Agricultural research systems in Egypt with an emphasis on the Agricultural Research Center (ARC)

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Abstract. Egypt has a total land area of one million square kilometres. Only about 4% of the total area of 7.7 million acres (3.2 million ha) is cultivated, resulting in one of the world's lowest per capita levels of agriculturally productive land at 0.05 ha. per capita. Rainfed agriculture in Egypt is performed on 2.3% of this agricultural land. The main constraints of agriculture in Egypt are limited water and land resources together with high population density.

The new advanced technology in Egyptian agricultural development consists of the interaction between three major components: the national agricultural research systems, the international agricultural research centres and advanced research institutions in different countries. These interactions take a variety of forms: bilateral and/or multilateral agreements, contracts, and research networks. A significant national level of research into food and agricultural production is being conducted throughout the nation and financed from various resources. Much of this research work is part of carefully planned and well-co-ordinated efforts led by the ARC and other research centres in Egypt. The ARC is considered to be the most productive research organisation in Egypt with considerable capacity for carrying out excellent adaptive agricultural research that substantially increases productivity. The ARC has established several links with several national research organisations such as RCRE and RRES. These links have promoted coordination between researchers, scientists, extension agents, decision-makers, the private sector and farmers to increase agricultural productivity in Egypt.

Overall Egyptian agricultural strategy and objectives have been focused on the introduction of a wide range of economic reforms, ensuring the most efficient use of water and land resources, alleviation of poverty, food security, reducing unit costs of production and sustainability of the overall agricultural development processes. Egyptian agriculture is currently moving toward a free agriculture system. The programme of economic reform and the liberalisation of the agricultural market have been under way since the late 1980s. As a result, overall agricultural production has been effectively promoted and farmers have safeguarded their decision-making power in management and their economic benefits. The most impressive achievements in productivity have been reflected in the increase of cereal production from 8 million metric tons in 1982 to 18 million metric tons in 1996, and the Egyptian food gap should narrow to only 17% in 2000. There is also still room for further improvement in high yield cultivars.

At present, the ARC consists of 16 research institutes and 7 central laboratories in Cairo. It also includes 4 regional councils for research and extension, 10 regional research, extension, and training stations, and 37 commodity-oriented research, extension, and training stations located all over the country. The ARC policy framework is based on active communication and interaction between three major activities; research, extension and training. The National research efforts in agriculture primarily depend upon governmental funding and use of foreign and donor supporting funds through projects, research grants, and regional networks. In addition, our basic, adaptive and applied research are exclusively directed toward sustainable practices. This will move agricultural research beyond productivity, with more consideration of environmental and social concerns and holistic resource management.

Keywords. Research – Research institution – Agricultural resources – Training – Extension – Egypt

Résumé. L'Egypte a une superficie totale de 1 million de kilomètres carrés. Seuls 4% de cette superficie totale de 7,7 millions d'acres (3,2 millions ha) sont cultivés, ce qui est l'un des plus bas niveaux du monde de terre productive agricole par habitant : 0,05 ha par habitant. L'agriculture pluviale en Egypte se pratique sur 2,3% de cette terre agricole. Les principales contraintes de l'agriculture sont les ressources en eau et la densité de population. La nouvelle technologie avancée concernant le développement rural égyptien résulte de l'interaction entre trois composantes essentielles : le Système National de Recherche Agricole, les centres internationaux de recherche agronomique et les institutions de recherche avancée dans différents pays. Ces interactions prennent de nombreuses formes : accords bilatéraux ou multilatéraux, contrats et réseaux de recherche. Un niveau de recherche national significatif en production alimentaire et en production agricole a été atteint dans le pays, financé par diverses sources. La plupart de ce travail de recherche provient des efforts bien coordonnés et planifiés conduits par le Centre de Recherche Agricole (CRA) et d'autres centres de recherche en Egypte. Le CRA est considéré comme l'organisation de recherche la plus productive du pays, avec une capacité considérable pour réaliser une excellente recherche agronomique adaptative qui accroît substantiellement la productivité. Le CRA a établi des liens avec plusieurs organisations nationales comme les RCRE et REES. Ces liens ont favorisé la coordination entre chercheurs, scientifiques, agents de vulgarisation, décideurs, le secteur privé et les agriculteurs, afin d'accroître la productivité agricole en Egypte.

La stratégie agricole globale de l'Egypte et les objectifs ont été centrés sur l'introduction d'un large éventail de réformes économiques assurant l'utilisation la plus efficace des ressources en eau et en terre, l'allègement de la pauvreté, la sécurité alimentaire, la réduction des coûts de l'unité de production et la durabilité du processus de développement agricole.L'agriculture égyptienne est actuellement en train d'évoluer vers un système d'agriculture libérale. Le programme de réforme économique et la libéralisation du marché agricole ont démarré à la fin des années 1980. Ainsi, la production agricole totale a été effectivement promue et les agriculteurs ont sauvegardé leur pouvoir de décision sur la gestion et leurs bénéfices économiques. Les succès les plus impressionnantes en productivité se sont reflétées dans l'augmentation de la production de céréales : de 8 millions de tonnes en 1982 à 18 millions de tonnes en 1996, et le manque de nourriture se réduira à seulement 17% en l'an 2000 dans le pays. Il y a encore place pour de nouvelles améliorations dans les cultivars à haut rendement. A présent, le CRA comprend 16 instituts de recherche et 7 laboratoires centraux au Caire. Ceci inclut également 4 conseils régionaux pour la recherche et la vulgarisation, 10 stations de recherche, de vulgarisation et de formation et 37 stations d'enseignement, de vulgarisation et de recherche orientés vers les produits situés sur tout le territoire. Le cadre politique du CRA est basé sur une communication active et une interaction entre les 3 principales activités : recherche, vulgarisation et formation. Les efforts de la Recherche Nationale en Agriculture dépendent tout d'abord des fonds gouvernementaux et de l'utilisation de fonds de soutien étrangers à travers des projets, des bourses d'étude et des réseaux régionaux. De plus, notre recherche appliquée, adaptative et de base, est dirigée vers des pratiques durables. Cela fera évoluer la recherche agricole au-delà de la productivité, avec plus de considération pour les questions sociales et environnementales et le management de la ressource holistique.

