crop physiology. Approximately 1,400 acres of land are available. The housing area, roads, offices and laboratories have required the use of about 250 acres. Over a thousand acres is used for field research work.

ARI has five disciplinary divisions and seven crop divisions. The institutional structure is given in Table 3.2.

Rice Division

This division is responsible for varietal improvement on different cultural types such as:

(1) Irrigated lowland rice
(2) Rainfed lowland rice
(3) Upland rice (low elevation)
(4) Upland rice (high elevation)
(5) Deep water rice
(6) Cold tolerant rice
(7) Salt tolerant rice

The cooperating agencies are the International Rice Research Institute (IRRI), Philippines, Applied Research Division (ARD), and the Agricultural Extension Division.

Sixteen high yielding varieties suitable for irrigated as well as rainfed lowland and upland areas have been released. The area under these varieties at present exceeds three million acres. Promising new varieties are under trials in farmers' fields annually.

The improved varieties developed by ARI up to 1984 are as follows: (1) through introductions which include six lowland varieties, five upland (low elevation) varieties, and three deep water varieties; (2) through locally developed hybrids which include three lowland varieties, two upland (low elevation) varieties, three salt tolerant varieties, and one deep water variety; and (3) through locally developed mutants of which there were two lowland varieties.

The research planning work for the Rice Division is shown in Table 3.1.

Table 3.1 Program of Work for 1984-85

Programs	Trials	Results
Breeding		
Hybridization		150 crosses
Selection in F1 generation		287 crosses
Selection in F2 generation		226 crosses
Selection in F3-F8 generation		14,515 progenies
Selection of fixed hybrids		439 progenies
Observation, selection and maintenance		
Germplasm collection		1,985 varieties
Observation and selection		369 varieties
Maintenance		1,283 varieties
Performance testing		
Preliminary test	12 trials	379 varieties
General test	12 trials	217 varieties
Advanced test	11 trials	137 varieties
FENST	2 trials	22 varieties
Pure seed multiplication		
Breeder seed		86 varieties
Foundation seed		41 varieties
Registered seed		10 varieties

Cereal Crop Division

This division stresses the following programs for the improvement of maize, wheat and sorghum. Maize activities include breeding for earliness with high yield potential, breeding for high population tolerance and evolution of synthetic and open-pollinated varieties. Wheat activities include breeding for earliness with heat tolerant character and for rust resistance. Sorghum activities include breeding for earliness with high yield potential of grain and fodder and for shoot-fly resistance. Maize agronomy activities include determining the optimum plant population for medium, medium early and early varieties and the study of the responsiveness of NPK fertilizers.

One synthetic and six open-pollinated varieties of maize were released during the period 1974-82. A population of 17,000 plants per acre for medium and 23,000 for medium early varieties were recommended. Applications of 50-120 lbs of Nitrogen, 55 of Phosphorous Pentoxide and 30 of Potassium Oxide per acre were issued to maize growers. As regards wheat and sorghum, five varieties of wheat and five varieties of sorghum were distributed to farmers.

Research planned for the cereal division for 1984-85 is as follows:

(1) Maintain 459 inbred lines through sibbing.
(2) Produce varietal hybrids for regional testing.
(3) Evaluate new introductions.
(4) Continue evaluation of 100 new inbred lines.
(5) Maintain 551 varieties of maize.
(6) Continue observation and selection of 4,100 varieties of wheat and 272 varieties of sorghum.
(7) Continue experiments on time of thinning seedlings, and time and methods of urea fertilizer application to maize.
(8) Determine effectiveness of NPK on wheat and sorghum.

Oilseed Crop Division

The main objective of the division's research program is to improve or replace the existing varieties with more productive ones. Regarding the varietal improvement, breeding work is being carried out only on sesamum, whereas the improvement of groundnut and sunflower is carried out by introduction and selection of exotic and local germplasms.

At present there are 162 exotic and 11 indigenous varieties of groundnut, 144 exotic and 143 indigenous varieties of sesamum and 26 exotic varieties of sunflower under trial and yield tests for varietal evaluation.

The division is also carrying out some agrotechniques, fertilizer and plant protection experiments on groundnut, sesamum and sunflower. Regional tests are also being carried out by the division in collaboration with extension staff at different localities to identify the specific varieties.

This division has released three improved varieties of groundnut and one improved variety each of sesamum and sunflower to the cultivators for commercial cultivation.

Fiber Crops Division

Breeding and agronomic research are the major activities of this division. The research programs in operation are for cotton and jute.

Breeding activities for cotton are for (1) high yield with better quality of fiber; (2) earliness with insect tolerance; (3) short-branched type with photoinsensitivity; and (4) cold tolerance with drought resistance.

Breeding activities for jute are for (1) high yield with better fiber quality; (2) non-branching type with photo-

insensitivity; (3) drought resistance with quick growth; and (4) high population tolerance.

For both crops, emphasis is given to the selection of cultivars which are compatible with rice-based farming systems in irrigation tracts.

Agronomy work for cotton includes (1) investigation of narrow spacing with short-branched type; (2) the study of effectiveness of different sprayers and insecticides on yield and quality of cotton; and (3) the study of efficient use of fertilizer.

Agronomy work for jute includes (1) observation of different stages of plant growth at harvest on the yield and quality of fiber; (2) determining the effect of time of planting on different types of capsularis jute; (3) the study of efficient use of fertilizer and manures including the Ipil Ipil (L. Leucosephala) leaves; and (4) the study of fiber distribution at different parts of the plant at different stages of plant growth.

Research planning works for the Fiber Crop Division are as follows: (1) selection for F1 to F4 generations of both cotton and jute; (2) evaluation of some promising varieties; (3) maintenance of 180 varieties of cotton and 185 of jute; (4) study of the effect of paraplough and subsoiler for cotton on paddy land; and (5) study of the effect of locally made jute ribbing apparatus.

Sugar Crop Division

This division conducts varietal improvement through hybridization and evaluation of 176 genotypes and regional testing of 72 genotypes. It also carries out research on optimum planting and harvesting dates as well as on water requirements of widely grown varieties.

Food Legume Division

This division is dealing with research on evaluation, adaptability tests, appropriate management practices and multiplication of promising new food legume crops.

Two each of the early maturing and the promising mung bean, cowpea, black gram and pigeonpea varieties have been released and extensively grown by farmers. The other promising food legume crop varieties have been identified and are ready for seed multiplication. Apart from the proper recommendation of adaptable varieties, the appropriate agrotechniques are advocated.

Horticulture Division

This division concentrates on research such as collection, selection, breeding of promising varieties, propagation and multiplication of fruit, floricultural, ornamental and medicinal plants. Production of pure vegetable seeds and flower seeds is also carried out.

The five disciplinary divisions emphasize programs to support crop production.

Agronomy Division

This division carried out experiments on cropping system research and development on 11 outreach stations. Out of 11 sites, 2 are under ARD, 1 at ARI is the main station and 8 are at Extension Division farms. There are 78 AC technicians involved in the program, of which 72 are conducting the research work. In 3 sites started in 1984, there are multilocation trials of promising patterns which involved 16 farmer cooperators.

Collaborative research work with IRRI and other research centers is being conducted in three other Asian Rice Farming Systems Network (ARFSN) sites. These are:

(1) Rice-Wheat rotation trials in three sites.

(2) Trials of corn, mung bean and groundnut before rice in two locations.
(3) Trials of soybean, sorghum, groundnut and cowpea in three locations after rice.
(4) Pigeonpea trial in one location.
(5) Tomato, mung bean, chinese cabbage and soybean trials from Asian Vegetable Research Development Center (AVRDC) through IRRI.
(6) Three sets of cowpea trials from IITA at Yezin.

Botany Division

The major activities of this division are the study of the physiological aspects of crop production and breeding. Mutation breeding, selection and evaluation and physiological studies of important crops have been carried out.

The research plan for 1984-85 is as follows: (1) continuation of the physiological studies on important crops; (2) continuation of selection of M4 and M5 progenies of Ngakwe, Taungbyan and Shwetasoke rice varieties; and (3) evaluation and selection of F2 generation derived from the culture of F1 crosses.

Soil Chemistry Division

This division deals with plant nutrition studies, bio-fertilizer application and bio-gas production from agriculture and forest waste. The planned programs for the year 1984-85 are:

(1) Determine the efficiency of urea, applied to the reduced zone of paddy soil.
(2) Study the response of rice crop to sulphur and zinc and the availability of the nutrients to rice plant.
(3) Study the uni-algal production of blue-green algae (BGA) and the potential amount of nitrogen fixed by BGA.
(4) Study the effect of azolla on rice yield.

(5) Determine the potential methane production of agriculture and forest waste.

(6) Develop efficiency of bio-gas stoves and lamps.

Entomology Division

This division stresses pest management on all important crop species. Evaluation of insecticides and applicators, screening of varietal resistance, insect collection and preservation, etc., are carried out.

Apart from these, collaborative activities with Plant Protection Project (Extension) and CIDA-IRRI Burma Project are also in progress.

