Low rainfall and high temperatures in Iran necessitate irrigation and over half the cultivated land is irrigated. Water availability and salinity are major constraints. Iran has long been a major importer of wheat but in 2003 and 2004 domestic wheat production almost satisfied the national demand. Several governmental measures supported production of the crop and favourable rainfall after a drought was also a major factor. Yields of both irrigated and rainfed wheat are low by world standards. The intensification of production, in particular through a greater efficiency of fertilization and irrigation, is required in order to achieve a permanent reduction in the country’s dependence on wheat imports, even under less favourable climatic conditions.
Fertilizer use by crop in the Islamic Republic of Iran

Land and Plant Nutrition Management Service
Land and Water Development Division

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00100 Rome, Italy
Tel.: +(39) 06 57051
Fax: +(39) 06 57053360
E-mail: land-and-water@fao.org
Web site: www.fao.org

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Preface

This study, commissioned by the Food and Agriculture Organization of the United Nations (FAO), is one of a series of publications on fertilizer use on crops in different countries.

The aim of the series is to examine the agro-ecological conditions, the structure of farming, cropping patterns, the availability and use of mineral and organic plant nutrients, the economics of fertilizers, research and advisory requirements and other factors that have led to present fertilizer usage. The reports examine, country by country, the factors that will or should determine the future development of plant nutrition.

During the past two decades, increasing attention has been paid to the adverse environmental impact of both the underuse and the overuse of plant nutrients. The efficient use of plant nutrients, whether from mineral fertilizers or from other sources, involves the shared responsibility of many segments of society, including international organizations, governments, the fertilizer industry, agricultural research and advisory bodies, traders and farmers. The publications in the series are addressed to all these parties.

Fertilizer use is not an end in itself. Rather it is a means of achieving increased food and fibre production. Increased agricultural production and food availability can, in turn, be seen as an objective for the agricultural sector in the context of contributing to the broader macroeconomic objectives of society. A review of the options available to policy-makers is given in the FAO/IFA 1999 publication entitled Fertilizer Strategies.

The contents of the series of studies differ considerably from country to country, in view of their different structures, histories and food situation. However, in each case the aim is to arrive at a better understanding of the nutrition of crops in the country concerned.
Acknowledgements

This study is based on the work of M.J. Malakouti of the Soil and Water Research Institute (SWRI) of Iran. Other contributors to the study were R. Khodaie (Public Relations and International Affairs Office, SWRI), R. Rikhtehgar and his colleagues (Statistics and Information Technology Office), A. Khalafi (Agronomy Department, Ministry of Jihad-e-Agriculture), I. Kalantari (Advisor to the President of Iran and the General Secretary of Farmers House), M. Baybordi, H. Amirmokri and M. Nafici, (all three Advisors, SWRI), A. Moameni (Soil Genesis and Classification), M. S. Ardakani (Researcher, SWRI), A. Keshavarz (Seed and Plant Improvement Research Institute), D. Salajegheh (Fertilizer Producers Society), R. Arjmandi (Central Organization of Iranian Rural Production Cooperatives-COIRPC), Cheraghali (Iranian Rural Cooperative), A. Jabalameli, and B. Motasharezadeh (Agricultural Support Services Company-ASSC), S. Asadzadeh (Clerk).

The study benefited from the contributions of K. Isherwood (consultant FAO), J. Poulisse and T. van den Bergen (FAO).

The background photograph (barley) is from the FAO Media FAO/23196/O. Tuillier as well as the pomegranate photograph FAO/23429/J. Boethling. The citrus photograph is from EcoPort (Arnoldo Mondadori S.p.A.) and the pistachio photograph is from J.M. Malakouti.
Abstract

With an area of more than 1.6 million square km, Iran is the sixteenth largest country in the world. In the ten agro-ecological zones of the country, the cultivated area amounts to about 15 million hectares, of which over half is irrigated. A wide variety of field, fruit and vegetable crops is produced but by far the most important irrigated crop is wheat.