Mots-clés. Recherche – Institution de recherche – Ressources agricoles – Formation – Vulgarisation – Egypte

I – Egypt and the global Agricultural Research System

Before World War II, there was little co-operation between countries in agricultural research or the generation of technology. Most countries had to work individually to develop the technology that they need. This is no longer true, especially with the absolute increases in population as well as limited arable land and water supplies that add substantially to food demand. Moreover, the concerns about the relationships between resources and environmental changes and sustainable growth in agricultural production have broadened. Yet a number of indicators suggest that health constraints on agricultural development are becoming increasingly important. Thus, the demands placed on agriculture for increasing efficiency and productivity and for reducing the impact on environment along with increasing complexity of farming systems and the need for alleviation of poverty make it imperative to apply more holistic approaches in agricultural research programmes. Today, the international community has established some major components of what can be described as a global agricultural research system. Within these major features, any country can join in research efforts to help to solve important problems.

In countries like Egypt where yields are already high, it seems apparent that the new approaches needed for research could be achieved with much greater difficulty. Accordingly, new advanced technology in Egyptian agricultural development consists of the interaction between three major components: national agricultural research systems, international agricultural research centres (IARC) and advanced research institutions in various countries. These interactions take a variety of forms, including bilateral and/or multilateral agreements, contracts and research networks. Egypt has had linkages with parts of the global research system for several years. These linkages need to be expanded and strengthened in the future, particularly through collaborative research.

Since the period of the green revolution, linkages have been with CIMMYT in both wheat and maize and with IRRI in rice. The new technology linked with the green revolution stimulated Egyptian breeders to make marked efforts to attain high wheat, maize, and rice productivity. Connections were also made with ICRISAT and INTSORMIL in sorghum-millet improvement and with IPGRI in the conservation of genetic resources. The Central Laboratory for Aquaculture energetically collaborates with the Pond Dynamics/Aquaculture. ICLARM recently established a new branch to strengthen the fishing industry under Egyptian conditions. In addition, Egypt is an active member in the Association of Agricultural Research institutions in the Near East and North Africa (AARINENA).

The most impressive regional collaborative research is through the Nile Valley Regional Programme for Winter Cereal and Cool-season Food Legumes including ICARDA, Egypt, Sudan, and Ethiopia. Egypt and ICARDA are also involved in the Red Sea and Nile Valley Network Research Programme in the WANA region. This programme is being financed through the Government of the Netherlands and the EEC and develops adaptive research in wheat rust diseases, wheat heat and drought tolerance, aphid

and virus diseases in wheat and legumes, *Botrytis* and root rot diseases in faba bean and the socio-economics of winter cereals and food legumes. This is in addition to other agricultural research projects funded by the European Commission in Egypt.

Linkages with the IARC have enabled Egypt to have ready access to global germplasm collections of important crops. Thousands of varieties and/or accessions have been introduced and actively screened for adaptation to Egyptian environments and for the identification of desirable characteristics and good yield potential. This approach has helped Egypt to gain greater stability of agricultural production. Moreover, other benefits such as new ideas, concepts, and training accrue from the peer relationships developed between Egypt and its IARC partners.

In addition, Egypt has been so active as a member state of the CGIAR that the CGIAR annual meeting is to be held in Cairo in June 1997. This close co-operation has allowed Egypt to be fully involved and to interact with the international agricultural research body under the auspices of CGIAR.

EMCIP and NARP and their inheritor projects were also very helpful in enabling Egypt to expand linkages with global agricultural research systems through USAID support. Linkages with universities and institutions in the USA are effective and are essential as are those with USDA. In horticultural research, the Egypt-California Project has opened up avenues for the use of tissue culture and micro-propagation techniques. The approaches of this project have generated opportunities for private sector investment. Moreover, the CIP branch in the Delta area of Egypt has been oriented for several years on potato research knowledge and skills and the promotion of the transfer of innovations and targeted training within national and regional structures. Grants for farm mechanisation have been an essential component in the modernisation of Egyptian agriculture.

In addition, a linkage was established with ACSAD that enabled Egypt to play a major role in the studies of arid zones and dryland. Moreover, GTZ has been working with us in rural/agricultural development and the conservation of natural resources. Similarly, IFAD has been actively funding several nation-wide rural agricultural developments in Egypt.

Moreover, the WB and its agent IDA have been active in co-operating and supporting agricultural development, research and activities in Egypt; they established MRMP on the north-west coast of Egypt. This project will help in the conservation natural resources of the area and in rural development as well as enhancing adaptive research. A strong linkage has also been established with FAO in several ways, such as through agro-consulting studies and the proposal of agricultural projects. FAO has also been connected with Egypt within its Near East Network Activities. UNDP has been in co-operation with Egypt for decades, especially in agricultural development activities.

Egypt must find ways and means to continue working relationships and linkages with components of the global agricultural research system. If the country were cut off from the larger community there would be little opportunity for sharing ideas, problems or solutions.