Plant Pathology Division

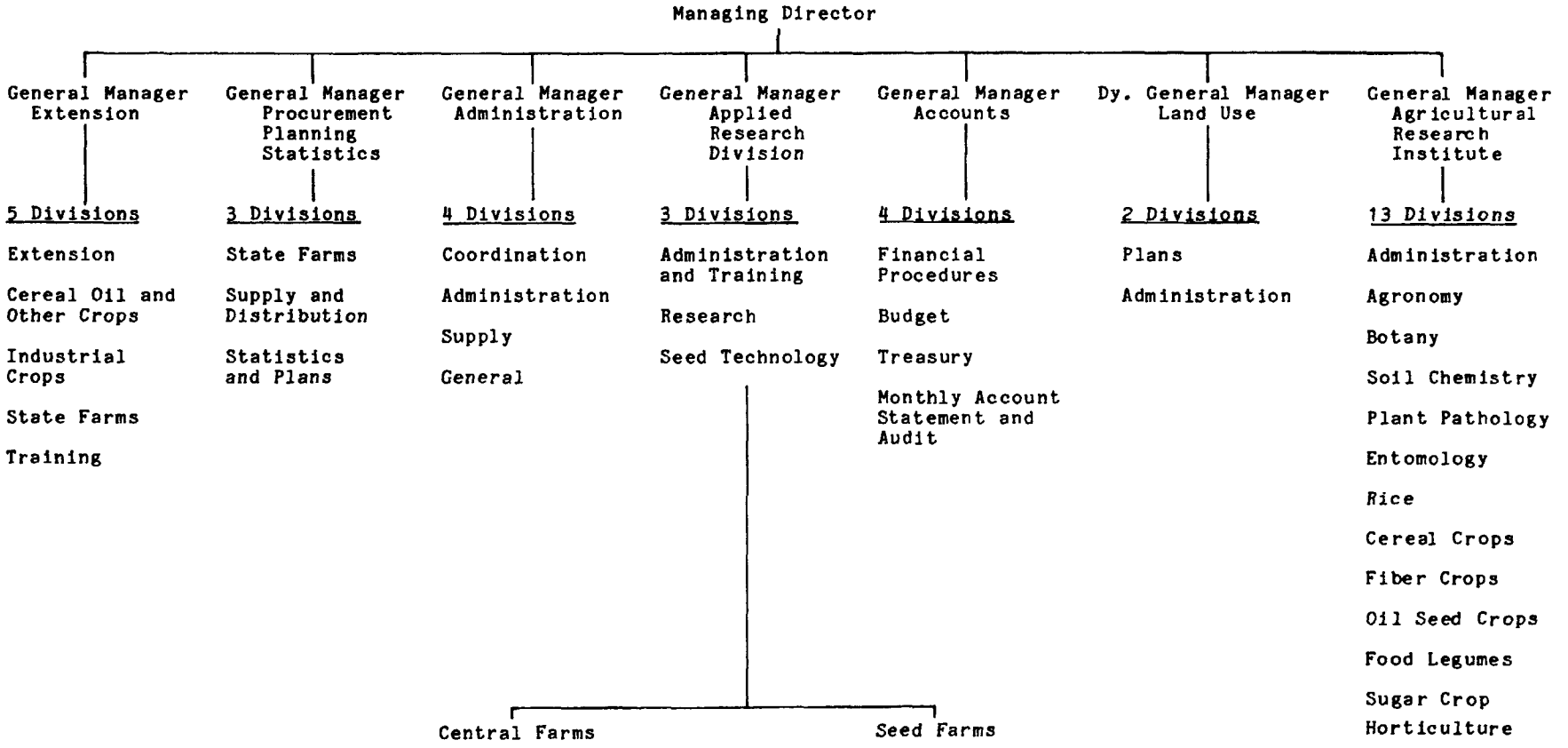
Screening for disease resistance and fungicides for important crop diseases is carried out every year.

Sugarcane whip smut had been controlled efficiently and resistant varieties against sugarcane red rot, rice blast and rice bacterial leaf blight diseases have been developed. Efficiency of rhizobial strains against different legumes have also been identified.

3.1.2 Applied Research Division (ARD)

This division is one of the seven main bodies of AC under the Ministry of Agriculture and Forests. ARD headquarters are situated in Rangoon and there are 20 central research farms and 20 seed farms, located in different climatic and soil tracts of the country where research is carried out. It consists of three divisions, namely the Research Division, Administration and Training Division and the Seed Technology Division. The structure of the ARD is presented in Table 3.2.

Table 3.2 Organization of Agriculture Corporation



The main objectives of ARD are: (1) to evolve improved crop varieties and to find out better crop management techniques for different agroecological zones of Burma; (2) to transfer improved technology to agriculturalists and farmers; and (3) to multiply and distribute quality seeds.

Research Division

The research activities carried out by the research division include: (1) varietal improvement through introduction and breeding; (2) crop management by cultivation techniques; (3) cropping patterns; and (4) plant protection through insect, disease and weed control.

Thus the main activities of ARD are very much the same as those of ARI.

Seed Technology Division

Apart from the normal pure seed production program, a special Seed Development Project has been conducted by ARD with financing from the World Bank since 1979. Under this project, six central research farms are being developed. Quality Seed Production Project GCP/BUR/016/DEN is also underway to assist in the implementation of the National Seed Program. Six central farms are being developed to establish a program for the production of Basic, Foundation and Registered Seed of wheat, maize and sorghum.

The main activities of this division are for quality seed production and distribution. Multiplication, drying, processing, seed quality control, testing, certification, storage and distribution are being carried out for quality seeds by this division. Six to eight thousand acres are devoted to seed production annually. The different crop seeds distributed in 1983-84 and 1984-85, together with the plan for the coming year, is presented in Table 3.3.

Administration and Training Division

This division provides technical training and information to in-service staff, peasants and army personnel. The types of training and numbers to be trained in 1984-85 are shown in Table 3.4.

3.1.3 Institute of Agriculture (IA)

This institute is under the Ministry of Education and is the only university level teaching center for agriculture graduate and postgraduate students in the country. It is an independent institute with its own basic science departments. It is sited in Yezin, where it shares a campus with ARI, FRI and the Institute of Animal Husbandry and Veterinary Science.

The institutional structure is depicted in Table 3.5. It has five major disciplinary departments, namely the Agronomy Department, the Agricultural Botany Department, the Agricultural Chemistry Department, the Plant Pathology Department and the Entomology Department. The major supporting departments consist of the Agricultural Economics Department, the Agricultural Engineering Department, Animal Science Department and the Horticulture Department.

The University Farm is used for teaching, research and demonstration programs of the University. It is well provided with irrigation and the farm area is about 200 acres.

The curriculum is modified to give the types of training suited to the present day requirement of the graduates. More emphasis is placed on training in crop production and strong concentration on practical training is given to the fourth and final year students.

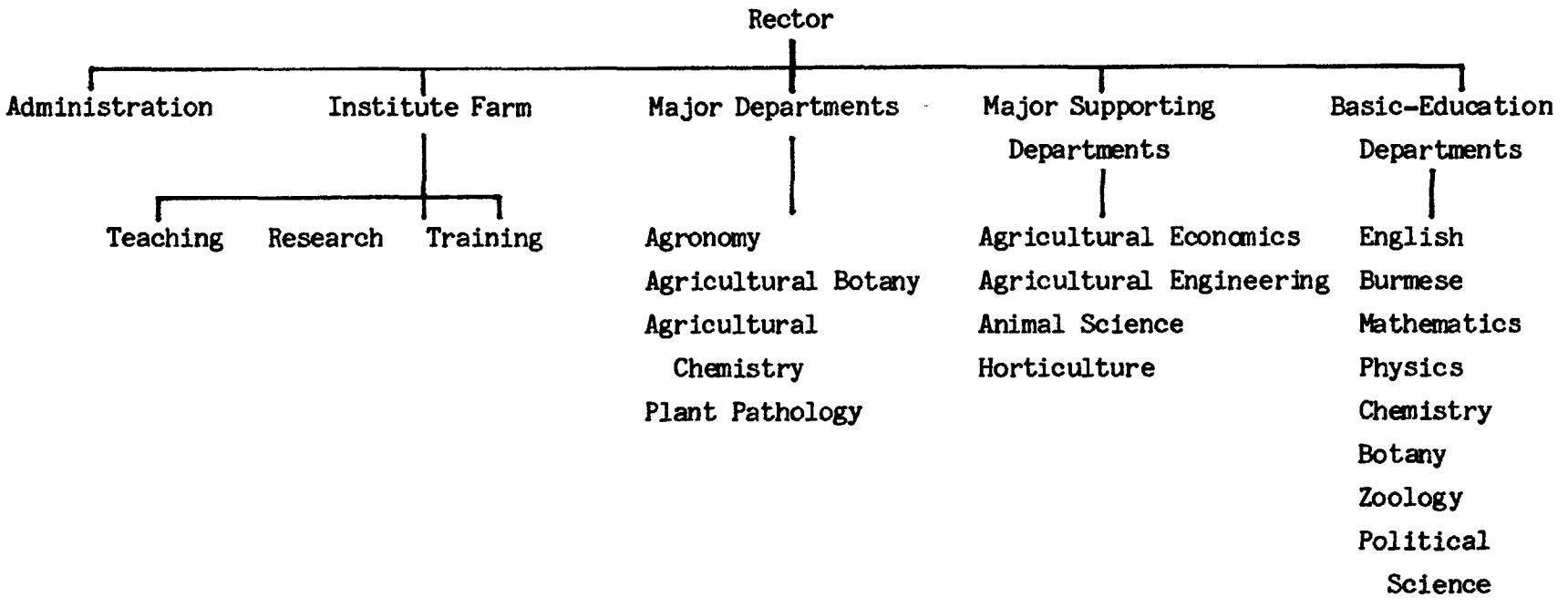
Table 3.3 Seed Distribution Program

Crop	Unit	Distributed		Projected
		1983-84	1984-85	1985-86
Rice	Basket	144,490	130,402	170,270
Wheat	"	1,123	1,796	3,783
Maize	"	6,611	9,403	11,562
Sorghum	"	641	2,081	2,685
Groundnut	"	3,870	3,926	6,399
Sesamum	"	1,826	1,457	3,754
Sunflower	"	2,742	2,131	4,463
Long Staple Cotton	Viss	81,936	340,954	409,940
Short Staple Cotton	Viss	7,906	4,754	9,127
Sugarcane	Ton	7,278	5,004	8,338
Pulses	Basket	1,094	1,937	4,726

Table 3.4 Training Programs for 1984-85

Type of Training	No. of Trainees
Farmers Basic Agriculture Training	508
Defence Service Agriculture Training	150
Party Cadre Basic Agriculture Short Course	1,200
In-service Training	2,840
Other Training (Seed Technology, Plant Protection, Mushroom, Plant Tissue Culture, etc.)	420
Total	5,118

Table 3.5 Organizational Structure of the Institute of Agriculture (IA)



Knowledge of the major disciplines is integrated to assist the development of agriculture policies and teaching, research and extension work.

The institute accepts about 300 students annually for a 5-year course leading to a BAg degree. Postgraduate training is available to candidates in the five major departments. The undergraduate curriculum follows a more traditional pattern rather than the semester system while the Master's courses follow a semester course system, coupled with a thesis.

The postgraduate research programs are discussed and coordinated by a research committee under the chairmanship of the Rector. Research is carried out by both staff and postgraduate students. Over 35 staff are involved in research -- 10 have PhDs and 25 have Master's degrees.

The close proximity of IA and ARI has helped to strengthen the interrelationship of the institutions. There is a good relationship at all levels with the various divisions of the AC, which is the main employer of graduates of the institute. As a large percentage of the staff of the Corporation are graduates of the Institute, personal relations between the two organizations are cordial.

