

Change comes again to the fertile crescent

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Photos: A. Dorozynski

Traditional farming near Aleppo: methods have changed very little over the centuries — until now.

The fertile crescent is that region, shaped like the moon in its first quarter, that curves from the Nile to the Tigris, encompassing the ancient lands of Palestine, Phoenicia, Babylonia, and Assyria, encroaching on Egypt to the south, the Taurus mountains of Anatolia and the Zagros in Persia to the north, and reaching east to the Persian gulf where flowered one of the most ancient known civilizations, that of Sumer.

It was in the fertile crescent at the end of the last ice age some 10,000 years ago, that agriculture came to being and transformed man's life from that of a roving nomad to settled villager.

Plants that are the ancestors of many of our major crops appeared there. Wild wheat, then one of the many wild grasses in the region, gave rise after countless haphazard crossings to fertile hybrids such as Emmer wheat, then to crosses of Emmer with other grasses, and eventually to a true "bread wheat" with a full head of seed. Wild lentils, beans and other legumes, first gathered by men, became domesticated. Fruit trees were planted close to human settlements.

It was there also that man wrought the tools of a new technology that is still basic to agriculture in much of the world today: the first flint sickle, set in a horn or a piece of bone, the olive mortar and the wine press, the baker's oven, then the plow, "lever to feed the earth", the wheel, and the pulley to draw water.

The names of the ancient cities in the fertile crescent ring out the beginning of the known history of mankind: Memphis, Jericho, Babylon, Suza, Assur, Nineveh and many others, where not only agriculture, but pottery and music, graphic arts and writing, were born, and geometry came to regulate land ownership, and arithmetic, perhaps to calculate taxation.

One of the most ancient, continuously inhabited cities of this region is Aleppo, already known by this name before it was conquered by the Hittites, before Assyria burst from Mesopotamia, the region between the Tigris and the Euphrates, to become one of the greatest empires in mankind's history, boasting a list of 116 successive kings who sat on Assur's throne.

Aleppo today is a lively commercial and manufacturing city, and it has become this year the symbolic centre of yet another major event taking place in the region: the transition from traditional agriculture which for thousands of years had fed a human population of a few million, to modern agriculture that must, today and in the years to come, feed hundreds of millions.

New people have come to Aleppo, long a crossroads for caravans between the Mediterranean and Mesopotamia. They have come from many parts of the world — or is it, one may wonder, from other planets? They are called the "wheat and barley people", "pulse people", a "weed man" and an "insect man", the "rotation people", and a "medic man" (who, incidentally, has nothing to do with medicine).

The newcomers are members of the newly established International Centre for Agricultural Research in the Dry Areas (ICARDA), whose responsibility extends far beyond the ancient fertile crescent, to a region stretching from Pakistan to the east and Morocco to the west, a region that contains today some 20 countries, inhabited by more than 250 million people.

ICARDA's mission is to augment the agricultural productivity of some 100 million square kilometres of arable land, most of it characterized by limited annual rainfall (300 to 800 mm) concen-

trated mainly during the winter months, by dry, hot summers, and by low agricultural productivity in the face of an increasing population.

Agricultural productivity must increase rapidly, as in many parts of this region food shortages are becoming a problem and there is increasing reliance on imports at the cost of hard-earned foreign currency. The situation threatens to worsen as the population keeps growing at such a rate that it is expected to double in 40 years or so.

What can be done, that can be done within a relatively short time span? Many things, but they require the concerted, intensive effort of members of a team whose business is agricultural research.

Consider an ancient custom, stemming no doubt from the observation that the land is not rich enough, and that it does not receive enough rain, for it to support a crop of cereal, such as wheat or barley, year after year. This has led to the fallow system, whereby cereals are grown one year, nothing is planted the following year, then cereals again and so on. It is as if half of the land were permanently abandoned. Although precise figures are difficult to come by, one of ICARDA's researchers, B.H. Somaroo, a Canadian, who explores the possibility of introducing crop rotation into the farming system, estimates that as much as 40 million hectares of land could be fallowed in one year in the region!

Legumes are a prime candidate for such a rotation system because they enrich the soil. Ancient Greek and Roman authors referred to the benefits to the soil that result from growing legumes, and we now know that this benefit is provided in the form of nitrogen fixed by bacteria living in nodules on a legume's root, and thus made available to the plant.