II – Agricultural Research System in Egypt

A significant amount of research into food and agricultural production is being conducted at national level throughout the country and financed from many resources. Much of this research work is part of a carefully planned and well-co-ordinated effort reflecting national goals and needs. The organisation chart of Egyptian research has various components:

- ❏ The Agricultural Research Centre (ARC) is the primary agency responsible for technology generation in the Ministry of Agriculture and Land Reclamation (MALR).
- ❏ The Desert Research Centre (DRC) is also under MALR, with five research stations, and is responsible for conducting research relevant to rainfed areas.
- ❏ The Water Research Centre (WRC) is part of the Ministry of the Public Work and Water Resources (MPWWR) and has 11 institutes and a training centre. It is responsible for conducting research on water resources and irrigation and drainage related to agriculture.

- ❏ The National Academy of Scientific Research and Technology and the National Research Centre (NRC) are also involved in agricultural research through their irrigation, food, and agriculture division. They belong to the Ministry of Scientific Research.
- ❏ The universities under the Ministry of Education.
- ❏ The National Centre for Radioactive Research (Ministry and Electricity and Energy)
- ❏ The private sector, which is increasingly involved in agricultural research, particularly in the area of seed production, tissue culture and micro-propagation and agrochemicals.

However, ARC is deservedly the most productive research organisation in Egypt with a considerable capacity for excellent agricultural research that is greatly enhancing agricultural development and increasing productivity.

1 Human resources in agricultural research

Table 1 provides an information about scientists involved in agricultural research in various centres, universities and the private sector.

Table 1. Current numbers of professional researchers within major Egyptian Agricultural Research Organizations classified by educational background

Agricultural research organizations	Highest Advanced Degree Awarded (individuals) Ph.D.	M.Sc.	B.Sc.	Total
ARC	2,450	1,375	900	4,725
DRC	155	75	31	261
WRC	155	25	60	240
NRC	464	246	115	825
Fisheries	113	63	185	361
Agr. Colleges (14)	3,045	548	415	4,008
Vet. Colleges (8)	781	192	117	1,090
Private sector	74	27	19	120
Total	**7,237**	**2,641**	**1,842**	**11,720**

Source: MALR, ARC, Information & Documentation Center, Manpower Study for Agricultural Research, 1994.

2. Linkage pathways between ARC and other National Agricultural Research Institutions

The interaction between the ARC and the other national research organisations is through several major components:

- ❏ Regional Councils for Research and Extension (RCRE).
- ❏ Regional Research and Extension Stations (RRES).
- ❏ Different national campaigns.
- ❏ Commodities committees and councils.
- ❏ Graduate students, especially with the universities.
- ❏ Local grants and projects.

In this context, RCRE reflects the best linkages. Four regional councils were established by H. E. the Minister of Agriculture's decree aimed at promoting coordination between researchers, scientists, extension agents, decision-makers, the private sector and farmers to increase agricultural productivity in Egypt.

A. The Regional Councils for Research and Extension

The Ministerial decree established four Regional Research and Extension Councils for the following regions:

- ❏ Delta.

❏ East Delta and the Sinai.
❏ West Delta and the North-west Coast .
❏ Middle and Upper Egypt.

B. The objectives of the Regional Councils

❏ Discussion of agricultural problems of the region and suggestion of solutions.
❏ Discussion of research and extension programmes.
❏ Approval research and extension programmes.
❏ Coordination of the programmes of different research centres and universities.
❏ Proposal of means to support research and extension programmes.
❏ Follow-up and evaluation of research and extension programmes.

C. Membership of these councils

❏ Director General of ARC.
❏ Deputy Directors of ARC.
❏ Dean of College of Agriculture.
❏ Head of the Central Administration for Research Stations.
❏ Regional Director of Research and Extension Stations.
❏ Heads of Agriculture Sectors.
❏ Three Directors for Specialised Research and Extension Stations.
❏ Head of the Board of Directors of the Principal Bank for Development and Credit.
❏ Seed Production Director for the Principal Governorate.
❏ Two Extension Directors from the Governorate of the region.
❏ Veterinary Affairs Director for the Principal Governorate.
❏ Irrigation and Drainage Director for the Principal Governorate.
❏ Representatives of the other National Research Centres (DRC, WRC, NRC, etc.).

III – Agriculture and resource bases

Egypt has a total area of about one million square kilometres or 238 million acres (99.2 million hectares), of which only a small portion (about 3.5%) is agriculturally productive. The agricultural land base of Egypt totals about 7.7 million acres (3.2 million hectares) in three different zones. About 0.2 million acres (0.1 million hectares) consists of rainfed areas or oases. Of the total Nile Basin and Delta area, about 5.6 million acres (2.4 million hectares) is old land and the remaining 1.9 million acres (0.8 million hectares) new reclaimed land.

Agriculture in Egypt is almost entirely dependent on irrigation; the country has no effective rain except in a narrow strip along the northern coastal areas and the Sinai. Egypt has only one main source of water, the Nile. The availability of the reliable water supply from the Aswan High Dam is governed by the existing water-sharing agreement under which 55.5 billion m3 is allocated to Egypt. Most of Egypt's water uses are in the agricultural sector (84%) and the rest is for industry (8%), municipalities (5%), and navigation (3%). Meanwhile, about 4 billion m3/year of agricultural drainage water is officially reused for irrigation. Fresh water resources total some 980 m3 per person per year in 1996 and the figure is expected to drop to about 630 m3 per person per year by the year 2025. With the expected increase in population, the demand for water by various sectors will continue to increase in the next decade and beyond. This implies that the agricultural sector will have to adjust to a smaller lower percentage of available water than previously.