3.2 Staffing in NARS

The number of scientists involved in the Agricultural Science Institutions (ARI, ARD and IA) are presented in Tables 3.6, 3.7 and 3.8. The numbers of highly trained professional staff involved in ARD is slightly more than ARI but the total scientific staff of ARD is at least four times greater than that of ARI.

ARD staff are spread over 20 central farms and 20 seed farms located in the various administrative and agroecological regions

Table 3.6 Staff of the Agriculture Research Institute in 1984

Type of Staff	Number
National Scientists	
PhD	2
MS	10
BS/BAg	82
	94
Technical Support Staff	
University Graduates	30
Diploma Holders	35
Non-Diploma Holders	24
	89
Other Staff	
Other Permanent Employees	101
Laborers	148
	249
Total Number of Employees	432

Note: In administration one individual holds an MS. In administration and research functions there are nine who hold the MS and two who hold the PhD. In research there are 35 individuals who hold a diploma and 112 who hold a BAg.

Table 3.7 Scientific Personnel of the Applied Research Division in 1984

Type of Staff	Number
National Scientists	
PhD	6
MS	14
BS/BAg	153
	173
Technical Support Staff	
University Graduates	53
Diploma Holders	127
Non-Diploma Holders	210
	390
Other	
Other Permanent Employees	478
Laborers	471
	949
Total	1,512

Note: In administration there is one PhD. In administration and research functions there are five PhDs and fourteen MS holders. In research functions only there are 127 diploma holders and 206 with the BAg.

Table 3.8 Scientific Personnel of the Institute of Agriculture in 1984

Type of Staff	Number
Research and Teaching	
PhD	10
MS	25
First Degree (BAg/BS)	14
First Degree (BAg)	50
Diploma	2
	101
Technical Support Staff	
University Graduates (All BAg teaching staff participate in research activities)	80
Non-Diploma Holders	100
Laborers	50
	230
Total	331

Note: In administration there are one PhD and two with the First Degree. In administration, teaching and research functions there are five with the PhD and nine with the Master's. In teaching and research functions there are four with the PhD, ten with the Master's and fourteen with the First Degree. In teaching functions there are six with Masters, 48 with the First Degree and two with a Diploma.

of Burma, and the headquarters with administrative and technical backstopping is in Rangoon.

In the Institute of Agriculture, research functions are carried out by the Departmental Heads, assisted by faculty members and students. More postgraduate degree holders are present in this institute compared to ARI and ARD, but the research work could be carried out only as partial fulfillment of the country's needs, since teaching is the main objective. However, the close proximity of IA and ARI has helped to strengthen the interrelationship of the institutions.

3.3 Multilateral and bilateral assistance projects with research components

Burma's use of external assistance has been rising steadily since 1970. Projects for external financing were included in the government's Twenty Year Development Program. Such projects form the basis for the third FYP. The highest priority is placed on easing the most immediate constraints to growth and particularly at increasing and diversifying production for exports. Accordingly, the emphasis is on developing Burma's primary producing sectors and supporting activities and, where appropriate, through quick yielding projects. In agriculture, foreign assistance is needed for projects which contribute to intensified use of existing cultivated areas and the reclamation of abandoned land. This would include: research and extension services; provision of essential inputs especially HYVs, fertilizer and light agricultural machinery; improvement of irrigation facilities including tubewell development; and integrated agricultural development projects where the relationships between services and inputs are important.

A number of bilateral and multilateral aid funded projects have been established in order to assist agricultural production and research within the country. A listing of the ongoing

projects, contributed funds, and consultancy support are given in Table 3.9. Most of the funding goes for production objectives except for a few identified specifically as research.

Table 3.9 Foreign Assistance Projects in Progress in 1985

Donor	Project	Duration (year)	Consultancy (months)	Donor Funding*
WB/IDA	Lower Burma Paddy Land Development Project I	6	33	0.51
WB/IDA	Lower Burma Paddy Land Development Project II	7	0	0.60
WB/IDA	BA Seed Development Project	4	56	5.50
WB/IDA	BA Rubber Rehabilitation Project I	5	33	4.50
WB/IDA	BA Rubber Rehabilitation Project II	6	38	9.00
ADB/OPEC	Crop Intensification Program I	2	0	20.00
ADB	Crop Intensification Program II	3	0	8.00
UNDP	Rubber Rehabilitation Project	4	69	0.74
UNDP	Industrial Crops Development Project	4	80	1.90
UNDP	Seed Development Project	4	0	0.97
CIDA	IRRI-Burma Cooperative Research Project II**	3	108	2.84
USAID	Maize and Oil Seed Development Project	4	206	30.00
Switzerland	Palm Oil Development Project	6	38	6.20
GTZ	Promotion of Fertilizer and Application	2	99	3.00
Japan	Whole Township Rice Production Project	2	0	2,500.00

*Million in donor's currency

**Phase I covered 1979-82

4 Impact of IARCs on NARS

4.1 Impact on some important crops in Burma

The agriculture research departments and other agencies under the AC with assistance from IARCs have greatly increased the crop yield in Burma.

The basic guidelines for the agricultural research program of Burma, laid down by the Research Policy Direction Board are aimed at the evolution of new technologies to increase unit area production in all major crops. The priority is given to food crops, with major efforts on rice and oilseeds, followed by other cereals, including wheat, maize, sorghum, food legumes, sugarcane, fiber crops, cotton, jute, etc.

4.1.1 Rice

Rice constitutes more than half of the sown area in Burma. Many steps have been taken to increase crop yield including distribution of local improved seeds, fertilizers and pesticides, assistance from the mechanization department in supplying draft power by tractors, and increases in the prices paid for delivery of paddy under monopoly purchasing systems. Despite all these attempts, national paddy yield has increased only about 0.85 percent annually during the year 1964-65 to 1975-76.

High yielding variety IR-8 seed was first introduced in 1966. In some areas, IR-8 gave a yield about three times that of local rice. But due to its short stature and unacceptable palatability, the acceptance by farmers was found to be very slow.

In 1970, the government placed a higher priority on crop improvement in its FYDP. The government sought technical assistance from the United Nations Development Program (UNDP). The first project, UNDP/FAO Project, BUR 72-003, to strengthen

the Research Institute at Yezin, materialized. The rice improvement program forms a major part of this project.

A varietal improvement program was started and the release of several introduced varieties well-adapted to various local conditions was initiated. The genetic potential of yield is considerably higher than the average paddy yield. Rice varieties received through various IARCs and formally released in Burma are listed in Table 4.1.

An acceleration of paddy production and yield was obtained after 1975. Prior to that year production had not exceeded 8.6 Mt, by 1978-79 it reached 10.5 and passed 14.0 in 1981 and 1982. Yields had never exceeded 1.8 t/ha until 1975-76. In 1978-79 they reached 2.1 t/ha and in 1981 and 1982 reached 2.9 and 3.1 t/ha. The sown area of HYV also increased from about 0.1 percent in 1967-68 to 50 percent in 1982-83 as shown in Table 4.2.

In addition to exotic HYVs, there are three local, two hybrids and two mutant HYVs sown in Burma. Their names and origin are given in Table 4.3.

One important factor in the increased rice production is the use of selective concentrative strategy known as Whole Township Crop Production Program (WTCPP) which now embraces 20 major crops including rice, maize, sorghum, wheat, potatoes, groundnut, sesamum, cotton and sunflower. The program involved a package of improved production practices including varieties, fertilizers, pest control, recommended transplanting time, weeding, etc. The program on rice was started in two townships in 1977-78 and it has expanded to 82 townships in 1982-83.

4.1.2 Wheat

The consumption of wheat in the Union of Burma has been increasing gradually, particularly in the form of bakery products. Present production is not enough to meet local

Table 4.1 Rice Varieties Received Through Various Research Institutions and Formally Released in Burma with Local Names

Local Name	Original Name	Country of Origin	Year of Release	Sown Acreage 1984-85
Yagyaw-2	IR-5	Philippines	1970	362,658
Si Lay	C4-63	"	"	156,393
Sein Lay	C4-113	"	"	4,189
Manawhari	Mahsuri	Malaysia	1972	1,261,915
Shwewar Hnan	IR-20	Philippines	"	1,388
Lone Thwe Shwe War	IR-22	"	"	604
Shwe War Yin	IR-24	"	"	5,909
Shwe War Lay	IR-28	"	1978	9,884
Sin Shwe Thwe	IR-34	"	1979	1,919
Sin Thein Gi	BR 51-91-6	Bangladesh	"	62,593
Manaw Thukha	Mahsuri-M	Malaysia	"	20,180
Sin Thiri	BG 90-2	Sri Lanka	"	39,558
Shwe Thwe Lay	IR 751-592	Philippines	1980	2,931
Palethwe	Pelita 1-1	Indonesia	"	16,639
Yenet-1	BKN 6986-108-3	Thailand	1981	800
Yenet-2	BKN 6986-167	"	1982	500
Sin Kalyar	Kulu	Australia	"	3,000
Yar-1	C 22	Philippines	"	2,000
Yar-2	Kn 96	Indonesia	"	1,500
Yar-3	Kn 117	"	"	1,000
Yar-4	LG 240	Philippines	"	2,500
Yar-5	IR 1529-680-3	"	"	500

Table 4.2 Sown Area and Percentage Increase of HYV Rice

Year	Total Area (ha)	HYV (ha)	Percentage
1967-68	4,934,562	3,434	0.10
1968-69	5,019,062	166,900	3.30
1969-70	4,954,745	134,022	2.70
1970-71	4,975,311	182,967	3.67
1971-72	4,977,659	177,578	3.60
1972-73	4,861,961	192,091	4.00
1973-74	5,089,104	237,522	4.70
1974-75	5,177,112	315,964	6.10
1975-76	5,203,472	432,532	8.30
1976-77	5,077,883	463,415	9.10
1977-78	5,135,701	521,693	10.15
1978-79	5,243,445	822,881	15.69
1979-80	5,026,124	1,342,057	26.70
1980-81	5,126,546	2,210,021	43.10
1981-82	5,103,274	2,314,566	45.35
1982-83	4,882,283	2,501,662	51.23

Table 4.3 Other HYV Rice Varieties Released

Type	Acres Sown 1983-84
Local varieties	
Ngwetoe	136,361
Pho-kaw-gyi	65,206
Shwe-ta-soak	1,322,842
Local crosses	
Sein-ta-lay, C 4-113 * Ye-baw-sein	151,200
Kyaw-ze-ya, IR-5 * Aungzeya	11,833
Mutant varieties	
Shwe-war-tun, IR-5 Mutant	2,266,829
Shwe-thwe-tun, IR-24 Mutant	11,671

demands. Consequently, unmilled wheat and wheat flour have been imported in quantities ranging up to 20,000 tons a year.