According to soil and land surveys, a total of about 17 million hectares of land could potentially be cultivated although most have some limitations. The main limitation to agricultural expansion is water availability not land availability. Low rainfall, high air temperatures and high evaporation rates result in a high water requirement for agriculture. Salinity and drought are among the most important environmental stresses that limit crop production in Iran.

Until recently, Iran relied heavily on wheat imports to meet its growing domestic demand. Annual imports have ranged from 2.5 to 7.5 million tonnes per annum during the past two decades, making Iran a major world wheat importer.

In the context of a policy to become self-sufficient in wheat, over the past two years the Government has raised spending on wheat farming sharply by supplying higher quality seeds, improving machinery services, augmenting fertilizer usage and enhancing water systems and pest management practices. The guaranteed procurement prices have been raised significantly.

A record wheat harvest in 2004 followed an already excellent crop in 2003, reduced wheat imports in 2004/05 to only 0.2 million tonnes. The strong government support for wheat production has played a large part in raising output but favourable rainfall during these seasons, after three years of drought, also had a major impact.

At least 40 percent of Iran’s wheat is rainfed with an average yield of only 0.8 tonnes/ha. Even under irrigation the average wheat yield rarely exceeds 3 tonnes/ha, which is low by world standards. The country cannot always rely on favourable rainfall and an intensification of production providing higher yields under less favourable climatic conditions is
necessary if the target of self-sufficiency is to be maintained. Balanced and efficient fertilization is a major component of such an intensification. An improvement in the efficiency of irrigation is also indicated. Water losses in conveyance and use are very high.

The consumption of fertilizers has increased by over 50 percent since 1999. The nutrient balance and provision of micronutrients has also improved. The use of biofertilizers is being promoted. However, further improvements are necessary. It is estimated that correct fertilization could increase production levels by up to 60 percent.

The Agricultural Support Services Company is responsible for providing and distributing mineral fertilizers, pesticides, seeds and improved plant varieties. The rural and agricultural cooperative network has 4,935 branches, 10,693 shops, and 11,794 units for the distribution of fuel. With around five million members, the network covers 98 percent of the villages of the country, with a population of approximately 25 million people. The cooperatives play an important role in the marketing of produce and providing services and support.

Fertilizer research in Iran is carried out mainly by the Soil and Water Research Institute. In cooperation with the agricultural universities, the Institute is carrying out research and development activities on a wide range of topics concerning the efficient use of plant nutrients.

Fertilizers are subsidized and the amount of subsidy has risen sharply with the increase in the amount of fertilizer used. There is some abuse of the system.

Unsatisfactory availability of fertilizers is a major constraint. The distribution of fertilizers needs to be improved, providing the required quantities and types of fertilizer at the time they are needed by the farmers.
Phosphate and potash may be expressed as their elemental forms P and K or as their oxide forms P$_2$O$_5$ and K$_2$O. Nitrogen is expressed as N. In this study, phosphate and potash are expressed in their oxide forms.

Abbreviations and symbols

ASCC Agricultural Support Services Company
COIRPC Organization of Iranian Rural Cooperatives
FUE Fertilizer use efficiency
GNP Gross National Product
OPFO Organization of Professional Fertilizer Producers
SRIO Scientific Research and Industrial Organization of Iran
SWRI Soil and Water Research Institute

AS Ammonium sulphate
DAP Diammonium phosphate
MOP Muriate of potash (potassium chloride)
NPK Compound fertilizer containing N, P and K
SOP Sulphate of potash
SSP Single superphosphate
TSP Triple superphosphate

N: Nitrogen
P$_2$O$_5$ or P: Phosphate
K$_2$O or K: Potash

* Phosphate and potash may be expressed as their elemental forms P and K or as their oxide forms P$_2$O$_5$ and K$_2$O. Nitrogen is expressed as N. In this study, phosphate and potash are expressed in their oxide forms.
Chapter 1
Introduction

With an area of more than 1.6 million square km Iran is the sixteenth largest country in the world. The country is situated in the eastern part of the northern hemisphere, in southwest Asia (Figure 1).