At present the total population of Egypt is estimated to be about 60 million of which about 55% is rural. Average annual population growth is estimated to be 2.2%. The labour force in agriculture has declined from 46% in 1973 to 33% in 1993. In contrast, employment is increasing in agricultural commodity processing.

IV – Objectives and strategy

Egyptian agricultural strategy is formulated in the context of the new economic environment resulting from the introduction of a wide range of economic reforms. The research priorities are articulated to ensure the most efficient use of water and land resources in an environmentally sustainable manner. The basic theme is to move forward in a context of equity taking into account issues of poverty alleviation, reducing the unit costs of production, and sustainability of the overall agricultural development processes. The targeted growth of agriculture is projected at an average of around 3.4% per annum for 1990s. This would make it possible to meet national GDP growth targets of 4 to 5% by 2000. The underlying focus of the strategy has been built on the momentum already created by the comprehensive economic reform programme adopted by the Government. This would need to be complemented by a strong national research programme aimed at enabling Egypt to become self-reliant in agricultural production, assure food security and achieve economic growth for the Egyptian people.

This is being accomplished through the major objectives of ARC by improving the technology and services available to Egyptian agriculture through research, extension and training by performing the following tasks:

1. Planning, co-ordinating, promoting, and reviewing agricultural research and policy.
2. Using the results of research.
3. Identifying problems and developing co-ordinated research programmes.
4. Developing and releasing high-yielding varieties and hybrids of superior quality.
5. Maintaining high quality basic and foundation seed for recommended varieties.
6. Planning and developing extension and technology transfer programmes.
7. Providing national training programmes for extension officers and other agricultural staff in addition to regional training programmes for neighbouring African and Asian candidates in co-operation with the Egyptian International Centre for Agriculture (EICA).
8. Managing agricultural research stations.
9. Disseminating new technologies and agricultural information.
10. Fostering appropriate collaborative networks at national and international levels.

V – Policy trends and achievements

Egyptian agriculture is currently moving towards a free agriculture system rather than the controlled agriculture of the recent past. The 1960s and 1970s were characterised by heavy government intervention in agriculture. Output prices were controlled, inputs were subsidised, there were fixed-price quota deliveries of the major food commodities, wheat, maize and broad beans were compulsory and land rent was controlled. Cropping patterns were influenced by area allotments required for the major crops like cotton, sugar cane, rice, and wheat. These policies affected output and input marketing, distribution and credit systems. Farmers' decisions were heavily influenced by this controlled system.

In contrast, the policy of the economic reform programme and agricultural market liberalisation have been adopted since the late 1980s. Output markets were liberalised and quota deliveries were eliminated. In addition, floor prices were introduced, subsidies on inputs were gradually cut and crop area allotments were eliminated for most crops. These systems have effectively promoted total agricultural production and safeguarded the farmers' own decision-making power in management and their economic benefits.

Research and extension activities have also been intensified. The development and introduction of high yielding varieties and improved cultural practices have increased productivity of the major food crops as well as animal production (Table 2).

Egypt has been praised for increasing agricultural production during the last decade to a degree larger than that in the previous 50 years of agricultural development. Significant improvements have been made in a broad spectrum of crop productivity (Table 3). Moreover, animal production has also contributed to narrowing the food gap in Egypt.

Table 2. Agricultural development in Egypt (1982-1995)

Object	1982	1995
Total cultivated area	5.8 million acre	7.7 million acre
Reclaimed land	0.8 million acre	1,9 million acre
Cereal production	8 million tons	17 million tons
Wheat self sufficiency	25%	55%
Fruits	2.2 million tons	5.2 million tons
Vegetables	8 million tons	12 million tons
Sugar cane	35 t/acre	45 t/acre
Sugar beet	13 t/acre	20 t/acre
Sugar self sufficiency	55.3 %	70 %
Fish	0.2 million tons	0.4 million tons
Value of animal production	$ 0.590 billion	$ 2.5 billion
Growth of agricultural development	2.6 %	3.5 %

Table 3. Annual yield gains in Egyptian crops from 1979-81 to 1990-92

Crops	Annual yiel gain kg/acre/yr.	Crops	Annual yield gain kg/acre/yr.
Wheat	72	Carrots	100
Rice	67	Cucumbers	57
Maize	83	Onoins, dry	561
Sorghum	47	Peas, green	106
Lentils	32	Tomato	412
Artichokes	236	Grapes	111
Beans, green	65	Sugar beet	685
Cabbage	147	Sugar cane	633

To understand how Egyptian agricultural development has been transformed, it is necessary not only to compare the past and present situations but to investigate the technological accomplishments that brought about the change. These significant advances can be attributed to four major factors:

1. Successful implementation of the modern agricultural policy reforms.
2. Effective research programmes to solve agricultural and natural resource problems.
3. A significant link between research, technology transfer, and extension activities.
4. Experienced and responsible farmers.

Perhaps the greatest impact of ARC and the achievements of the research system is best reflected in the fact that field and horticulture crop production has increased more in Egypt since the mid-1980s than in the whole of the previous history of the country.

The total production of wheat, maize, rice, sorghum, and barley has substantially increased by some 62, 44, 36, 41 and 67%, respectively. These tremendous efforts cut wheat imports from 7.2 million tons in 1987 to 6.6 million tons in 1990 and to 5.7 million tons in 1995 (Food Crops and Shortages, FAO, March/April 1996). However, national wheat consumption has increased to about 11.5 million tons mainly due to the rapid increase in population. The population has increased by about 15 million during the past decade.