From 1960 onwards, the Department of Agriculture encouraged wheat planting. Accordingly the wheat area increased year after year and reached a maximum during the year 1965-66 (165,637 ha). The national average yield has fluctuated considerably from year to year depending on the rainfall. The period from 1962 to 1983 ranged between 381 and 1,334 kg/ha. Monywa White and Mexipak are the two main commercially grown varieties.

In 1967, the bread wheat variety Mexipak was introduced from Mexico and two Indian bread wheat varieties, Kalyan Sona and Sharbati Sonora were introduced from India. In spite of its earliness, Sharbati Sonora acreage has not increased due to its low yield compared to Mexipak and Kalyan Sona. However, some farmers preferred to grow Kalyan Sona but not Mexipak due to

quality preference. The earliness characteristic of Sharbati Sonora is useful in areas when wheat planting is delayed.

Almost all the existing varieties have been introduced from abroad, where they have been bred primarily for irrigated agriculture and for comparatively low winter temperature and longer growing season. Thus, in Sagaing division, where 80 percent of the total wheat is grown and the wheat growing season is short and warm, it was found that these varieties are not quite adaptable to the local conditions.

In the 1979-80 crop season, varietal improvement work on wheat was carried out under the Crop Development Project. Eight commercial and experimental varieties of wheat obtained from India, Pakistan and Philippines together with a large number of exotic germplasm were tested at different localities, both under rainfed and irrigated tracts. Most of the new varieties were found to be better than the existing cultivars. Several of them had outyielded the check varieties at most places and all the new varieties are resistant to leaf rust disease. The new varieties are also suitable for intensive crop rotation since in one of the trials, planting as late as the end of December after rice harvest gives satisfactory performance.

Agronomic studies such as seed rate, fertilizer application, weed control and crop rotation were also initiated.

In 1981-82, the AC extended its various high yield variety programs to take maximum advantage of the prevailing conditions and to minimize the adverse effects of the constraints. A new strategy was devised. The Whole Township Wheat Production Program was assigned to 14 townships, covering about two-thirds of the country's wheat area. The results are shown in Table 4.4. The increase was more than double the national average. Although the experimental yields were comparatively higher, the present national average yield level is about 900 kg/ha. The main

reasons for low yields are scanty residual moisture during the growing season and the inadequate tillage operation resulting in low population densities.

Table 4.4 Whole Township HYV Wheat Producton

Year	Sown (ha)	Harvested (ha)	Yield (kg/ha)	Production (kg)
1979-80	9,081	6,080	1,099	6,684,920
1980-81	59,615	53,919	1,398	75,401,921
1981-82	57,818	52,246	1,512	79,012,760
1982-83	87,675	69,432	1,197	83,126,985

4.1.3 Maize

Among the cereal grain crops, maize possesses a potential for highest yield per unit of time and area. Its numerous diversified uses as human food, animal feed and industrial raw material make it a valuable agricultural commodity.

The productivity constraints are the low yielding varieties, low plant population, delayed thinning of overplanted fields, ineffective weed control and lack of fertilizer use. With these constraints in view, a considerable emphasis in government planning to boost production of maize was carried out in 1978. The crop development program developed under UNDP/FAO assisted project BUR/72/003 includes maize crop.

The following strategy for improvement in maize was carried out by ARI:

(1) Varieties of short to medium maturity for early and late monsoon planting.
(2) Drought tolerant varieties wth better yielding stability for moisture deficit areas.
(3) Varieties suited to winter planting.
(4) Varieties suited for planting in hilly areas.
(5) Short duration varieties with relatively short and sweet grain and prolific habit for green cob harvest.
(6) Developing superior qualities for different optimum soil and moisture conditions.

For the above development programs adequate amounts of germplasm were received from Thailand, the Philippines and IARCs like CIMMYT. These are used as source material for various characteristics. A considerable amount of locally adapted germplasm was also tested for high population tolerance, drought tolerance and early maturity. At present ARI has released six HYVs of maize introduced through IARCs. Table 4.5 shows the original names and local names of the related varieties. Out of the six varieties, Shwe-wa 1 and 2 and Indonesian Early cover 90 percent of the HYV sown area in 1984.

A comparative study of local and HYV maize shows that HYV produced over 2,000 kg/ha whereas the local yield was about 700 kg/ha. The production of HYV maize for the years 1980-84 is presented in Table 4.6.

In many areas the rainfall is inadequate and erratic and is frequently interrupted by long spells of drought which drastically reduce the yield of maize crops. In several of the other areas, continuous heavy rains, particularly in mid- and late-monsoon seasons, result in poor germination and considerable early seedling damage due to flooding, ultimately leading to a poor stand of the crop and reduced yield. Strong winds accompanying heavy rains cause lodging and stalk breakage, predisposing the crop to further damage by rodents. Continuous

Table 4.5 Maize Varieties Received through IARCs and Formally Released in Burma with Local Names

Local Name	Original Name	Country of Origin
Shwe-wa 1	La calera	Mexico
Shwe-wa 2	Petrolina	Mexico
Shwe-wa 3	Tropicana	Mexico
Shwe-wa 4	Indonesian Early	Indonesia
Shwe-wa 7	TL-7322	Mexico
Shwe-wa 8	Population 35	Mexico

Table 4.6 Sown Area, Harvested Area, Yield and Production of HYV Maize

Year	Sown (ha)	Harvested (ha)	Yield (kg/ha)	Production (kg)
1980-81	24,730	23,142	1,473	34,087,763
1981-82	31,133	26,640	2,027	54,009,602
1982-83	38,288	32,840	2,323	76,304,597
1983-84	44,354	40,906	2,307	94,380,807

wet spells sometimes make the post-harvest drying of ears and grains very difficult and deteriorates the quality of grain particularly for seed.

In places where agroeconomic conditions are quite favorable for maize growing and the farmers are industrious, they are willing to adopt any package of technology that would warrant a substantial increase in their yields. However in areas of flutuating weather conditions, maize is usually considered to be a high risk crop when compared with a crop like groundnut, and farmers in these areas are willing to adopt a package of technology only if it will contain HYVs with greater stability of performance and that would ideally fit into their existing cropping patterns.

Thus out of the six HYV maize varieties, medium, medium early, and early varieties are selected to suit the various agro-climatic conditions of the country. The specifications of the selected maize varieties are presented in Table 4.7.

Table 4.7 Maize Varieties for Different Agroclimatic Conditions

Variety	Life Period	Plant Height	Rainfall
Shwe-wa 2	90 - 95	82 inches	40-50 inches
Shwe-wa 8	80 - 85	73 inches	35-40 inches
Shwe-wa 4	70 - 75	57 inches	30-35 inches

Seed multiplication and distribution programs for the above varieties are already underway and it was reported that by 1986-87, most of the area of the country under maize cultivation is intended to be sown with Shwe-wa 2, 8 and 4.

The area under maize has gradually increased from about 89,000 ha in 1964-65 to over 170,000 ha in 1982-83. Production increased from 53,000 t in 1964-65 to 239,000 t in 1982-83, which is partly attributable to an increase in area and partly to HYVs.

4.1.4 Sorghum

The drought tolerance of sorghum makes it suitable for inclusion in the multiple cropping systems, particularly in the semi-arid and arid regions of the country. Besides, sorghum grain has a good export potential. The introduction of HYV sorghum with good eating quality has received increasing attention in the government's agricultural development programs.

Two HYVs, IS 8965 and CS 105 with a maturity period of 125 to 130 days, were selected from materials received from IRRI. These were further tested in 1979 and at the same time their seed was increased. In 1980, improvement work on sorghum was expanded. A germplasm collection of 161 local and exotic varieties of sorghum was evaluated for various characteristics during the monsoon season. Six high yielding exotic varieties of sorghum were distributed to various townships from ARI for extensive on-farm tests and demonstrations. The local and original names of the six distributed varieties are presented in Table 4.8.

The seed increase field of IS 8965 was kept for ratooning after the harvest of plant crop in October 1980. Under conditions of extreme moisture stress the ratooned crop matured in 75 to 80 days and yielded about 540 kg/ha. No fertilizer application or irrigation was provided. This practice is worth

adapting by farmers. It is planned to evaluate the promising varieties for ratooning ability.

During 1980 and 1984, a total of 28 entries were received from IRRI and 254 entries from ICRISAT. These varieties, along with several other promising ones, were planted on a larger scale for performance test and seed increase. Evaluation of new germplasm was also carried out at several localities in the country. As a result of evaluation of new germplasm, three white seed varieties of sorghum (M-90906, M-36248, and M-3635) with significantly better eating quality than the varieties already released, were identified in 1984.

These white varieties were reported to be more favorable for human consumption as well as for cattle feed, since the stalk of sorghum was used for cattle feed by the farmers. A comparative data for the new white varieties and that of the red varieties, with regard to plant height, seed color and yield is presented in Table 4.9.

Although the yield of the white varieties was about the same as that of the HYV red varieties, due to its better eating quality and seed color, higher price could be obtained in the international market. For this reason the cereal crop division of ARI is planning to replace the HYV red varieties of sorghum with the white varieties. In 1985-86 over 600,000 acres of white sorghum are expected to be cultivated.

The average yield of sorghum for the whole country was around 400 kg/ha. The country's sown area and harvested area have remained almost constant at around 180,000 and 160,000 ha respectively, since the early 1960s. In areas where HYVs were cultivated, a yield increase of over 60 percent was obtained. The production and yield of the HYV sown areas in Burma is depicted in Table 4.10.

