

Israel's Agriculture in the 21st century

by Jon Fedler

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A combination of sophisticated, applied science, rugged determination and government support have helped Israel's farmers to modernize and adapt to changing geopolitical, market and climatic conditions, giving them a strong base from which to proceed in the coming decades.

Israel's agriculture continues to thrive, and supplies most of the country's food needs, though profitability in export sectors has declined sharply in recent years. Among the numerous problems the crop-growing sectors have contended with since the State was founded, water scarcity remains the principal - and growing - threat. Nevertheless the ongoing introduction of new and recycled water sources, coupled with altered irrigation methods and more water-efficient crops, promises long-term security.

By the year 2020 Israel's population is expected to grow by about a third, to 8.5 million. This will cause huge increases in demand for agricultural produce and products; but urban use of land and water will also increase enormously. The amount of fresh water allocated for agriculture was reduced radically, by 50 percent (to 580 million cubic meters), in 2000. By 2020 it is unlikely to exceed this amount, and may well be considerably less. At the same time, the amount of suitable land available for farming (360,000 hectares) will also be some 18 percent less than at present.

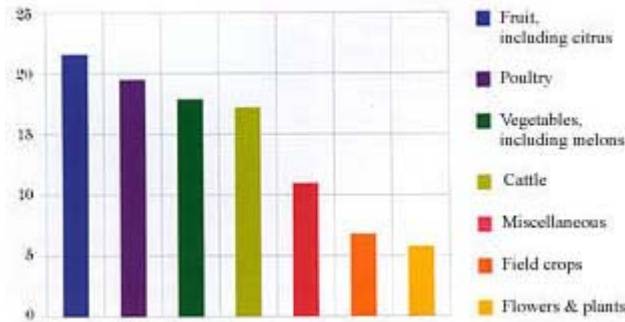
Part of the higher demand - notably for field crops (such as cereals, oilseeds and sugar) and for milk products, fish and beef - will have to be met by increased imports. Nevertheless a substantial part of the additional requirements will have to come from increased domestic production. Sweeping changes - like a 33% increase in the labor force and a reduction in irrigated field crops, such as cotton - will be required to make water available for growing fruit and vegetables for the local market.

The above is based (with minor updates) on a study by the Ministry of Agriculture ("Agricultural Production Forecast for the years 1995-2020" (Hebrew), by E. Delayahu and E. Hadass, General Planning Department, Ministry of Agriculture), which forecasts that despite its handicaps Israel will be able, by 2020, to increase production of agricultural goods. This is certainly consistent with historic development. Except for brief, sporadic declines, agricultural output has grown almost uninterrupted since 1948.

Today, agriculture represents a mere 2.4 percent of the Gross Domestic Product and four percent of exports, compared to 30.3 percent of exports during the 1960s - the heyday of the famous Jaffa orange. Nevertheless, despite the decline in its importance relative to other economic branches, agriculture has grown in absolute terms and played an important part in Israel's economy for over five decades.

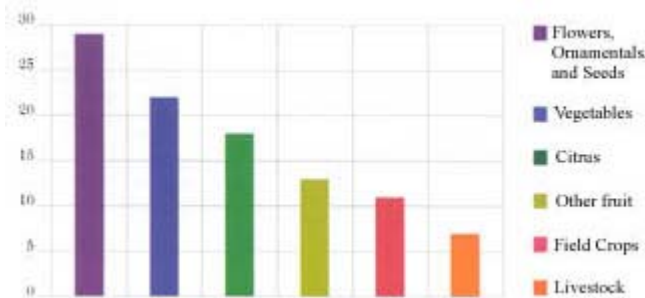
Agricultural output in 2000 was worth about \$3.3 billion, of which 20 percent was exported. Exports brought in seven percent less than the previous year, due to a combination of foreign currency fluctuations (i.e. lower shekel prices) and smaller quantities. The price of inputs climbed 10 percent in 1998-2000, to about \$2.2 billion.

Agricultural Output (percentage of value), 2000



Source: Statistical Abstract of Israel, 2001

Export of Fresh Agricultural Products (percentage of value), 2000



Source: Israel Farmers Federation

Agriculture is of major importance: in certain areas, such as the Arava and the Jordan Valley, it provides almost the sole means of livelihood for the population. In 2000, approximately 72,000 people were involved in farming, constituting about 1.7 percent of the country's workforce.