The elevation ranges from below sea level to more than 5 000 metres above sea level. The temperature varies between minus 30°C and plus...
50°C. Annual precipitation varies from about 25 mm in the Central Plateau to over 2 000 mm in the Caspian Coastal Plain, with a national annual average of 250 mm. Central Iran is a steppe-like plateau with a hostile climate, surrounded by desert and mountains (Zagros on the western border and Alborz to the north). Approximately 90 percent of the country is arid and semi-arid.

Underground water irrigates the oases where a wide variety of grains and fruit trees are cultivated. The shores of the Caspian Sea have a humid climate and are suited to tropical and subtropical crops (citrus, cotton, rice and tea). The annual evaporation loss is high, ranging from about 700 mm along the Caspian Sea shores to over 4 000 mm in the Central Plateau and southern part of the Khuzestan and Southern Coastal Plains in the southwest, more than 16 times the annual average rainfall (Moameni, 2000).

In 2002, the population of Iran amounted to 68 million people, the rural population being about 23 million. The food sector accounts for about 40 percent of Iran’s gross national product (GNP) and 40 percent of the “added value” in the national economy. The farming subsector contributes 57 percent of the added value of the food sector. Food security has a high priority in the country.

According to FAO statistics, in 2001 the cultivated area amounted to 16.5 million ha, of which 14.3 million ha were planted to arable crops and fallow and 2.3 million ha to permanent crops. The irrigated area in 2001 amounted to 7.5 million ha. Agricultural land availability is not a major constraint in the development of Iranian agriculture. The major constraint is the availability of water.

About 90 percent of the irrigated land is under annual crops (including fallow), the remaining 10 percent being used for the production of perennial crops (mostly orchards). In rainfed areas, annual crops constitute about 98 percent of the total production (Moameni, 2000). During dry years, about 8 to 12 percent of the total production comes from dry land areas. However, in wet years this figure can rise to 35 percent. Figure 2 shows the land use distribution.

In many regions of the world, the increasing demand for food in the coming decades cannot be met by extending the area of land under cultivation but only by increasing the intensity of their agriculture. A more efficient use of the land as a result of intensification requires less
forest to be cleared for farming purposes and preserves a greater genetic diversity of plant species. In Iran the cultivable land area could in principle be increased but an intensification of crop production is needed to compensate in particular for water scarcity.

It is unlikely that the required level of crop production could be obtained simply by increasing the irrigated area. An intensification of production is necessary. This involves several factors, such as land consolidation, leveling, improved irrigation methods, balanced fertilization, improved seeds, disease and pest control and mechanization. Balanced fertilization is an essential factor for achieving yield and quality improvements (Malakouti et al., 2004).
Chapter 2
Soils, agro-ecological zones, climate and irrigation

SOILS

There are four main soil-order types in Iran, i.e. Entisols, Aridisols, Inceptisols, and Alfisols. According to Dewan and Famouri (1964), the most important soils of plains and slopes consist of alluvial, colluvial, humic-clay and various kinds of salt-affected soils belonging to the major classes Aridisols, Entisols, Inceptisols, and Alfisols. Due to their origin, many soils of the country are rich in calcium carbonate and are classified as calcareous. Plant availability of most nutritional elements, especially micronutrients, is low. The proportions of the dominant soil types are shown in Figures 3 and 4.

Soil survey and land classification studies during the past 50 years reveal that the majority of land resources possess various degrees of limitations, either individually or in combination, related to soil properties, salinity and alkalinity, topography, erosion and drainage. Therefore, the production capacity of soil resources of the country depends not only on the degree of soil salinity but also on other soil deficiencies that hinder sustainable crop production.