Total annual maize production increased from 3.2 million tons in 1980 to 5.2 million tons in 1995. Imports of maize grain are expected to decrease by about 360,000 tons to 2.0 million tons. The tremendous jump in total rice grain output has increased the per capita share of rice to approximately 40 kg and has made it possible to export about one million tons annually. However, government policy aims at reducing the area under rice to about 0.9 million acres (375,000 hectares) to balance irrigation water requirements. In this strategy, increasing productivity per unit area would become an essential task for keeping pace with rice self-sufficiency and export advantages. Although sorghum production continues to be hampered in Egypt, the future plan tends to replace the tall local cultivars by short cultivars and hybrids to cover about 50,000 hectares by year 2001. This is expected to raise productivity from 5.0 t/ha to 7.0 t/ha.

Cotton is one of the most important cash crops and yield productivity has increased to reach a record of 7.3 quintals/acre (1.3 t/acre) in 1995. Current cotton varieties mature almost two months earlier than those grown in the 1920s and 1930s. The earlier the variety matures, the better it escapes boll worm damage. Early maturation also enables greater use of the land for the preceding and subsequent crops and especially food crops. The high yielding ability of the modern cotton varieties grown today have reduced the cultivated area in 1950s from 2.0 million acres (0.84 million hectares) to about 0.7 million acres (0.3 million hectares) in the 1990s without any loss in total cotton production.

Absolute increases in Egyptian population as well as limited water supplies add difficulties to sugarcane production. However, the areas under sugarcane have been dwindling and national output has increased from 35 t/acre in 1982 to 45 t/acre in 1995. Moreover, sugar beet yield has increased dramatically since 1980 from 13 t/acre to 20 t/acre in 1995. The new improved sugarcane varieties as well as the modern sugar beet varieties released by SCRI have substantially increased sugar self sufficiency to 70%.

The same yield increase trend can be seen in fruit tree and vegetable crops. Tree fruit production has almost doubled in the last decade. Production increased from 2.2 million tons in 1982 to 5.2 million tons in 1995. For example, citrus, representing about 39% of the total fruit acreage, has produced about 2.5 million tons (51% of the total production). In 1992, citrus exports amounted to 256,000 tons. The national objective is to exceed 500,000 tons by the year 2000.

On the other hand, the vegetable crop has also increased from 8 million tons in 1982 to 12 million tons in 1995. With increasing competition between crops for limited land, vegetables are the most expensive crops to grow; however, they are comparatively profitable. High yielding tomato varieties and hybrids and appropriate packages of agronomic practices were introduced by the ARC. This has resulted in a doubling of the average yield per acre, which has reached 16 tons for improved varieties and more than 40 tons for hybrids. Total production of potato has also increased to about 1.5 million tons. Potato is a major cash crop and second only to cotton as an export crop. Exports to European and Arab countries increased from about 250,000 tons in 1992 to 430,000 tons in 1995.

The impact of livestock research has mainly been in improving the milk and meat production of buffalo and cattle, increasing the ovulation rate of the local sheep breed and improving the twinning rate and milk production of sheep and goats. In poultry, research has developed new strains of local chickens which produce more meat and eggs. These breeds have been distributed to farmers. Fish production has doubled during the last two decades. This increase is attributed to research and development in fish farming.

The impact of post-harvest research was recognised in the improved quality of processed food and the use of food by-products and waste for feed and other purposes.

Egypt has basically made impressive steps toward solving the problem of food supply and there are many favourable objective factors helping to maintain such achievements. In the course of future development, natural agricultural resources, production conditions, technical levels and advanced agricultural infrastructure ensure great potential in this respect.

There is potential for increasing the yield per unit area on the existing cultivated land. There is also potential for exploring untouched arable land resources. Moreover, there is scope for scientific and technological improvement.

1 The food gap

Egypt is facing many challenges due to the increasing population density in which the annual birth growth rate has reached 2.1%, in addition to the shortage of arable land. It is anticipated that the population of Egypt may increase by the end of this century to about 70 million. To what extent and for how long can Egypt continue to produce the food necessary for this rapidly increasing population?. This is the challenge that has been facing us as Egyptians and as ARC researchers.

Dr. York's mission to Egypt in the early 1980s estimated the potential food gap to be 26.0 million metric tons by 2000. However, the same mission headed by Dr. York returned to Egypt in the early 1990s to

evaluate the food gap situation ten years after the first estimation. Fortunately, they reported that the food gap in Egypt is narrowing. Projections to the year 2000 now show a potential food gap that is only 17% (4.5 million metric tons) of the food gap projected in the early 1980s (26 million metric tons). This is shown very clearly in figure below.

National cereal crop production (e.g. wheat, rice, maize, sorghum, barley, etc.) reached 18 million tons in 1996 due to several factors. The major factor was the newly released cereal cultivars developed, maintained and released by the Field Crop Research Institute. The substantial increases in cereal yield production would result in narrowing the Egyptian food gap to about 17% by the year 2000.