In monetary terms, Israel produces almost 70 percent of its food requirements. It imports sugar, coffee and cocoa and much of its grains, oilseeds, meat and fish. However, these imports are partially offset by exports of fresh agricultural produce and processed foods valued at \$800m. Today, just under a fifth of the income of Israel's farmers derives from the export of fresh produce, including such products as flowers, avocados, vegetables that are out of season elsewhere, and certain exotic fruits grown exclusively for export. In addition, some 442,000 tons of fruit and vegetables - 16 percent of the entire crop - were sold to factories for processing and export in 2000.

All this is a far cry from the situation a century ago. When Jews began resettling their historic homeland in the late 19th century, their first efforts were directed towards reclaiming the mostly semi-arid land, much of which was rendered untillable by deforestation, soil erosion and neglect. Rocky fields were cleared and terraces built in the hilly regions; swampland was drained, and systematic reforestation begun; soil erosion was counteracted, and salty land washed to reduce soil salinity.

Since Israel attained its independence in 1948, the total area under cultivation has increased from 165,000 ha. to some 420,000 ha., and the number of agricultural communities has grown from 400 to 900 (including 136 Arab villages). During the same period, agricultural production has grown sevenfold, keeping ahead of the population, which grew by a factor of six.

Israel's varied climatic, topographical and soil conditions (from sub-tropical to arid, from 400 meters below sea level to 1000 meters above and from sand dunes to heavy alluvial soils) made it possible to grow a wide range of agricultural produce. The success of the country's agriculture stems from the determination and ingenuity of farmers and scientists who have dedicated themselves to developing a flourishing agriculture in a country which is more than half desert, thus demonstrating that the real value of land is a function of how it is used.

Research and Development

The fact that agricultural production continued to grow despite severe water and land limitations was no accident. It was the result of a unique Israeli phenomenon: the close and ongoing cooperation between researchers, extension workers, farmers and agriculture-related services and industries.

Continuous, application-oriented research and development (R&D) has been carried out in the country since the beginning of the last century. The agricultural sector today is based almost entirely on science-linked technology, with government agencies, academic institutions, industry and cooperative bodies working together to seek solutions and meet new challenges.

The Ministry of Agriculture's research body, the Agricultural Research Organization (ARO), accounts for nearly 75 percent of all nationwide agricultural research. As such, it is the primary driving force behind Israel's internationally-acclaimed agricultural achievements. The ARO incorporates seven institutes on its main campus, and four off-campus experimental stations. Numerous ARO developments, particularly in irrigation, arid zone agriculture and unique varieties of fruits, vegetables and ornamentals have been commercialized in Israel and abroad.

Dealing with subjects ranging from plant genetics and blight control to arid zone cultivation, Israel's agricultural R&D has developed science-based technologies, which have dramatically enhanced the quantity and quality of the country's produce. The key to this success lies in the two-way flow of information between researchers and farmers. Through a network of extension services (and active farmers' involvement in all R&D stages), problems in the field are brought directly to the researcher for solutions, and scientific results are quickly transmitted to the field for trial adaptation and implementation.

The drive to achieve maximum yields and crop quality has led to new plant varieties, to breeding of improved animal species and to a wide range of innovations in irrigation and fertigation, machinery, automation, chemicals, cultivation and harvesting. The telecommunications revolution of the late 1990s also made its mark on farming methods in some sectors, with more and more farmers employing mobile phones, the Internet and computer-guided farm supervision as basic working and marketing tools.

Irrigation

Near the Desert Plant Research Station of Ben-Gurion University in the Negev is a farm cultivated over 2,000 years ago by the earliest desert farmers, the Nabateans. Their agricultural methods were astonishingly sophisticated. By building terraces and

clearing the soil of stones, every drop of runoff water was collected and then diverted to the lower-lying fields and orchards.

The methods have changed, but after several years of meager rainfall, saving water, finding new sources and making optimal use of scarce land still characterize the country's agriculture.

Water saving has been the farmers' leitmotif since 1948. The country has eight major and several small-to-medium-sized companies producing irrigation and filtration equipment, all internationally active. In no other field of agricultural technology has Israel so distinguished itself.