In Iran, soil characterization and mapping are based on the standards given in the Guide for Soil Survey and Land Classification for Irrigation, prepared by the Soil Institute of Iran, affiliated to the Ministry of Agriculture, with the help of FAO experts. In accordance with the
TABLE 1
Main land classes and subclasses

<table>
<thead>
<tr>
<th>Land classes</th>
<th>Basic subclasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I: Arable</td>
<td>S = Soil limitation, (texture, dept, soil permeability, infiltration rate, etc.).</td>
</tr>
<tr>
<td>Class II: Arable</td>
<td>A = Salinity or alkalinity limitation.</td>
</tr>
<tr>
<td>Class III: Marginal, Arable</td>
<td>T = Topography/erosion limitation.</td>
</tr>
<tr>
<td>Class IV: Restricted, Arable</td>
<td>W = Drainage limitation (flooding, ponding, presence of groundwater, pseudo gley, etc.).</td>
</tr>
<tr>
<td>Class V: Undetermined, Arable</td>
<td></td>
</tr>
<tr>
<td>Class VI: Non-Arable</td>
<td></td>
</tr>
</tbody>
</table>

standards given in this guide, land areas were grouped into six classes, depending on their capabilities and limitations as regards the cultivation of annual crops under gravity irrigation, assuming that no land improvement is carried out which would remove the present limitations and improve the quality of the land.

Depending on the type of limitation, land classes lower than class I land were subdivided into subclasses by appending to the class number a letter showing the type of limitation (Table 1).

The results of the soil survey and land classification activities in Iran (reconnaissance, semi-detailed and detailed), obtained from 1953 to 2000 are shown in Table 2. Of a total of 20 million hectares of land surveyed, which included most of the cultivated land, good-quality land (class I land) covers only 1.3 million hectares (6.5 percent). The remaining land areas have various degrees of limitations and/or hazards for irrigated farming.

Class I land has no limitations as regards salinity, topography or drainage, for irrigated farming under existing conditions. It is capable of producing sustained high yields of a wide variety of climatically adapted crops, at reasonable costs under good management. These land areas are considered to be highly sustainable for irrigated farming and have a high income potential under normal conditions of soil and water management. However, in the semi-arid conditions of the country, their productive capacities are threatened by mismanagement. If crop production on these soils is to be sustainable, changes in their quality under irrigation farming must be monitored through long-term studies.

Land areas having slight to moderate hazards and/or limitations of soil, salinity, topography or drainage, for irrigation farming (class II + class III lands) cover about 9.5 million hectares or about 48 percent of the total land areas surveyed (Table 2). Moderately suitable land areas

<table>
<thead>
<tr>
<th>Land classes</th>
<th>Area ('000 ha)</th>
<th>(percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>1 300</td>
<td>6.5</td>
</tr>
<tr>
<td>Class II</td>
<td>4 290</td>
<td>21.5</td>
</tr>
<tr>
<td>Class III</td>
<td>5 340</td>
<td>26.7</td>
</tr>
<tr>
<td>Class IV</td>
<td>3 120</td>
<td>15.6</td>
</tr>
<tr>
<td>Class V</td>
<td>2 700</td>
<td>13.5</td>
</tr>
<tr>
<td>Class VI</td>
<td>2 250</td>
<td>11.3</td>
</tr>
<tr>
<td>Complexes (any cross bred of above land classes)</td>
<td>1 000</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20 000</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

for irrigation (class II lands) are either suitable for a somewhat narrower range of crops compared with class I land areas or are more costly to prepare for irrigation (drainage, leveling, etc). Under present conditions, these land areas are expected to give lower yields, compared with class I land. Land areas that are marginally sustainable for irrigation (class III land) either have restricted crop adaptability or are expected to give lower yields than those of class II land, or require more costly land improvement and land preparation operations or more costly management practices.

The problematic lands (class IV, V and VI land areas) cover about eight million hectares or 40.5 percent of the surveyed area and undifferentiated land (complexes) cover about one million hectares or 5 percent.

Owing to their severe limitations of soil and/or topography for irrigation farming, class IV lands are considered to be unsuitable for irrigation under normal conditions of irrigation management. Under present conditions, they must be used for the cultivation of special crops or with special conditions of management that can cope with these limitations. Under normal conditions of management most of the common tilled crops cannot be grown profitably on these land areas. However, under special conditions (operation in units of abnormal size such as very intensive, or extensive cropping, irrigation from cheap sources of water, including flood waters, irrigation on steep slopes either after terracing, or by sprinkler, special crops such as vegetables, fruit trees, rice, pasture) irrigated farming can be profitable. This category of land also includes areas on which crops such as date palms, rice, etc. can be grown under severe limitations of salinity and/or drainage.