Table 4.8 Released HYV Sorghum

Local Name	Original Name
Shwe-ni 1	IS - 8965
Shwe-ni 2	IS - 2940
Shwe-ni 3	CS - 99
Shwe-ni 4	UPLB - SG5
Shwe-ni 11	CS - 105
Shwe-ni 14	498003

Table 4.9 Comparison of Existing Red Varieties and New White Varieties of Sorghum

Original Name	Local Name	Height of Plant	Color of Seed	Yield (bsk/ac)
M - 90906	Yezin white 1	7'5"	white	40-45
M - 36248	Yezin white 2	7'5"	white	40-45
M - 36335	Yezin white 3	7'5"	white	40-45
IS - 8965	Shwe-ni 1	7'5"	red brown	40-45
CS - 105	Shwe-ni 11	3'5"	white brown	40-45
498003	Shwe-ni 14	5'5"	grey	40-45

Table 4.10 Sown Area, Harvested Area, Yield and Production of HYV Sorghum

Year	Sown	Harvested	Yield (kg/ha)	Production (kg)
1980-81	15,503	13,921	695	9,672,558
1981-82	15,297	14,355	1,007	14,461,457
1982-83	27,034	12,804	806	10,321,350
1983-84	27,792	22,972	1,050	24,129,882

4.1.5 Groundnut

A survey of groundnut production during the last two decades (1963-83) shows that the area under groundnut cultivation fluctuated from 458,000 to 690,000 ha, whereas the annual production fluctuated between 278,000 and 530,000 t.

A rank-correlation study showed that there was neither a significant upward nor downward trend in groundnut production during the last two decades: production has stagnated around an average quantity of 400,000 t/yr.

The major groundnut production areas are the Magwe, Mandalay and Sagaing divisions which comprise 71 percent of the total groundnut sown area. The region next in importance is the Delta Region, represented by the three divisions of Pegu, Rangoon and Irrawaddy. About 22 percent of the total groundnut area in Burma falls into this region. The rest is sown in the hilly regions of Burma.

Varieties belonging to both the important subspecies, fastigiata (Spanish and Valencia) and hypogaea (Virginia) are grown in Burma. SP 121/070, M-9, M-10 and M-11 are Spanish varieties developed at Magwe. They mature in about 100 days in

monsoon and about 120 days in the post monsoon season. Sinpadaytha-1, an early mutant, was developed from M-10 at ARI, Yezin. It matures almost a week earlier than the parent variety, M-10.

Varieties belonging to the Valencia type, locally known as Big Japan and Small Japan, were introduced from India. Kyaung Gon and M-30/38 represent the Virginia type in Burma. Both are spreading types, taking about 150 days to mature. There is also a local Virginia runner type, having a crop duration of 170 days.

Improvement work on groundnut was started in 1980. A germplasm collection of about 50 varieties from Israel and 8 released varieties from India, was evaluated in small-scale preliminary tests and the following varieties, belonging to the Spanish and Valencia types, were identified as promising: Line 71-78, New Mexico Valencia, Congo Valencia, UF 79-3311, Starr BB, Spanish No. 5, Tamnut, NG 9-268 and JL-24.

The yield of all these varieties is 20 to 40 percent higher than the local checks, M-10 and M-28. Additional germplasm comprising 239 samples was obtained from ICRISAT, and has been planted for evaluation. In the course of tests conducted, 10 exotic varieties, which gave higher yield than the local improved varieties M-10 and M-28, were identified. Out of these varieties it was reported that JL-24, Avir (from Israel) and NG 9-268 (from the Caribbean islands) gave the highest yields. The best local varieties reported in 1981-82 are SP 121/070, M-28 and M-10. The best exotic varieties reported in that period were Avir, NG 9-268 and JL-24.

In the area growing long duration varieties, several exotic varieties obtained from Israel, U.S.A, and India, and Robut 33-1 (which was recommended from ICRISAT as being exceptionally high yielding) were tested. It was reported that although Robut 33-1 has a higher yield potential than JL-24, it needs a relatively

high plant population of more than 200,000 plants/ha to give its highest yield and the drastic fall in yield at lower population densities shows that this variety lacks the ability to compensate for missing plants.

Large demonstration plots are arranged every year at ARI in order to show the agronomic innovations and varietal introductions. The demonstrations include the following concepts in groundnut cultivation:

(1) Summer cultivation of groundnut.
(2) Concept of land shaping by using various bullock-drawn implements.
(3) Dryland agricultural techniques.
(4) Demonstration of mixed cropping of groundnut with sesamum, maize and pigeonpea.
(5) Demonstration of plot of new varieties, Sinpadaytha-1 (M-28), Sinpadaytha-2 (JL-24), and Sinpadaytha-3 (Robut 33-1), etc.

A vigorous varietal screening program is carried out, including a large number of lines from ICRISAT.

4.1.6 Food legumes

Food legumes form an important component of Burmese agriculture. Annually cultivated in an area of nearly 0.7 million ha, they account for 8 percent of the total cropped area. Their importance as a cheap source of protein in the human diet is well recognized and so is the beneficial effect on the fertility of the soil on which they are raised. In the area generally recognized as the central dry zone of Burma, the agricultural landscape is dominated by legume cultivation. Another zone of predominant legume cultivation is the delta area of the Irrawaddy River basin. Besides these major areas, food legumes form a minor component of the agricultural production system in the entire country.

Cultivation of food legumes in Burma is for one or more of the following three purposes: (1) as traditional staple food; (2) as a catch crop i.e., in between two main crops; and (3) as a contingent crop, when other crops fail. The sown area, the harvested area, production and yield of food legumes in 1982-83 is given in Table 4.11.

Table 4.11 Sown Area, Harvested Area, Production and Yield of Food Legumes, 1982-83

Crops	Sown Area (ha)	Harvested Area (ha)	Yield (kg/ha)	Production (ton)
Butter Bean	63,907	42,173	1,135	47,952
Chickpea	161,771	117,573	723	85,193
Soybean	28,955	26,584	756	20,135
Green Gram	42,051	22,635	381	8,644
Pigeonpea	70,523	56,781	476	27,107
Garden Pea	25,857	21,864	762	16,691
Lima Bean	47,746	27,217	512	13,980
Lablab Bean	81,237	69,595	538	37,524
Black Gram	76,445	62,941	757	47,768
Total	598,492	447,363		304,994

Up to 1975, except at the Regional Experimental Stations at Mahlaing and Magwe, the other regional experimental stations did not undertake any major research program on food legumes. The evolution of improved varieties like Mahlaing Flat of white lima bean, and P-11-30 of black gram are the results from these regional stations. The ARI, in the absence of a food legume division, had no organized research program on these crops.

The Food Legume Division at ARI came into being after 1975. In 1978, a strategy for increasing food legume production in Burma was formulated. Given the low genetic productivity of most local varieties of the commonly grown food legumes, including green and black gram, cowpea, pigeonpea, chickpea, lima bean and mung bean, the main research thrust is aimed at improving the germplasm base and conducting a vigorous program of hybridization and selection of yield and disease/pest resistance. Agronomic trials include work on optimal plant population densities for early and late planting. The Rhizobium research program is closely associated with the food legume program and provides, to the extent possible, appropriate cultures for inoculation trials.

Since the establishment of the Food Legume Division, national and international collections of legume germplasm have been initiated. So far 570 accessions of food legume broad based genetic materials have been collected and evaluated. At present ARI is in contact with eight international institutes and the accessions collected up to date are shown in Table 4.12.

Germplasm evaluation and adaptability tests of promising genotypes are the main tasks in the breeding program of ARI. The achievement of crop improvement up to the present date is given in Table 4.13.

4.2 Training

The current total staff of the AC is about 18,000, but only 2,239 hold Agriculture Science degrees. Of these, 15 have a PhD, 40 have a Master's degree and the rest have BS (Agriculture) or BAg degrees. Among the technical support staff, 2,064 have a diploma in agriculture. Thus the core of trained agricultural scientists holding advanced degrees, which are required for agricultural development in Burma, is very small.

Table 4.12 Accessions Collected from International Institutions

Species	Institution	No. of Accessions	Total
Mung Bean	IRRI	17	
	IARI	21	
	AVRDC	27	
	(Indonesia)	1	
	(Thailand)	1	67
Cowpea	IITA	93	
	IRRI	26	
	AVRDC	1	
	USA	5	125
Lima Bean	CIAT	13	
	IITA	8	
	Niftal	6	27
Black Gram	IARI	20	20
Pigeonpea	ICRISAT	96	96
Chickpea	ICRISAT/ICARDA	181	181
Soybean	IRRI	10	
	AVRDC	26	
	INTSOY	18	54

Table 4.13 Crop Improvement Testing Conducted by ARI

Specie	Variety Released	Original Institution	Distinguishing Characteristics
Pigeonpea	HAP-1	ICRISAT	High yielding with early maturity (150 days)
	BR-172	ICRISAT	High yielding with early maturity released for its white seed color
Black Gram	PU-19	IARI	High yielding and photo-insensitive
	P45-1	IARI	High yielding and large seed size
Cowpea	Vita 4	IITA	High yielding and large seed size
	Red Cowpea	IRRI	Released for its red seed color and high yield
Mung Bean	Bhacti	Indonesia	High yielding with early maturity and big seed size. Suitable for both mono- and multiple cropping
	CES-14	IRRI	High yielding and good for multiple cropping

Many internationally aided projects assisting agriculture development recognize this need and utilize about 15 percent of the funds for training components.

UNDP/FAO have been the primary donors to date, assisting ARI to upgrade its scientific capacity at postgraduate level and they are urging acceleration of such fellowship training programs.

The IRRI-Burma Cooperative Project II which is the current program providing training resources for ARI has programmed 24 postgraduate fellowships (16 MSc and 8 PhD level) and 48 persons for short-term training courses.

The Canada-IRRI-Burma Project I, completed in 1982, had a training component for 15 Master's degrees, out of which 12 were for AC and 3 for AMD. Seven trainees from AC and all three from AMD have returned, as well as the 57 persons who attended the short-term training courses, thereby strengthening their respective departments. Five postgraduate students are still under training.

The USAID-supported Maize and Oilseeds Production Project (MOPP) to be completed in 1986 is providing up to 36 advanced degrees (11 PhDs and 25 Master's) for key staff of the AC including ARI and ARD, and 70 short-term trainees. At present 16 trainees are under training for the Master's degree.

A large number of short-term trainees were sent to IRRI to study different subjects related to rice. Altogether, 65 persons participated in training courses held during 1980-84.

From 1980 up to the end of 1984 many AC agricultural scientists had completed their training at different IARCs. These training courses are short-term, lasting from 1 week to 13 months.

Other short-term training courses attended by the national agricultural research scientists at different IARCs from 1980 up to the end of 1984 are listed in Table 4.14.

Over 40 trainees were also sent to different countries to attend conferences, symposiums and workshops on subjects related to agriculture.

It could be noted that short-term training was scheduled throughout the life of the projects at specialized institutions. Since the government views this type of practical short-term training as the most immediate response to its needs, the number of participants has been kept as high as possible within the limitations of available funds.