The last few years have been characterized by low rainfall, resulting in the adoption of emergency conservation measures. In terms of annual rainfall, even in 'normal' years, 60% of the country has been defined as arid or semi-arid. Rain only falls between November and April, with uneven distribution of yearly precipitation, historically raging from 28 inches (70 cm.) in the north to less than two inches (five cm.) in the south. During the past few years, agricultural use of potable water has been reduced substantially - from 900 million cubic meters (mcm) in 1995 to an estimated 740 MCM in 2001. As a result of ongoing government pricing and rationing measures to curb fresh water use, and the commissioning of more sewage treatment plants, use of treated sewage rose from 250 MCM in 1990 to 270 MCM at present, and is expected to rise to 500 MCM by 2005 as new sewage treatment plants and pipelines are commissioned.

Over the past 25 years agricultural output has increased sevenfold (source: Statistical Abstract of Israel, 2001) with hardly any increase in the amount of water used. This reflects technological advances of different types - water efficiency (up by more than 30%) and crops with higher yields and market value. To reduce water consumption for agriculture, advanced water-saving techniques were applied, notably the drip system, which directs the water flow straight to the root zone of plants. In addition, computerized irrigation systems were introduced and climate-controlled greenhouse agriculture was significantly expanded.

Israeli engineers and agriculturalists created the revolutionary drip system, which has reduced water consumption by 50-70% compared with gravity irrigation, and by 10-20% compared to sprinkler irrigation. Recently growers have been introducing the first generation of ultra-low application rate (minute irrigation) drip emitters for soil-less media in greenhouses, emitters with 100-200 cc/h flow rates. Considered even more advanced than the drip system, they create optimal air-water relationships in the plants' root zones and, being more efficient, save yet more water.

Micro-spraying and micro-sprinkling irrigation accessories have also been developed, mainly for use in orchards, where each tree is irrigated by its individual sprayer.

To overcome regional imbalances in water availability, most of the country's freshwater sources have been joined into the National Water Carrier, an integrated network of pumping stations, reservoirs, canals and pipelines which transfers water from the north, where most of the sources are, to the agricultural areas of the semi-arid south. As a result, the amount of irrigated farmland has increased from 30,000 ha. in 1948 to some 192,000 ha. today.

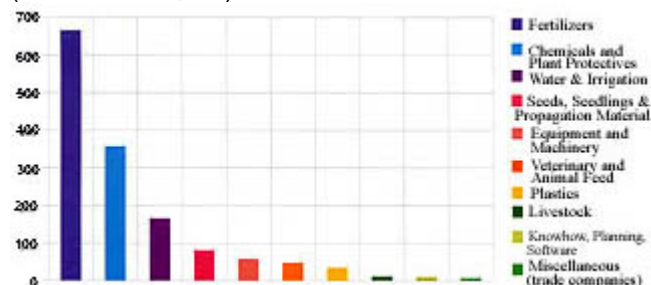
The future direction and success of Israeli farming, too, will depend on water availability: in particular, the ability to even further minimalise water use, and in geneMechanization and Agro-technology

Development of know-how and technology has been both a cause and effect of the country's farming prowess. In fact, exports of agricultural inputs in 2000, including chemicals and fertilizers, were almost double those of exports of agricultural produce.

In order to lower costs, increase yields, improve quality and save manpower, innovative agricultural machinery and electronic equipment have been locally designed and manufactured, and are widely used. Intensive experimentation on the drawing board and in the field has resulted, inter alia, in the development of heavy-duty soil preparation machinery; advanced tillage, planting and transplanting equipment adaptable to intensive farming; and, as mentioned, diverse irrigation systems. Automated milking and dairy herd management systems, egg-collecting equipment, computerized feeding systems and production-recording computers have been introduced, as well as machinery for the grading, packing, control during refrigeration and transporting of produce.

Locally developed agrotechnologies include computerized fertigation, which injects fertilizer through the irrigation system, simple, gravity-based drip systems for developing countries, and advanced temperature and humidity control methods, which provide healthy environments for poultry, flowers, out-of-season vegetables and the like.

Export of Agricultural Inputs in 2000
(in millions of \$US)



Source: Israel Export Institute

Government Involvement

The Ministry of Agriculture supports and supervises the activities of the country's agricultural sector, including R&D, maintenance of high standards for plant and animal health, agricultural planning, extension research and marketing. For many years, agriculture was tightly controlled, with allocations of production and water quotas for each crop. At present only quotas for milk and selected milk products, and some control of eggs, broilers and potatoes are in effect.