Establishing such a rotation system may appear to be simple enough: plant wheat this year, forage legume the next, and feed your sheep on these legumes. But it is not as simple as that. Legumes must be selected to suit the soil, to resist local insects, to be beneficial to the following year's cereal crop, and not to draw too much moisture from the soil, lest it be left parched for next year's all-important wheat crop. Farm size, agricultural practices, interest (or lack of it) in livestock, economic and social constraints, also come into the picture.

One particularly promising approach is explored by the "medic man", John Doolette, an Australian scientist who has had a long acquaintance with a small bush-like plant with yellow flowers, the medic (or *Medicago*). The medic, that can be seen growing freely on roadsides around the Mediterranean, has an interesting past. A century or so ago, some medic seeds were accidentally carried aboard ships sailing from Europe or Africa to Australia, and medic started growing there, particularly in the south, where conditions are similar to those in its native land.

Legume research is part of the ICARDA plan to maximize agricultural output in the region.



Australian farmers, many of whom also left their cereal fields fallow, noticed that medic was a favourite food for sheep, who thrived on it; some of these farmers started planting medic on a rotation basis. Soon they realized that if they planted medic after the wheat harvest, not only could sheep graze on land that previously had been left fallow and produced little grass, but the wheat harvest improved because land had received free nitrogen fertilizer from the medic.

In addition, it turned out that provident nature had endowed medic with one particular characteristic that would be difficult to invent if you wanted to. The plant has a very hard seed coat. After the seeds are plowed under the earth, most of them do not germinate on the following year, when cereals are planted. It is only on the second year that most medic seeds crack and germinate. So that in theory (and this has been a fact in Australia) medic seeds need only be planted once: they continue giving crop after crop every other year. In between, wheat or barley is grown.

John Doolette had befriended medic in his own country, and then experimented with it for six years in Tunisia under the sponsorship of CIMMYT (the International Centre for Improvement of Maize and Wheat, in Mexico) and the Ford Foundation. He hopes to move fast with his program, adopting what he calls "the best bet approach".

"Nitrogen fixing bacteria native to the Middle East and North Africa appear to be adequate," he says. "In rotation trials in North Africa wheat following medic produced without fertilizers as much as wheat fertilized with 60 kgs of nitrogen

per hectare following a fallow year. Medic also competes with weeds. This is an important point since a survey has shown that weeds lower wheat production by about 20 percent. So, the best bet is to try right here the system developed in Australia, tested in and adapted to Tunisia. Or else, we would have to spend another 10 to 20 years to go through all the preliminary work."

The "best bet" approach, while it saves time, nevertheless requires the screening of several lines of medic and of strains of nitrogen fixing bacteria against different soils in different climatic conditions. This rotation system, believes Mr Doolette, is particularly suitable to regions receiving 350 to 500 mm of rain, where cereal production is marginal. "I believe that in many regions where this rotation can be introduced, cereal yields can be improved, and animal production can at least be doubled," he says.

Food legumes, or "pulses", are another important area of research. It is true that in terms of world production, food legumes are far behind cereals, but they should not, says Geoffrey Hawtin, a British researcher who is ICARDA's "pulse man", be considered only a poor man's food (as they were in ancient Greece, when the saying "he doesn't like lentils any more" was the equivalent of "he's risen from rags to riches".) In fact food legumes represent an important source of cash income, and they often turn up on the "luxury market", whether used raw as vegetables or snacks, or transformed into traditional delicacies such as *hommos*, a paste made with chickpeas and sesame.

ICARDA's legume research program will focus on three major "pulses" in the region: broadbeans, lentils, and chickpeas.

The total annual world production of broadbeans is around 5 or 6 million tons, and much of this is grown in the Middle East. ICARDA is off to a good start, as it has "inherited" a germplasm collection of some 1,200 lines of broadbeans from the Arid Lands Agricultural Development Program (ALAD — the forerunner of ICARDA, jointly funded by the Ford Foundation and the IDRC). Most of the results of ALAD's research, and a number of ALAD's scientists, have been incorporated into the larger ICARDA program. From such a collection (which will still grow, particularly if China, an important broadbean producer, contributes to it) a huge number of crosses can be made, for the painstaking selection of qualities best suited to local needs.