4.3 Relations between national research centers and CGIAR-supported centers and other organizations

The AC has active cooperation with IRRI, CIMMYT, ICRISAT, CIP, IITA, CIAT and IBPGR. From these international centers, Burma receives genetic materials, training fellowships and opportunities to establish contact with researchers and scientists in other countries for continuous exchange of ideas. Publications from most of these centers were also sent to the national research institutes.

IRRI

Rice constitutes more than half the sown area in Burma, and half of the area under rice is now grown with HYVs. Thus it was found that of all the related IARCs, ARI and ARD are most intensively linked with IRRI in the Philippines. Burma's first improved variety, IR-8, was obtained from IRRI in 1966. Some HYVs introduced into Burma through IRRI include: Mashure, IR-5, C4-63 and BR 51-91-6.

Table 4.14 Short-Term Training Courses Provided by IARCs from 1980 to 1984

Training Course	IARC	Country	Duration	Number of Trainees
Wheat Breeding/Agronomy	CIMMYT	Mexico	13 months	1
Maize Breeding	CIMMYT	Mexico	7 months	1
Rainfed Wheat Production	CIMMYT	Mexico	6 months	1
Maize Crop Training	CIMMYT	Mexico	5 months	1
Rice Wheat Cooperative Study Tour		Bangladesh and Thailand	1.5 months	2
Collection and Conservation of Perennial Crops	IBPGR	Thailand	1 month	1
Meeting of Liaison Officers for the South Asian Regions	IBPGR	Nepal	6 days	1
Fertilizer Management and Logistics	ICRISAT	India	1 month	2
Agricultural Meteorological Observation	ICRISAT	India	5.5 months	2
Sesamum/Agronomy	ICRISAT	India	6 months	1
International Groundnut Workshop	ICRISAT	India	10 days	1
Chickpea Scientist Meeting	ICRISAT	India	10 days	2
Seed Potato Production	CIP	Australia	3 months	1
Third Regional Potato Symposium	CIP	Indonesia	10 days	1
Workshop on Optimizing Potato Productivity in the Farmer's Field	CIP	Philippines	15 days	1

Through the breeding program, the high yielding capabilities of some IRRI varieties have been crossed with native varieties from which high yielding good quality varieties of rice adaptable to various ecological conditions of Burma have been obtained. IRRI also provides valuable assistance in training. The IRRI-Burma Cooperative Research Project was utilized for foreign consultants (25 percent), training (34 percent), equipment (25 percent) and other support.

Under different internationally aided projects, an IRRI rice breeder and an agronomist have been continuously working with ARI for about 10 years.

CIMMYT

Maize is the second most important cereal crop in Burma. The sown area is about 170,000 ha of which 80 percent is matured for grain, with a production of around 200,000 t, while the remaining is picked as green cobs for human consumption. The average yield of maize seed prior to 1979 was only about 700 kg/ha. In 1980, HYVs of maize were introduced from CIMMYT and Indonesia. A 50 percent increase in the national yield was attained. The four varieties of maize now widely cultivated in Burma are: (1) Lacalera, (2) Petrolina, (3) Tropicana, and (4) Indonesian Early.

The first three varieties of maize were received from CIMMYT. HYVs of wheat were also introduced. The introduction of new wheat varieties had increased the average yield from about 700 kg/ha in 1975-76 to 1,100 kg/ha in 1980-81.

ICRISAT

Extensive research experiments are in hand with HYVs of sorghum, pearl millet, chickpeas, pigeonpeas and groundnut materials received from ICRISAT. The HYVs of sorghum IS-8965 and IS-2940 received from this center through IRRI are the most popular varieties with Burmese farmers.

CIP

Up to 1967 the average yield of potatoes was only about 3,000 kg/ha. Steps have been taken to increase the yield by using fertilizer and improved cultural methods together with the germination techniques received from CIP. The average yield was increased to about 10,000 kg/ha and in some areas 12,000 kg/ha was achieved. An exchange of research scientists was also carried out with CIP. Genetic materials for HYVs that were introduced are still in the experimental stage.

IITA

Indigenous varieties of food legumes have very low potential in their economic yield, and their low genetic variability becomes a drawback for hybridization. Thus exotic varieties were introduced for crop improvement. IITA introduced 93 lines of cowpea and 8 lines of lima bean to Burma. An exchange of research scientists was also achieved.

CIAT

Improved seeds for butter bean, fodder legumes and grass seeds were received from this center for the national crop improvement program.

IBPGR

Regular publications on agricultural research are provided.

Up to the present period the major support for agricultural research has been received from UNDP through FAO executed projects. USAID is supporting the MOPP with components on training and research. The World Bank, IAEA, CIDA (Canada), ADB, OPEC, JICA, DANIDA and GTZ also support funds for various projects concerning agricultural research.

5 Research Impact on Agricultural Production

5.1 Important innovations

The Department of Agriculture was established in 1901 with its research, extension and marketing sections. The research section is responsible for the agricultural research activities together with certain training facilities. The first training institute was a diploma school at Mandalay founded in 1924. It had an average annual intake of 20 students. In 1938 the Mandalay College, under the jurisdiction of Rangoon University, offered a bachelor degree in agriculture with an average annual output of 20 graduates. The first central farm was established in 1906 at Hmawbi and by 1929, 18 agricultural farms had been established. These farms, the year of their establishment and their specialization is given in Table 5.1.

During the Second World War, research facilities at the Central Experimental Stations were destroyed. The breeding lines of different crops were also lost, so that the research activities resumed after the war were initial in nature. The research programs were mainly laid down on breeding of crops with a few experiments on crop husbandry practices.

Up to 1956, there was no separate Research Institute with specialized divisions in it. The Chief Research Officer (CRO) was responsible for all the agriculture research activities. The Central Farms and the major and minor seed farms all over the country were under the Agriculture Department. Moreover, the Central Farms were not well equipped and staffed. They were established with the main object that adaptive research could be carried out in a representative area. Experiments for fertilizer recommendation, varietal testing, cultural practices, plant breeding and plant introduction were carried out. Some achievements were the introduction of new varieties of rice, sugarcane, groundnut and cotton bred on these central farms.

In 1965, ARI, with its five disciplinary divisions, was established at Gyogon near Rangoon. However due to lack of skilled personnel and equipment, the research activities being undertaken could not influence the agricultural development plan at that time.

ARI, equipped with professional research workers and laboratory facilities was supposed to develop new technology suitable for various agroecological conditions of the country. In turn, the central farms were intended to try out the adaptability of such technologies for particular regions. However as the ARI and the central farms, in spite of being under one organization, were administered by different heads, coordination was weak. This caused disruption to the intended approach and was in no way complimentary to the agricultural development plan. Similarly, coordination between ARI and IA, which is under the Ministry of Education, was also not well defined. Nevertheless, the need for increasing the number of central research farms and seed multiplication farms was recognized, and at present 20 central research farms and 20 major seed farms have been established all over the country.

In 1966, the Research Policy Direction Board was formed by the Government and the board gave direction for eleven separate professions. Under the board's policy, the agricultural sciences committee adapted long-term and short-term research programs with greater emphasis on the crops that were of economic importance to the country. Meanwhile, the international organizations such as the UNDP, FAO, CIDA and IAEA aided ARI with necessary equipment, experts and training for the national staff in the form of technical assistance. Due to such encouragement, research activities expanded, gradually producing research results applicable to Burmese agriculture.

Table 5.1 Agriculture Farms and Their Specializations

Name	Year Opened	Farm Acreage	Major Crops
Hmawbi	1906	454	Rice
Mandalay	1907	431	Rice
Tatkon	1914	120	Oilcrop, Maize
Mahlaing	1920	251	Cotton
Aunglan	1921	145	Oilcrop, Cotton
Akyab	1923	79	Rice
Sagaing	1924	10	Tobacco
Paukkaung	1925	12.5	Sericulture
Magwe	1925	200	Oilcrop, Pulses
Pyinmana	1925	75	Sugarcane
Padu	1925	105	Wheat
Kyemon	1925	300	Pulses
Pwint byu	1925	160	Rice
Kyauk pyu	1925	85	Rice
Myaungmya	1926	86	Rice
Mudon	1926	206	Rice
Kanbalu	1928	530	Rice, Maize

At present, two main agricultural research institutions exist, the ARI and ARD. Both of these organizations are headed by their own general managers. The ARI is to undertake the basic research problems and ARD to handle applied research work.

There are 13 major divisions in ARI and the ARD consists of 3 major divisions. The facilities of ARD include 20 central farms and 20 seed farms. Both of these institutions are involved in executing some foreign-aided agricultural research projects besides their normal functions.

The research activities now being carried out are crop oriented rather than disciplinary in nature. More attention is being directed to the solution of field problems. The impact has been on the practical aspect of crop production. The research frequently proceeded to the grassroot level and sought out agricultural problems. They also obtained better coordination and cooperation from other divisions such as Extension and Planning. Accordingly, research managed to keep abreast of the national crop development plans and guidelines.

The facilities as well as activities of the agricultural research developed considerably. Moreover, the transfer of technology from research to farmers was smooth because farmers had full confidence and were impressed with research findings. As a result, the agriculture research contribution projected a noticeable impact on crop production.

The new varieties of important crops developed and released by the research institutes are: 29 varieties of rice, 6 varieties of sorghum, 6 varieties of maize, 5 varieties of groundnut, 5 varieties of wheat, 7 varieties of cotton, 6 varieties of jute, 8 varieties of pulses, 2 varieties of sugarcane, 2 varieties of sunflower and 1 variety of sesamum.

The distribution of quality seeds also became more comprehensive. The yearly distribution is given in Table 5.2.