Ongoing government programs to increase the country's water potential involve rainfall enhancement through cloud seeding, desalination of brackish water and sewage recycling. In 2001 preparations began on a series of tenders for major seawater desalination plants, slated to become operative from 2004 onward.

Supervision of the country's water supply includes determining water quotas, progressive pricing, fully controlling groundwater pumping, initiating conservation and supply enhancing projects. A ten-year program underway since the late 1990s foresees, in addition to water rationing and desalination, the treatment and re-use of all urban wastewater.

Growing Crops in the Desert

Since 1948, the sparsely populated desert area between Be'er Sheva and Eilat (the Arava and the Negev) has played an important role in agricultural production. More than 40 percent of the country's vegetables and field crops are grown there, and 90 percent of the melons exported come from the Arava. Today, because the supply of farmland in the country's densely populated central region is shrinking (only 17 percent of the country's total land area is arable and a growing share is used for housing) the importance of the Negev and the Arava for farming is increasing. In the process, the pattern of farming in the desert is also undergoing change, and new varieties of crops suited to the region's conditions are being developed and introduced, along with animal husbandry, which was hitherto confined to more northern areas.

The common advantages of the two regions are their long hours of sunshine and relatively high temperatures, the fact that land is relatively cheap and adequate water (saline or recycled effluent) is available. This makes it possible to grow for export to Europe during the winter months - October through March - using less energy, when prices are highest.

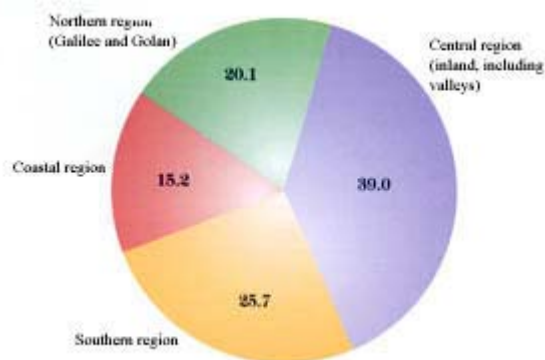
Until the 1990s, the accent was on field crops, vegetables, fruit and dates. These branches continue to expand in the Negev and the Arava. In addition, giant citrus groves (11,000 ha.) have been planted by industrial companies in the northern Negev. Plans to expand the growing of flowers, grapes for wine, olives for oil, cattle for meat, ostriches and fish are now being consolidated.

The new wave of 'greening the desert' has been encouraging. In the Negev, more suitable climatic conditions and cultivation of new citrus varieties have resulted in yields 50-100 percent higher than those in the north. Closely-planted 'industrial' olive plantations irrigated by brackish water have achieved per-acre oil yields that are six times higher than in traditional rain-fed groves elsewhere in the country. Within the past two years the Negev/Arava fish farmers, who began operations in 1996, have reached production of several hundred tons a year (out of a national total of 32,000 tons).

At Kadesh Barnea, a small moshav (cooperative settlement) on the Egyptian border, one can get a foretaste of what Israeli desert farming might look like in the future. The farm's beef cattle - the first in the Negev - are fed fodder grown with brackish water recycled from 'bubbles' - covered tanks for intensive fish cultivation. Similarly, at Kibbutz Revivim, water from fish tanks nourishes alfalfa for ostriches.

Desert agriculture is already playing an indispensable role in Israel's food economy. Learning from other countries, a large range of arid soil plants from Asia, Africa, Australia and the Americas has been introduced and tried out under local conditions, occasionally adapting and commercializing them.

Agricultural Production (in percentages) according to location



Know-how on desert crop growing has become a focus for regional and international cooperation. Since the late 1950s, Israel has been sharing its agricultural expertise with scores of countries. MASHAV, the Center for International Cooperation of the Ministry of Foreign Affairs, is active in Asia, Africa, the Mediterranean Basin, Eastern Europe and Latin America as well as several Middle Eastern countries.

Agricultural projects and research collaboration constitute about half of Israel's international cooperation programs. Emphasis is placed on training courses in agricultural subjects, with some 1,400 participants from over 80 countries attending specialized courses in Israel every year, and thousands of trainees receiving on-the-spot training in their own countries. Since 1958, thousands of Israeli agricultural experts have been sent abroad on long- and short-term assignments.