There is another, intriguing, aspect to broadbean research. Broadbeans were grown as far back as Pharaonic times, but were regarded as unworthy food, perhaps because they were (and still are) associated with a sometimes lethal disease, favism. Two specific proteins in the bean have been associated with this disease, and it may be possible, through selective crossbreeding, to screen these

proteins out, eliminating a major drawback of this protein-rich food.

Lentils (world production 1 million tons) have a well-substantiated history as one of the first pulses, perhaps the first, to have been domesticated by man. (The earliest lentils unearthed at Mureybit in northern Syria have been dated to 7500-8000 BC — the beginning of agriculture, and there are references to lentils being cultivated in the hanging gardens of Babylon).

Whereas the far-flung ancestor of the broadbean remains anonymous, the paternity for lentils has been attributed to *lens orientalis*, of which wild specimens have been found. This finding has more than academic interest, as *lens orientalis* can easily be crossed with *lens culinaris*, the domesticated species (both have the same number of chromosomes). This could lead to varieties resistant to drought and diseases, perhaps even to early maturing varieties that could be planted in the spring after the winter rainfed harvest to thrive on residual moisture in the soil.

The chickpea was known in ancient Egypt under the name "hrw-bik", meaning falcon face, in reference to the shape of the seed; and in ancient Greece under that of "erebinthos", which also means testes (hence the association of the chickpea with fertility). There are two major groups of chickpeas, the Middle Eastern "kabuli" (presumably named after Kabul) with a large, light-coloured seed, and the smaller, usually darker Indian "desi" (meaning "local" in Hindi). ICARDA's research will concentrate almost exclusively on the kabuli, the only traditionally acceptable chickpea in the region, perhaps because of its looks, perhaps because it is particularly suitable for the making of *hommos*.

Recently a new species of wild chickpeas (*Cicer reticulatum*) was discovered in southern Turkey, and it is now believed to be the true progenitor of the cultivated species. It crosses readily with the cultivated species. Research is also underway to improve harvesting methods for these food legumes, that are becoming increasingly expensive as labour costs go up. "Already," says Geoffrey Hawtin, "we have a beautiful, tall chickpea coming along for mechanized harvesting".

While these "pulses" are important sources of protein-rich food and income in ICARDA's bailiwick, cereals, of course, remain the principal food crop, and the cereal improvement program, under the direction of Indian wheat breeder J.P. Shrivastava, represents the major research thrust.

Wheat and barley are sown on nearly 40 percent of the region's rainfed arable land. Research on wheat is carried out in cooperation with CIMMYT, well known for its contribution to developing the new, high-yielding varieties of wheat that have played such an important role in the "green revolution", as well as with other regional and national organiza-

Training in modern agricultural techniques also forms an essential part of ICARDA's work.



tions. High-yielding, drought-resistant lines, with good protein content and superior breadmaking qualities are being developed and tested on the 1,000 hectare Aleppo site donated by the Syrian government, as well as in nurseries throughout the region. Wheat genotypes are also being studied for salty soils, for resistance to local and regional diseases and insects. Hundreds of crosses are being made, both from locally available germplasm and with seeds received from CIMMYT in Mexico and from breeders and research centres in Australia, North America and Europe.

Of particular importance to the area is barley: in many cases, it can be grown where the growing season is too short or the rainfall inadequate for wheat and other cereals.

Barley has excellent nutritive value, comparable to that of wheat, and it performs well in harsh, dry climates, but it has been largely neglected as human food because it contains little gluten, the elastic protein that gives bread its "bouncy" consistency. Wheat, with its higher gluten content, has thus become the traditional bread-making cereal in most parts of the world and also has benefited from most of the research devoted to cereals.

Barley, however, will receive special attention because its nutritive value can further be improved, notably by increasing its lysine content. Lysine, an amino-acid, is essential to human nutrition but is absent from, or in short supply in, most food grain.

In April ICARDA co-sponsored a meeting in Amman, Jordan, of some 120 agricultural scientists to discuss ways of improving yields of barley. Yield varia-

tions reported from one region to another give an indication of the potential for improvement: they are as low as 400 kilograms per hectare in the dry areas of South Yemen, 700 in Jordan, 1,500 in Saudi Arabia, and as high as 3,000 under experimental irrigation in Egypt. The importance of barley research in the region has been underlined by the fact that the Consultative Group on International Agricultural Research (CGIAR), a consortium of donors that supports ICARDA has named it the world centre for barley, lentils and broadbeans.