Class V land areas are considered to be at present unsuitable for irrigation because of their severe hazards and/or limitations of salinity and/or drainage for any type of irrigation farming. If freed from limitations such as salinity and excess water, these land areas could play an important role in crop production and hence in the economic development of the country. In most cases, however, they require substantial land improvement operations. It must be proven through investigations and trials that crop production on these land areas is not only possible but also economically feasible.

Class VI land areas possess hazards and limitations for any type of irrigated farming under present conditions. Since their reclamation is not
technically and/or economically feasible at present, they are considered to be non-arable land areas.

**AGRO-ECOLOGICAL ZONES**

Iran has been broadly divided into different agro-ecological zones in accordance with their similar conditions of climate and the type of crops grown (Table 3 and Figure 5).

**AGRICULTURAL PRODUCTION**

In Table 4, the cultivated area and agricultural crop and orchard production in the different agro-ecological zones in 2001/02 are shown. Approximately 44 percent of the cultivated crops are rainfed and they produce only 12 percent of the total crop production. However, rainfed wheat accounts for about 35 percent of the total production and rainfed barley for about 34 percent. Ninety percent of the orchards are irrigated (ASSC, 2004; Agronomy Department, 2004; Malakouti et al., 2004).

**Zone 1 – Central zone:** The southeastern part of the zone is situated in dry climatic conditions while the vast western part has seasonal dry conditions. This zone has sedimented soils, calcareous Lithosols and saline swamps.

**Zone 2 – Caspian Coastal zone:** With wet and humid conditions this expanse covers the coast of the Caspian Sea.
Zone 3 – Northwestern zone: This zone covers the north west part of country. It has seasonal dry periods, moderate summers and extreme winters.

Zone 4 – Central Zagros zone: With good rainfall in winter, this region is characterized by dry, warm winds in May-June.

Zone 5 – Khuzestan zone: Extreme transpiration, very hot and humid, this zone in winter has temperatures which can go below 0°C.

Zone 6 – Arid central zone: To the east of this zone is the dry Dasht-e-Kavir desert. But there are parts to the west which receive good rainfall.

Zone 7 – Southern Zagros zone: The average rainfall crosses 270 mm. This region is characterized by extremely warm springs.

Zone 8 – Southern coastal plain zone: The average temperature rarely goes below 15°C and the rate of evapotranspiration is high in winter. This region has seasonal dry conditions.
Zone 9 – Arid Southern zone: With cold winter and warm summers, this zone has similar climatic conditions to zone 8 in that the temperature rarely falls below 15°C.

Zone 10 – Khorasan zone: This zone has an average rainfall between 240-270 mm per year. It is characterized by long cold winters and late rainfall.

Table 5 presents the areas under the major crops.

Information on the main crops, irrigated and rainfed areas under cultivation, total fertilizer use and the fertilizer nutrient ratios, in each province of each agro-ecological zone, is given in the Annex.

Until recently, Iran relied heavily on wheat imports to meet its growing domestic demand. Annual imports have ranged from 2.5 to 7.5 million tonnes per annum during the past two decades, making Iran a major world wheat importer. A record production in 2004 following an already excellent crop in 2003 reduced imports in 2004/05 to 0.2 million tonnes. Over the past two years, the Government has sharply increased
spending on wheat farming by supplying higher quality seeds, improving machinery services, augmenting fertilizer usage and enhancing water systems and pest management practices. The guaranteed procurement prices have been raised significantly. Strong government support for wheat production has played a large role in raising output but favourable weather during these seasons also has had a major impact. At least 40 percent of Iran’s wheat is rainfed with an average yield of only 0.8 tonnes/ha. Even under irrigation the average wheat yield rarely exceeds 3 tonnes/ha, which is low by world standards. (FAO, Food Outlook, April 2005).

Evidently a continuation of favourable weather cannot be guaranteed and efforts to improve yields by manageable means are clearly indicated. These means include balanced and efficient fertilization.