Most of Israel's agriculture is organized on cooperative principles, which evolved in the country during the first decades of the 20th century. Motivated by both ideology and circumstances, the early pioneers set up two unique forms of agricultural settlements: the kibbutz, a collective community in which the means of production are communally owned and income is equally distributed; and the moshav, a co-operative village where each family maintains its own household and works its own land, while purchasing and marketing are conducted cooperatively. In recent years both systems have undergone vast ideological and structural changes, though they still account for the lion's share of productive crop-growing area. For example, in 1999 they accounted for three quarters of the total area producing crops.

Agriculture by Branches

Fruit

The country's varied climatic, topographical and soil conditions have made it possible to grow a wide range of fruit. Thus the fruit sector is able to offer juicy citrus, creamy avocados, tangy kiwis and litchi, aromatic guavas and succulent mangoes from the orchards of the coastal plain, sweet bananas and honey-rich dates from subtropical areas and crisp apples, tasty pears and plump cherries ripened in the chilly air of the northern hills. The varied climate also enables fruit to be picked out of season, or at the beginning or end of a season, prolonging its appearance on the shelves.

Declining prices abroad, as a result of currency fluctuations, and a corresponding trend to reduce orchards, have been reflected in a continuous decline in export sales - from \$278 million in 1996 to \$192 million in 2000. The most marked decline has been in citrus, whose sales abroad plummeted by half during the period. This was

reflected in a 16 percent reduction in citrus plantation areas. Recently the branch has also been hit by a shortage of laborers due to political events.

On the positive side, farmers have responded to all these obstacles by raising yields: they have established new plantations with varieties offering better yields; and have introduced the latest agrotechnology. For example, seven years ago the average yield of avocados was 70 kg per 1000 m²; today it is 1250 kg/1000 m². Another, indirect indicator is that while the citrus sector's output dropped 16 percent in 2000, income fell only six percent.

The cultivation of vineyards, first promoted as a commercial enterprise at the beginning of the last century, has been expanded to include special varieties of grapes for a wide range of prize-winning red and white wines. These include grapes grown with saline water in desert conditions - a worldwide first.

Citrus, the country's oldest export sector, remains the third largest agricultural export, with 250,000 tons of oranges, pink and white grapefruits, lemons, pomelos and several varieties of easy-peeling tangerines, as well as concentrates, juices and other products, shipped abroad annually. Efforts are now being made to develop new citrus varieties with smaller seed content, a longer shelf life, a pleasant appearance and a long marketing season.

Vegetables

Growing vegetables has become an art in Israel - based on choosing the right hybrid varieties, fertilizers and irrigation methods, selecting greenhouse covers designed for specific crops and employing innovative growing tools, harvest equipment and post-harvest treatments. In recent years farmers have also been seeking profitable market niches. Examples are a big increase in production of organic produce, as well as specialties like herbs and selected mushrooms.

Vegetables account for about 17 percent of Israel's total crop output value. In 2000 the country's farmers produced some 1.2 million tons, of which 150,000 tons were exported; large quantities of processed vegetables are also exported. Technologically advanced methods are employed, including soil-less greenhouses with climate control systems. From 1990-1999 the area of greenhouses for vegetable cultivation was tripled, to 3000 hectares. While tomatoes growing in the open field reach yields of up to 80 tons per hectare, an average 200-300 tons can be grown in greenhouses under controlled climatic conditions. Israel exploits the sunshine and high temperatures to grow high-quality vegetables during the off-seasons of competitors abroad. In the last few years varieties of some crops, notably tomatoes and melons, have been adapted for growth in the desert with saline water irrigation. These are marketed under the brand name "Desert Sweet."

Field Crops

About two-thirds of Israel's field crops are grown on un-irrigated land. These rained crops include wheat for grain and silage, hay, legumes for seeds and safflower for oil. The remainder is summer crops such as cotton, sunflowers, chickpeas, green peas,

beans, corn, groundnuts and watermelon for seeds, mostly irrigated. With water in short supply, crop farmers have been concentrating, for the remaining land, on new varieties that produce the same or higher yields, with less or no irrigation. In addition, irrigation increasingly consists of treated sewage.