Cereal research is moving along at a fast clip: over 1,000 crosses made by ICARDA staff have been grown mainly in a major nursery in Egypt, advanced a generation by summer planting in Kenya, and harvested in time for transfer to the Aleppo station before the winter rains.

Some 700 sets of cereal germplasm have also been distributed to regional nurseries, and their performance was reviewed in collaboration with national program scientists. The study of the superior genotypes will continue on the basis of these observations. In the meanwhile an entomologist, Dr Ali El-Ali, professor at the Faculty of Agriculture of the University of Aleppo, is setting up ICARDA's entomology laboratory, where the region's major insect pests, that may cause the loss of as much as a third of a crop in some areas will be studied.

Last but not least is the important, and sometimes sensitive aspect, of the evaluation of the needs of the farmers, and the adaptability of new systems to these needs. There may be a risk that new technologies disturb established tradi-

tions too brusquely, exacerbate income inequalities, accelerate land erosion and create localized unemployment and excessive dependence on imports of seeds, machinery, fuel, and fertilizers.

These aspects must be carefully examined, and as part of the initial "farming systems program" ICARDA has contracted a multidisciplinary team (four people from the Overseas Development Group of Britain's University of East Anglia, working with Syrian research assistants) to carry out a survey of the rural economy of Aleppo Province and to develop an applied research program for the main agro-ecological zones of the area.

Fields of investigation include agro-climatology, agronomy, agricultural engineering, socio-economics, rural development, and administration and planning. The program is expected to last for three years. During the first year detailed studies of six villages will be made, each village being representative of a distinguishable agro-ecological zone and form of agricultural organization.

Researchers will live for some time in selected villages to work closely with the farmers while they study climate, soil, crops and farm operations.

This approach should ensure a two-way flow of information between researchers and farmers so that the priorities of the programs at the main ICARDA site relate to the needs of the majority of the region's farmers, many of whom operate under marginal conditions. Later the program will include the development of alternative technologies, where appropriate, and with the full participation of farmers. "Any new systems must be developed within realistic farm environments, not in isolation with the intention of imposing them on existing farm structure," say socio-economist

Adrian Martin and agriculturalist Jim Harvey.

No less important are the training and communications components, that will be run by Shawki Barghouti, a Jordanian, who is both an agriculture and a journalism graduate. This program will bring together field workers from various countries in the region to discuss strategies for research and development, to identify problems at the local level in each country, to study the interdependence of physical, biological, economic and social factors affecting crop improvement, and to introduce, when relevant, methods of extension work to shorten the time-lag involved in the adoption of new technology by farmers.

Mr Barghouti's responsibility will also extend to the production of technical newsletters and periodicals related to the various ICARDA research programs, so that results are made available to scientists elsewhere, who may at the same time benefit from, and contribute to, this research.

Now that the Aleppo land donation has been approved by the Syrian parliament and signed by the President, the pace at this major ICARDA site has picked up. In September the IDRC, which had acted as the executing agency for the establishment of ICARDA completed its mission, and site development was underway. ICARDA at the present has an international staff of about 40, headed by Dr H.S. Darling, who has relinquished his post as principal of Wye Agricultural College in England and moved to Beirut, ICARDA's administrative centre.

Trucks, tractors and bulldozers have now invaded the Aleppo site, dominated by a hillock atop which the remnants of an ancient Roman fortress can still be seen. Full development of this site will take several years.

Another station will be developed near Tabriz, in climatic conditions representative of the high plateaus with extremes of temperature between winter and summer. This rugged area of north-eastern Iran used to be part of the ancient kingdom of the Mannaans, which reached its peak during the 8th century B.C. and was devastated by Assurbanipal, King of Assyria, a century later.

This site, located at an altitude of 2,000 metres, has not changed much since that time. It is still covered with snow from November to May, and lean is the yield of the scattered fields where nomad tribes with their sheep and pack animals can still be seen as they travel along their vast transhumance routes through mountain ranges, winter snow and spring flood water, in search of grazing lands.

The nomads may stop now and then, in wonderment before the signs of a changing way of life: here, the road from Tabriz, where 500 or 600 trucks every day provide the background of man-made thunder as they carry their loads of Western goods to Teheran and beyond; and there, surrounded by snow, is rising a warehouse that will house the strange new people who might have come from another planet. □

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Sociologist Adrian Martin and Syrian assistant interviewing local farmer: new systems will be developed in consultation with the farmers.