5.2 Adoption of innovations

The transmission mechanism of innovations takes place mainly through the Extension Division of the AC. Under the control of the General Manager, the Extension Division is organized on a state/divisional basis, with offices at township, village tract and village level. Field supervising staff are the Village Extension Managers, who are in charge of a village with 1,200-2,400 ha of cultivated land depending on the locality and state

Table 5.2 Distribution of Quality Seeds of Principal Crops

Crop	Unit	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81
Paddy	bsk	930,670	543,940	191,996	260,722	445,426	659,408	1,669,322
Wheat	bsk	11,177	16,676	636	1,134	1,282	1,531	3,163
Maize Seed	bsk	11,723	3,604	2,291	2,473	5,809	10,928	3,394
Groundnut	bsk	20,081	3,073	1,409	389	683	26,876	133,717
Sunflower	bsk	5,028	3,361	2,419	18,276	22,897	15,508	3,915
Long Staple Cotton	viss	3,431,690	2,641,545	1,826,079	2,288,250	2,184,912	2,570,898	1,093,776
Mahlaing 5/6 Cotton	viss	1,218,480	2,325,195	386,565	389,827	592,875	417,394	1,363,318
Wagyi Cotton	viss	—	—	14,000	10,700	—	1,901	—
Jute	bsk	7,879	4,260	2,835	6,757	6,681	2,443	940
Rubber								
Sapling	ea	—	150,000	124,016	384,400	189,631	80,000	163,000
Budwood	ea	—	2,350	644	743	270	75	—
Sugarcane	ton	88,993	266,656	24,616	17,556	17,004	12,502	10,206
Coffee	plant	23,400	60,000	2,404	4,150	6,324	15,500	109,385

of communication. A village tract manager supervises the work of about 10 village extension managers, each of whom work directly with about 1,000 farmers. It is currently planned to improve upon the ratio of the number of farmers to extension workers to one village extension manager for 500 farmers by 1985. The organizational structure and number of staff in each level of the Extension Division is given in Table 5.3.

The responsibilities of this division are to: disseminate agricultural research findings; implement the annual agricultural plan; distribute essential supplies to farmers and assist in procurement of these inputs; distribute pure seeds in coordination with the central farms; and help to coordinate the agricultural activities with the village council and township councils.

To accomplish these many duties, the General Manager of Extension is assisted by Deputy General Managers; 14 state or divisional managers at the township level; 426 village tract and 4,040 village managers at the village level.

More trained personnel were employed down to the village level, and the services of the extension workers came to be recognized and accepted by the farmers. The role of village manager is most pivotal in transferring the new technologies or executing the agricultural development plans, as they are the link with the grassroot level. The village managers recruited annually were recent graduates from Agriculture High School, Diploma Institutes and the IA. They are young, active and well trained. Moreover, there is full governmental support and leadershp to the extension staff members.

Previously, many agriculture extension strategies had been introduced in Burma for implementing the crop production programs. The approaches, however, were not appropriate for Burmese conditions. Subsequently a strategy that would take

Table 5.3 Organization Chart and Number of Staff in Each Level of Extension Division

General Manager
(Extension)

Dy. General Manager
(2nd in Chief)

Dy. General Manager (Seasonal Crop)	Dy. General Manager (Extension and Education)	Dy. General Manager (Industrial Crop)

State/Divisional Managers	= 14
Dy. State/Divisional Managers	= 7
Asst. State/Divisional Managers	= 14
Dy. Township Managers (Pest Control)	= 14

Township Managers	= 190
Farm Managers	= 9

Dy. Township Managers	= 253
Dy. Farm Managers	= 28

Village Tract Managers	= 426
Village Tract Managers (Farm)	= 33
Village Tract Managers (Pest Control)	= 28

Village Managers	= 4,040
Village Managers (Farm)	= 83
Village Managers (Pest Control)	= 90
Village Managers (Special Projects)	= 200

maximum advantage of Burmese conditions was designed and that strategy was proved suitable. The essence of the strategy was selective concentration. It consisted of five components: (1) a correct and proven technology; (2) political will and political guidance; (3) selectivity and concentration; (4) mass participation; and (5) emulation and competition.

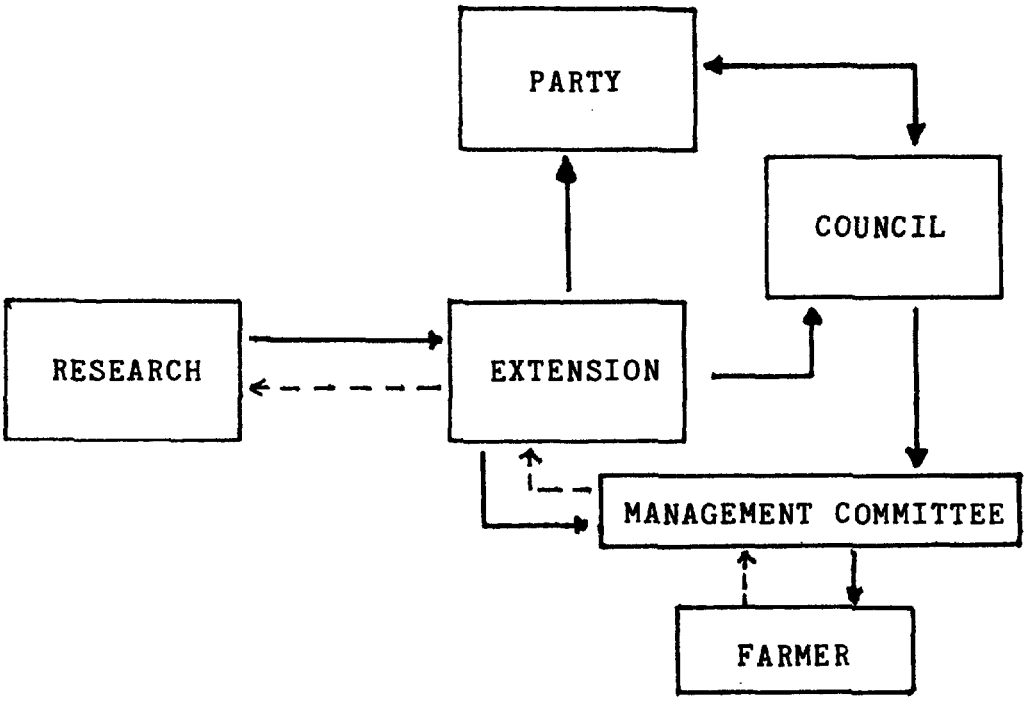
The strategy was put into effect for the program and was found to perform well under Burmese conditions. The national rice production increased to 23 percent without any considerable changes of the sown area. The program was expanded to other crops and the achievements there were also very satisfactory.

The extension staff of the village tracts actually live in the production camps in proximity to the farmers' fields. Thereby they have close contact with the farmers and are in a position to monitor the cultivation process and at the same time pinpoint the impact points of the crop production technology.

To support the extension strategy, the Party, Council and State agencies provided political leadership to all levels of the agricultural extension organization. The four important committees are (1) Agricultural Management Committee, (2) Cultivation Activity Committee, (3) Procurement and Distribution of Input Committee and (4) Disease and Pest Control Committee.

These committees were known as agricultural management committees. In these committees usually people's council members serve as the chairpersons while agriculture extension workers act as secretaries. The strategy has now been established as the "Extension Strategy" and has resulted in healthy collaboration and cooperation among the departments and corporations connected with agriculture. The transfer of technology is shown in Figure 5.1.

Figure 5.1 Technology Flow



Technology ———
Problems - - - -

6 Conclusions and Suggestions

6.1 Agriculture sector

Increasing agricultural output depends upon either increasing the output of existing farms or expansion of cultivated area. Official data indicate that there are 21.1 million acres of cultivable wasteland. However, even without bringing additional land into cultivation, agricultural output can be increased by increased yields of crops and by intensifying land use through minor irrigation development. Burma has vast irrigation potential but irrigated area comprises only about 13 percent of the total area sown to agricultural crops, and it was found that only 12.5 percent of the irrigated area is double cropped.

For paddy, the principal monsoonal crop, improved input distribution and farm incentives could lead to an increase in yield per acre. In addition, improved marketing, including processing, storage and transportation, could further increase the supply of food grains.

In dry season and also for 12 months of the year in the dry zone, scarcity of water is a major constraint to increasing crop production. Development of adequate water supply plus proper water control and management would stimulate production and relatively high yielding crops in areas and seasons where the yields are low and where crops are not grown for much of the year. Burma has the resources to develop minor irrigation facilities for large areas.

There are many causes of a stagnation in yields and production and some are interrelated. These constraints are:

(1) Inadequate economic incentives for farmers to use more purchased inputs,

(2) Difficulties in financing purchased inputs and longer term investments by farmers because of inadequate credit facilities,
(3) Low utilization of irrigation resources which could be used to improve the agroclimatic environment,
(4) Inadequate marketing arrangements, including processing, storage and transportation, so that full potential for food supplies are not obtained from crop inputs,
(5) Shortage of draft power for preparation of land, especially for multiple cropping.

Suggestions

Price Policy. It was noted that procurement prices are very close to their cost of production. Therefore it could be suggested that a statistically acceptable sample survey of cost of production for farms should be stratified to cover the crops which are to be purchased by the government in the following year. The sample should be further stratified for each crop by agroclimatic region and by season of production. The monopoly purchase price should then be set to cover the cost of production as well as to leave some reward for the farmers so as to increase their incentives to participate in the programs.

Credit Facilities. Farmers have limited financial resources and have access to limited institutional credit, including advance purchase by AFPTC. The individual farmer's ability to adopt improved tech-nology and increase yields is limited by these financial con-straints. Medium-term credit for financing on-farm improvements
is scarce. If peasants in the central core are expected to invest in such improvements, it could be suggested that means for providing such credits should be considered.

Irrigation Resources. Between 1962 and 1980, the irrigation department completed 8 major projects with a total irrigable area of 137,000 ha. The department also completed 4 major flood

protection projects providing protection for over 50,000 ha. However, irrigation resources are not well developed. There is a large quantity of minor irrigation resources which could be developed for multiple cropping during the dry season as well as for supplemental use during the monsoon. At present a full benefit which should be available from these projects has not reached its prime. Thus it is recommended that these projects be given the highest priority for completion at the earliest possible time, since development of water resources would accelerate the development of multiple cropping as well as increase yield, thereby increasing production.

Marketing. AFPTC is the main agency responsible for paddy procurement on a national basis. The chief constraints of marketing are: (1) inadequate storage, (2) inefficient processing and (3) in-adequate transportation.

Paddy which is sold to AFPTC during harvesting season is often piled in the open and milled several months later. There are large losses from insects, rodents, spoilage, etc. It is suggested that improvement in storage facilities and milling practices could increase the supply of rice in Burma.