Figure 1. Domestic food production and utilisation (1960-1980, with extrapolations to 2000)

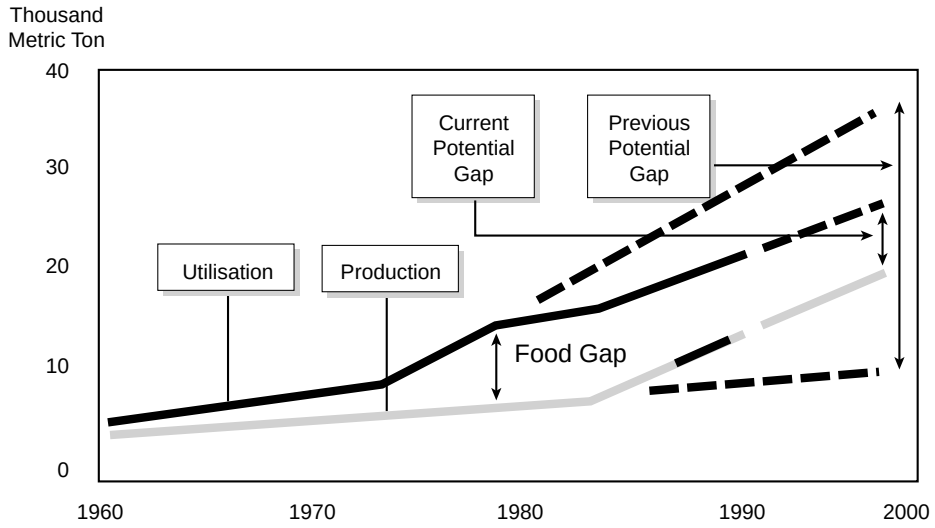
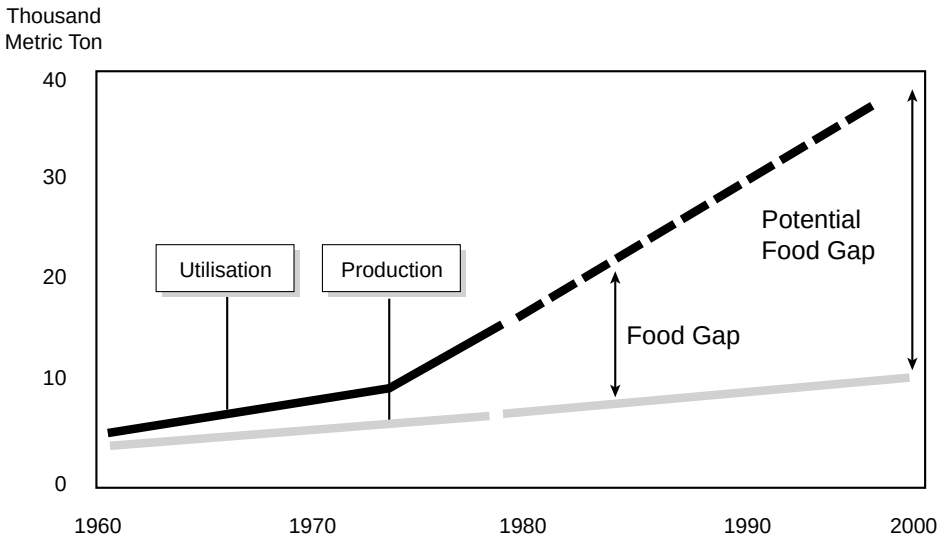


Figure 2. Domestic food production and utilisation (1960-1990, with extrapolations to 2000)



VI – Organisation of ARC

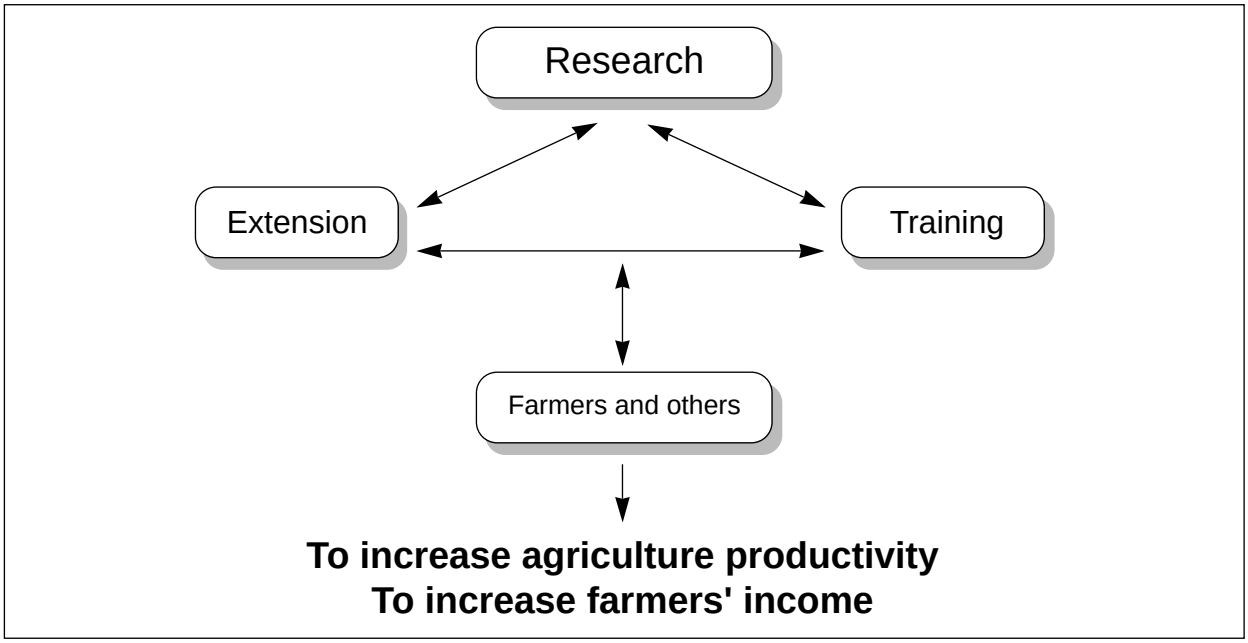
At present, the ARC consists of 16 research institutes and 7 central laboratories located at Cairo. The ARC includes also 4 regional councils for research and extension, 10 regional research and extension stations, and 37 commodity -oriented research and extension stations located throughout Egypt. Nineteen of these stations are bound for field crop commodities as well as their related supported disciplines. Six horticultural and 12 animal research stations are also in service. Moreover, there are 21 agricultural experimental units scattered throughout the different governorates for on-farm research verifica-

tion in farmers fields. The agricultural research stations control about 3,500 acres (1,470 hectares) for field experiments as well as 23,000 acres (9,660 hectares) devoted to foundation seed production.