Wheat is the dominant crop in terms of acreage planted - 100,000 hectares, of which Bedouin farmers till some 20,000 ha. It is intended mainly for grain.

The scale of cotton planting fluctuates widely, depending on market prices. In 1998 some 31,000 ha. were planted; 9,500 ha. in 2000; and 15,400 ha. in 2001. Almost the entire cotton crop is drip irrigated, using mainly treated sewage. Seed cotton yields per unit of land are currently among the highest in the world, averaging 16 kg per hoof fiber for both the Ocala and Pima varieties. The entire crop is exported. In terms of sown area, Israel represents only a very small percentage, but in Europe it currently has a 20 percent market share of the Pima variety, and is increasingly switching to this variety. The sector is completely mechanized and each worker produces on average \$100,000 worth of cotton annually.

Dairy Farming

Dairy and beef herds account for 17 percent of the country's total agricultural production. Israel has for several years held the world record for milk production - 10,200 kilograms of 3.3 percent butterfat milk per cow. This is no accident, but reflects a number of complementary steps, each aimed at achieving maximum efficiency:

- A careful breeding of cows that can cope with Israel's hot climate. The dairy herd consists entirely of Israel-Holstein, a high-yielding, disease resistant breed, developed through careful selection procedures. Breeding, based on computerized production data and genetic factors, is by artificial insemination; and since Israel has almost no grazing land, most of the herd's nutrition is based on a total-nutrient, barn-fed feed mix.
- Feeding and milking the dairy herds by computerized programs, in order to determine feed composition ration according to stage of growth, milking and yield. Thus, for example, the farmer can determine the correct balance for a milk-yielding or a dry cow during the gestation period or develop a suitable diet for young calves. In addition, automated, computerized management systems - nowadays with wireless links to hand-held computers to ensure control while mobile - have been developed. These are able to monitor the individual cow's milk output per milking, warn of mastitis infection and even detect heat through counting the number of steps a cow takes. Computerized climate control systems for the dairy parlor are also widely used.

The sector supplies all of the country's dairy requirements. A surplus of butterfat is used to produce a wide variety of dairy products. Until the late 1990s production was regulated by a strict policy of planning and quotas. Today, the government is reducing the (regulated) prices on an annual basis, while encouraging small dairies to merge in order to cut production costs. These measures have reduced profitability and led to the closing, or merging, of some 300 small dairies.

The sheep and goat milk sectors have developed significantly in recent years, with a growing part of the cheeses produced earmarked for export.

The result of these advancements is that Israeli dairy know-how, equipment and experience are sought after worldwide. Sperm from locally proven bulls are in considerable demand abroad.

Other dairy-related exports include: heifers; computerized milking and feeding systems; cooling systems for dairies in hot countries; mini-dairies for milk processing; systems to recycle organic waste into cattle feed; and recycling systems for cattle manure. All this is provided by government agencies, consultancy firms and partnerships in international project development and, of course, the companies that produce the inputs and equipment.

Poultry and Beef

Several years ago the US Department of Agriculture officially acknowledged the quality and standards of Israeli poultry, and in 1997 veterinary officials of the European Union granted Israel 'associate status' for poultry imports and exports. This means, de facto, that Israel's breeding methods, the level of veterinary services, veterinary legislation and independent supervision systems are regarded as being up to world standards.

Poultry sales, almost equally divided between broiler chickens and turkeys, are a major component of Israel's agriculture. Meat production increased almost 1.5-fold between 1976 and 2000, to 400,000 tons, and today its processed products are also an important industry. At home, per capita consumption of both eggs and poultry is among the highest in the world. This is reflected not just in a large and well-organized network of breeders and producers, but in the development, by local companies, of specialized equipment for the poultry industry. Breeders have concentrated on developing poultry breeds that are both heat- and disease-resistant, and which provide a high growth rate, high egg production and low-fat meat.

Eggs account for some 20 percent of the country's total poultry output. Average production of eggs for eating is 250 per layer. Annual meat yield per square meter of broiler house, over the course of five growing cycles, now reaches 150 kg.

Israel is the world's largest per-capita consumer of turkey meat and the industry represents a third of total meat output. Breeding and broiler farms, as well as meat processing, are fully automated. A high level of automation, strictly hygienic conditions and development of disease-resistant breeds contribute to high meat production. A wide variety of turkey products is exported, mainly to western Europe.