From our study it was found that when paddy is milled it is processed by mills which are quite inefficient. Official statistics show a yield of about 54 percent in 1975-76 and 57 percent in 1974-75. At present the yield has become even lower. A yield of 68 percent should be attainable with rice mills which are in reasonably good shape. The rice mills in Burma are the traditional stone sheller-polisher type that are in poor condition. Product efficiency from these mills is low, especially considering the low level of repair and maintenance. Spare parts are very difficult to obtain and are slow in delivery. However, the mills are not the sole cause of low production efficiency. Handling and conditioning prior to milling also effects milling yields. Modern rice mills would

recover these losses. However, a complete improved approach to a total handling system is recommended to increase the product quality and system efficiency.

Transportation in Burma, particularly land transportation, is poor. Thus it is difficult to transport agricultural produce from the areas of production to the areas of consumption and export. Thus it is suggested that improved transportation should be considered.

Draft Power. Farmers are faced with a significant draft power shortage, especially in those areas where multiple cropping is carried out. Present resources could not supply the draft power needed for large expansion in multiple cropping. It is suggested, therefore, that major expansion of mechanization be considered and preparations should be coordinated with expansion in irrigation and multiple cropping.

6.2 The National Agricultural Research System

The national agricultural research activities in Burma are largely carried out by ARI and ARD under the AC. The activities of these two institutions are overlapping in many important areas. While ARI is to carry out the basic research and ARD to carry out applied research, both divisions are actively engaged in breeding of HYV rice and other important crops.

Suggestions

ARI with its well-equipped laboratories and centralized location should give special attention to kinds of research works that require both laboratory and field facilities. ARD with its 20 central farms and 20 seed farms, has a larger area for field work and thus should concentrate on seed production and distribution.

The research activities of ARI and ARD should be combined as an Agricultural Research Services (ARS). ARS, with its headquarters at Yezin, should be responsible for all agricultural research activities and production of breeders' seed.

The staff at Yezin should continue to use the facilities of the central farms where they are needed.

The major constraint for increased research activities at ARI is the lack of qualified scientists, having only two PhDs and ten MSs among the research scientists. Thus scientific staff at Yezin should be urgently increased to the authorized strength with qualified scientists so that the activities of ARI should continue successfully.

Due to inefficient use of available water supply, multiple cropping could not be carried out effectively. Therefore, a new division for water management should be added to the present five disciplines at ARI.

The present central farms should be strengthened in an attempt to assist in advanced agricultural research resulting in improved production.

Additional staff positions at the regional research centers, particularly in the plant protection areas should be provided.

6.3 Relations with the Institute of Agriculture

The university level teaching IA shares the same campus with ARI. One of the basic ideas of moving ARI from Rangoon and IA from Mandalay to Yezin was to promote close working relations between the two institutions. At present, communications between the University and ARI occur only on an informal basis. There is no formal agreement covering the working norms. The AC and particularly ARI officials participate in curriculum planning at

the IA and the General Manager of ARI is a member of both the academic and administrative bodies of IA. Some ARI personnel give occasional lectures at IA and some IA lecturers and students visit ARI to study the research activities. Nevertheless, the major advantages of the neighboring situations are not exploited. Any direct collaboration, especially requiring the sharing of resources, is often difficult.

Suggestions

Formalization of a working agreement between ARI and IA should be examined at the earliest opportunity.

Direct collaboration and sharing of resources would be of benefit to the junior research workers of ARI with BAg degrees. They could attend the Master's course work at IA as part-time students and work on their research programs for a thesis at ARI.

ARI scientists with postgraduate degrees should be appointed as part-time professors. It could be reported that at present, negotiations are progressing.

6.4 Multilateral and bilateral assistance projects with research components

A number of bilaterally and multilaterally funded aid projects have been established in order to assist agriculture research within the country.

All these organizations first send survey teams to negotiate with the national authorities for utilizing the available funds most effectively in carrying out the projects. A study of many projects shows that around 30 percent of the financial support is utilized for foreign consultancy, while 15 pecent is alloted for training and 45 percent for equipment.

Consultancy Component

Consultants recruited for the projects are of two categories -- long-term and short-term consultants. Many long-term consultants provided valuable assistance in establishing improvement programs. The implementation of the project could be carried out more effectively and efficiently with the help of the consultant. It was also found that biological materials from the IARCs could be obtained more easily.

There have been isolated cases of consultants being badly chosen, and cases of consultants who had difficulties in adapting to national conditions. The qualifications of some of the consultants do not meet the requirements of the national centers, and in some cases consultants of second or third caliber had to be accepted due to a shortage of the required personnel. In such cases it was found that effective efficiency was not obtained. National centers should examine candidates more carefully and select those with relevant overseas experience to avoid this in the future.

The short-term consultants assigned for the projects were unable to give much assistance to the national centers due to the short duration of the assignment. Most of the available time was utilized for studying the national conditions and collecting materials from the national counterparts for writing up a report.

Suggestions

Qualifications and experience of the technical assistance should be weighed carefully.

A description of living and working conditions under which consultants will be required to operate and a delineation of all responsibilities should be included in the request for proposal and contract.

The contribution of funds for consultancy should not be a fixed one and the provision of expert consultancy should be acquired only when needed.

Training

AC as a whole is in urgent need of well-qualified agricultural scientists. To fulfill this deficiency, AC is sending many of its scientific staff for training to different IARCs and universities through internationally aided projects. However, many of these training courses are of a non-degree, short-term nature and could be regarded only as a means of training subject matter specialists for extension. A general shortage of staff, particularly a shortage of adequately trained research staff, is one of the major constraints limiting sustained growth in agricultural productivity.

This needed increase in trained staff is being addressed by the bilateral and multilateral projects and other international donors through various scholarship programs. The training components of all the projects have amounted to about 20 PhDs and 69 MSs.

In Burma, selection examinations are held for postgraduate trainees and the candidates have to fulfill the following requirements: (1) a minimum of 3 years service, (2) minimum post equivalent to village tract manager, (3) minimum qualification Bachelor (can study only for Master's degree) and (4) a scholar for PhD must possess a Master's degree.

Consequently, new employees of the AC who otherwise would be available are not considered eligible. Also, staff who have had foreign training are not eligible for further overseas training until they have served at least 3 years with the AC after such training.

Suggestions

The above rules should be looked into with a view to improvement.

The primary selection examination should be opened to all agricultural graduates under AC, so that some fresh graduates with excellent qualifications will be recruited for further study.

AC should identify candidates for screening and English language testing should be carried out as early as possible.

Equipment

As already stated, 45 percent of the project expenditure is utilized for the purchase of equipment. In our study it was noted that field machinery such as tractors, land levelers, bulldozers, planters, etc. are effectively used. However, some of the expensive highly technical laboratory instruments at the research centers and at AI were purchased without due consideration and some are only sparingly used. Much of the equipment destined for the regional centers was still undelivered. It was also found that some of the laboratory apparatus requires a constant source of regulated voltage electrical input. This is not yet available at Yezin.

Suggestions

Since multiple cropping is developing on a significant scale there will be a need for sharp expansion in draft power for land preparation. Thus expansion of draft power should be carried out.

Future equipment needs should be carefully assessed and if necessary more allocation should be made for training component.

Emphasis should be given to more field equipment, rather than laboratory apparatus in the future.

6.5 Relationships between IARCs and NARS

Burma has been collaborating with the IARCs for over 15 years. Burma's most intensive cooperation with the IARCs of the CGIAR system has been with IRRI, from which the first improved rice variety IR-8 was received in 1966.

At that time the local rice yield per acre was around 30 baskets and IR-8 yielded about three to four times the local yield in some areas. Thus IR-8 was given the local name Yagyaw, meaning over a hundred. But due to its short stature and unacceptable palatability the acceptance by farmers was found to be very slow. Since then, Burma has received many HYVs of rice from IRRI.

Cooperation is increasing with other centers at present, and the next largest programs are probably those with ICRISAT and CIMMYT whose sorghum are regularly sown, and from whence millet and groundnut materials are drawn. Cooperation is also maintained with CIP (potatoes), IITA (food legumes), CIAT (fodder legumes), and IBPGR for regular publications.

The Whole Township Crop Production Special Program which sought to adopt HYVs developed by IARCs and NARS to the national environment and climate is successful and can be compared to the miracle of the Green Revolution experienced in many countries.

<u>Suggestions</u>

The present international relations should be accelerated and collaboration in seed exchange should be facilitated.

Appendix

Persons visited

U Khin Win, Managing Director, AC
U Aung Khin, General Manager, ARI, Yezin
U Hla Shwe, General Manager, Administration Division
U Tin Hlaing, General Manager, Extension Division
U Hla Myint Oo, General Manager, Planning Division
Dr. Myint Thein, General Manager, ARD
U Mya Maung, Project Director, MOPP, Extension
Dr. Tun Saing, Deputy General Manager, ARI, Administration
U Ohn Kyaw, Deputy General Manager, ARI, Rice Division
U Hla Than, Deputy General Manager, ARI, Plant Pathology
U Myat Htwe, Deputy General Manager, ARI, Fiber Crop Division
U Pe Maung Thein, Deputy General Manager, ARI, Food Legume Division
U Tun Hlaing, Deputy General Manager, ARI, Sugar Crop Division
U Saw Win Kyi, Deputy General Manager, ARI, Oilseed Crop Division
U Hla Than, Deputy General Manager, Headquarters, Planning
U Ba Toke, Deputy General Manager, Headquarters, Planning
U Nyi Nyi, Deputy General Manager, Headquarters, Planning
Dr. Kyi Win, Deputy General Manager, Headquarters, Planning
U Aung Thaung, Project Director, Irrigation and Water Management Extension
U Tin Aung, Deputy General Manager, CADTC, Extension
U Sann Myint, Deputy General Manager, Extension
U Hla Shwe, Deputy General Manager, ARD, Research
U Tun Hla, Deputy General Manager, ARD, Administration
U Chit Ngwe, Deputy General Manager, ARD, Seed Technology
U Kyaw Win, Assistant General Manager, Headquarters, Planning
Dr. Thaung Tun Hlaing, Assistant General Manager, Headquarters, Planning
Daw Mya Mya, Assistant General Manager, Mandalay Farm
U Min Aung, Farm Manager, Hmawbi
U Thein Han, Assistant General Manager, ARI, Food Legume Division
U Kyaw Shin, Assistant General Manager, ARI, Agronomy Division

Places visited

Various Divisions at Agriculture Corporation Head Office, Rangoon

Agriculture Research Institute, Yezin

Institute of Agriculture, Yezin

Applied Research Division, Gyogon, Rangoon

Mandalay Central Research Farm

Central Agriculture Development Training Center, Hlegu

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