VII – ARC activities

The policy framework of ARC is based on active communication between three major components; research, extension, and training (Figure 3).

Figure 3. Arc activities



1 Research activities

The ARC framework for achieving the technological advance required for agricultural development in Egypt is governed by 18 national programmes consisting of more than 50 sub-programmes:

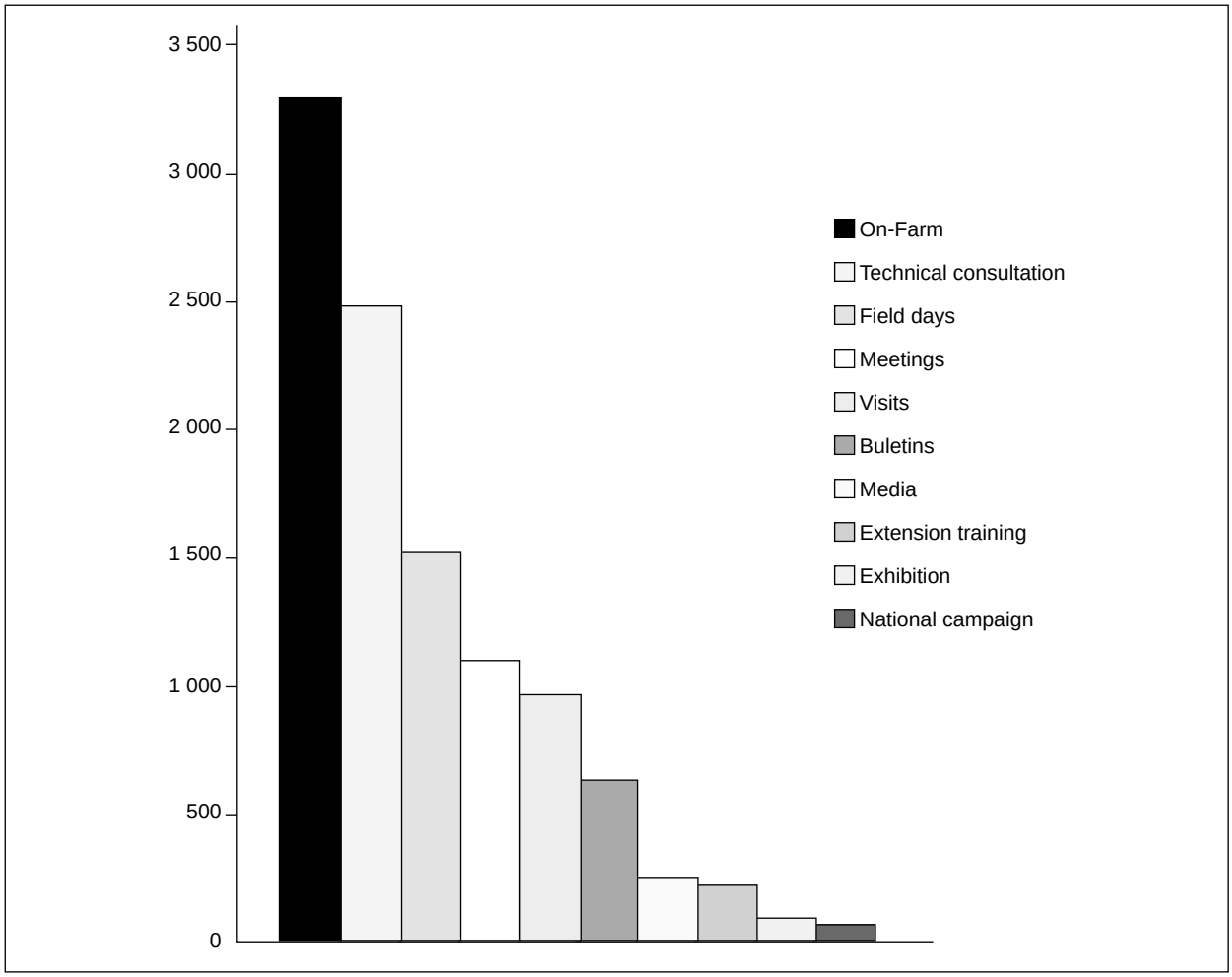
1. Fibre Crops
2. Cereal Crops
3. Oil Crops
4. Legumes
5. Forage
6. Sugar Crops
7. Fruit
8. Vegetables and Ornamentals
9. Animal and Poultry Production and Health
10. Soil and Water
11. Agricultural Mechanisation
12. Plant Protection
13. Food and Feed Technology
14. Socioeconomic and Statistical Research
15. Expert Systems
16. Extension and Rural Development
17. Genetic Engineering
18. Aquaculture

2 Extension activities

The main objectives involve the development of agricultural extension programmes that are timely and meet the needs of a growing Egypt in a changing global environment. A major focus of the extension programmes deals with decentralising planning and implementation of extension programmes for rural development of field crops, horticulture and the production of animals, poultry and fish in order to make local programmes more accessible and meaningful to farmers. Another aspect of extension programmes is the recognition and quantification of the social changes that occur in rural areas as a result of development of the agricultural sector.