At 106,000 tons in 2000 - 62 percent of it imported - Israel's consumption of beef was only 29 percent of its consumption of poultry products. This pattern is partly habit, partly price-dictated. Pasture is a limiting factor in production, though efforts have been made to expand grazing areas by improving existing pastures and introducing different grasses and new grazing techniques. Between 1990 and 2000 the herd increase was 21 percent, while output increased from 50,000 tons to 80,000 tons. Most of this was a result of a lifting of government barriers on the import of live calves: some 28,000 were imported in 2000 compared with 26,000 in 1998.

Aquaculture

Israel imports about two-thirds of the fish it consumes. Demand at home is steadily rising: from 11.7 kilograms per capita in 1994 to 13.4 kgs. in 2000, a 13 percent increase. Growing demand - both local and worldwide - is prompting Israel to step up fish production, especially in the arid southern part of the country, where brackish geothermal water can be used.

The 1990s saw the introduction of mariculture, a development that enabled a 25 percent increase in domestic breeding in the final decade of the 20th century.

Activities are in three focal points: fish growing in artificial ponds, including tilapia, mullet, carp, trout, bass and silver carp, mainly in the northern part of the country; salt water fish, including bass and sea-bream, raised in floating cages in the Mediterranean Sea and the Gulf of Eilat; and fresh-water fishing in Lake Kinneret.

One of the main water-thrifty pond methods currently being developed and rapidly increasing in volume is the use of covered ponds fed by oxygenation, with water passing to and from the ponds via a reservoir/bio-filter. Such systems have yielded production increases as high as 400% compared with open tanks. Equally impressive yields have been achieved in the Negev and the Arava, using covered 'bubble' or 'tent' systems. The warm, geothermal saline water is recycled from the fishponds to irrigate a variety of crops, from greenhouse tomatoes to cattle fodder.

In the light of the initial commercial successes, it appears that by promoting fish farming in the south using geothermal water sources, local production may be dramatically increased, thus lowering the current high demand for imported fish.

Floriculture

Flowers are Israel's leading agricultural export (29 percent). Individual farms average less than a hectare and together occupy less than 2 percent of crop-producing land. These units are small by international standards and have hitherto been highly profitable, though depreciation of the shekel against the European currencies has sharply reduced income and profitability in recent years. The expertise of the farmers, backed by private and government research and development and field service supervision, contributes to the high quality and wide variety of flowers (over 100). These include cut flowers such as roses, gypsophila, carnations, solidago, limonium, gerbera, anemone, and ornamental plants.

The varieties include 'summer flowers' from Europe, acclimatized so that they can be picked and exported during Europe's winter season, and flowers indigenous to the southern hemisphere. Although the number of flower growers has fallen drastically in recent years, production has risen steadily to around 1.4 billion flowers a year. This is due to technological advances and an intensive system of production. About half of all the area devoted to flower growing consists of advanced, computerized greenhouses and some 12 percent of the area is under protective netting.

Today, some of the more innovative growers are connected on-line with the auctions and follow transactions in real time. Some are selling their flowers directly to buyers in the flower auctions of the Netherlands, Belgium, Germany and elsewhere.

Nevertheless, marketing as well as shipping are handled by a new private company - Aviv - and by the long-established joint government-growers export company Agrexco, which has special air and sea terminals in Israel and Europe and ensures quality and timely arrival at the markets. The Flower Production and Marketing Board provides each grower with daily results of sales.

Ornamental plants are a rapidly growing industry. In 2000 about \$120 million worth of scores of different ornamental plants, either as rooted or un-rooted cuttings, or in pots in various stages of growth, were exported worldwide, predominantly to Europe. Most of these plants serve as the starting materials for European house- and garden plant nurseries, who may gain a season or even a year (and save a lot of energy) by having the initial stages of growth carried out in Israel's warmer climate. Much of this industry is based on person-to-person contractual arrangements. Once a distant second to citrus, export of flowers and ornamental plants now holds first place. With continuing R&D investment, export sales are likely to continue growing.

A combination of sophisticated, applied science, rugged determination and government support have helped Israel's farmers to modernize and adapt to changing geopolitical, market and climatic conditions, giving them a strong base from which to proceed in the coming decades.