An effective technology transfer programme is based on good communication among researchers, extension agents and farmers. To accomplish this goal, several extension teaching methods have been used by researchers and extension workers to accelerate the transfer of new agricultural technologies to farmers (Figure 4).

Figure 4. Extension activities in Egypt throughout the 1992-97 Five-year Plan



3 Training activities

Training has played an effective role in strengthening agricultural technology in Egypt during the past decade

Active in-country training programmes of both research and support staff within ARC as well as others outside ARC have gained top priority (Table 4). Out-of-country training can take the form of graduate studies, post graduate studies and short training courses.

Table 4. The number of local and out of ARC training courses and number of trainees in 1990-1997

	No. of training courses		No. of trainees	
Yaear	ARC	Others	ARC	Others
90/1991	14	50	498	317
91/1992	19	52	433	422
92/1993	45	51	1092	240
93/1994	105	95	1800	269
94/1995	258	85	5119	331
95/1996	201	118	4107	243
96/1997	248	63	5401	274

4 Funding of research-related activities

National research efforts in agriculture are primarily dependent on funding by the Government of Egypt. This funding totals about $80 million annually for salaries, research inputs, equipment and infrastructure. There is little insurance that this fund will be adequate for maintaining a vigorous research programme, particularly if USAID support is greatly reduced. However, there are possible approaches through which funds could be generated to complement Government funding:

- ❏ Check-off programme with agricultural inputs and farm commodities.
- ❏ Role of the private sector in agricultural research.
- ❏ Possible use of foreign and donors supporting funds through projects, research grants, and regional networks.

VII – Future challenges

Research programmes should be started today to address the issue of what is often termed holistic resource management. In fact, technology is now reaching the point where it is a tool and not a research topic. However, we must direct our basic, adaptive and applied research exclusively to sustainable practices. This would move agricultural research beyond productivity with more consideration of environmental and social concerns. The future concepts that should be incorporated include:

- ❏ Research activities to improve crop production under newly environments.
- ❏ Development of varieties more tolerant to environmental stresses.
- ❏ Maximising yield per unit of land and water.
- ❏ Fertiliser and pesticide use would be efficient and non-polluting.
- ❏ Crop-livestock operations maintaining soil organic matter, improving soil structure and field capacity and increasing forage production.
- ❏ Emphasis on research dealing with food animals.
- ❏ Integrated pest management (IPM) which reduces the need for pesticides through crop rotation, weather monitoring, use of resistant cultivars and biological control.
- ❏ Improved management systems that improve plant health and increase water use efficiency.
- ❏ Concerns about nutritional deficiency as a source of poor health.
- ❏ Improvement of extension and technology transfer.
- ❏ Development of an “Expert Systems” programme to be used by both extension agents and the private sector in technology transfer.
- ❏ Research to address long-term strategic issues.
- ❏ Remote sensing technology to guide site-specific farming agricultural practices as well as to support better management strategies of national natural resources.
- ❏ Application of genetic engineering to the traditional discipline of plant breeding with a better understanding of the elements controlling gene expression.
- ❏ Nitrogen fixation by bacteria in symbiotic or free-living association may become a major contributor to crop yields.
- ❏ Insight in the role of socio-economic entrepreneurs in Egyptian agriculture and motivation of the role of women in agriculture, home economics and community activities.
- ❏ Developing appropriate mechanisation technology for both large and small scale farming systems.
- ❏ Promote research on post-harvest losses from grower to retailer and their economic implications.
- ❏ Analysis the efficiency of the price policy for future agricultural strategies with more emphasis on domestic and foreign marketing.
- ❏ Market research and development.
- ❏ Enhance the economic value of food industries and their products.
- ❏ Increase research collaboration both internationally and domestically.

Acronym

AARINENA
Association of Agricultural Research Institutions in the Near East and North Africa

ACSAD
Arab Center for Studies of the Arid Zones and Dry Land (Syria)

ARC
Agricultural Research Center (Egypt)

CGIAR
Consultative Group on International Agricultural Research (USA)

CIMMYT
International Maize and Wheat Improvement Center (Mexico)

CIP
International Potato Center

CRSP
The Pond Dynamics/Aquaculture

DRC
Desert Research Center (Egypt)

EEC
European Economic Community

EICA
Egyptian International Center for Agriculture (Egypt)

EMCIP
Egyptian Major Cereals Improvement Project (Egypt)

FAO
The Food and Agricultural Organization (United Nations)

GDP
Growth Domestic Production

GTZ
German Agency for Technical Cooperation (Germany)

IARC
The International Agricultural Research Centers

ICARDA
The International Center of Agricultural Research in the Dry Areas (Syria)

ICLARM
International Center for Living Aquatic Resources Management

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics (India)

IDA
International Development Association (World Bank)

IFAD
International Fund for Agricultural Development (Italy)

INTSORMIL
International Sorghum and Millet

IPGRI
International Plant Genetic Resource Institute (Italy)

IRRI
International Rice Research Institute (Philippines)

MALR
Ministry of Agriculture and Land Reclamation (Egypt)

MPWWR
Ministry of the Public Work and Water Resources (Egypt)

MRMP
Matrouh Resource Management Project

NARP
National Agricultural Research Project (Egypt)

NARS
National Agricultural Research System(s)

NRC
National Research Center (Egypt)

RCRE
Regional Councils for Research and Extension (Egypt)

RRES
Regional Research and Extension Stations (Egypt)

UNDP
United Nations Development Program (United Nations)

USAID
United States Agency for International Development (USA)

USDA
United States Department of Agriculture (USA)

WANA
West Asia and North Africa

WB
World Bank

WRC
Water Research Center (Egypt)