**CLIMATE**

On the basis of the three criteria of moisture regime, winter type and summer type, a total of 28 agro-climatic zones has been differentiated, of which only six (A-C-W, A-C-VW, A-M-VW, SA-K-W, SA-C-W, and SA-K-M) occupy nearly 90 percent of Iran (Figure 6 and Table 6).

The annual rainfall in the past two decades is shown in Table 7 and Figure 7.

**IRRIGATION AND SALINITY**

Of the 15.5 million hectares of cultivated land, over 7 million hectares or 45 percent are under irrigated agriculture (including fallow), with an average holding size of 2.9 ha. By far the most important irrigated crop is wheat. Salinity and drought are among the most important environmental stresses that limit crop production in Iran. Low rainfall, high air temperatures and high evaporation rates are the main factors that cause

### TABLE 5

Areas of the major crops in 2004

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area ('000 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>6 600</td>
</tr>
<tr>
<td>Barley</td>
<td>1 600</td>
</tr>
<tr>
<td>Rice</td>
<td>570</td>
</tr>
<tr>
<td>Maize</td>
<td>250</td>
</tr>
<tr>
<td>Pulses</td>
<td>1 185</td>
</tr>
<tr>
<td>Oil crops</td>
<td>380</td>
</tr>
<tr>
<td>Fruit crops</td>
<td>1 141</td>
</tr>
<tr>
<td>Vegetable crops</td>
<td>550</td>
</tr>
<tr>
<td>Other crops and fallow</td>
<td>4 224</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16 500</strong></td>
</tr>
</tbody>
</table>

Source: FAOSTAT.
water stress and contribute to the development of a saline environment surrounding the plant roots. Natural soil salinity and high concentration of salts in irrigation waters aggravate the situation.

To reduce the impact of these stresses on crop growth, agronomic and genetic approaches may be employed. The advances in biotechnology have made it possible to look for genes that control certain traits suitable for crop tolerance or avoidance of such stresses. Once they are identified, these genes can be transferred from the original genotype to other genotypes or cultivars of a certain crop using genetic engineering procedures. In many regions of Iran, freshwater resources are in short supply. However, saline surface streams or poor-quality groundwater sources are available in large volumes. In such regions, growing salt-tolerant crop species can dramatically increase agricultural output.

There are extensive areas where soils are potentially suitable for crop production but where water is inadequate for economic crop production. Growing drought-tolerant crops can greatly contribute to the economic development of such areas.

According to records in the Planning and Economics Division of Jahad-e-Agriculture Ministry (The Institute for Planning Research and Agricultural Economics), the area under irrigated agriculture has increased from 4.7 to 7 million hectares. It is planned that the area of irrigated land should increase to 10 million hectares by the year 2020. However, during the past 25 years only some 483 000 hectares have been added to irrigated farmland, despite a great deal of effort.

Surface irrigation techniques are used on 98.8 percent of the area equipped for irrigation, 1.2 percent using pressurized irrigation systems. In general, irrigation has a low efficiency, 30 percent as a national average, losses in conveyance and use being very high (FAO, AQUASTAT, Iran country report).

In some areas, a petrogypsic horizon is present in the soil profile, in which secondary gypsum has accumulated to such an extent that the horizon is cemented or indurated. Under these conditions, and if the natural soil drainage is poor, irrigated farming leads to soil salinization. Due to various problems associated with irrigated farming on such soils, it is recommended that such areas should be devoted to pasture.
FIGURE 6
Agro-climatic zones

LEGEND
ROADS
- Highway
- Highway under construction
- Freeway
- Main road
- Other roads
- Secondary roads
- Single-line railway
- Railway under construction
- Capital
- Province capital
- Small province capital
- City
- Town
- Special location

Source: de Pauw, Gaffari and Gasenic, 2002.
### TABLE 6
Agro-climatic zones of Iran, moisture, temperature and area

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Moisture regime</th>
<th>Temperature regime, Winter</th>
<th>Temperature regime, Summer</th>
<th>Percent of country</th>
<th>Approx. area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA-M-VW</td>
<td>Hyper-arid</td>
<td>Mild</td>
<td>Very warm</td>
<td>2.5</td>
<td>41 647</td>
</tr>
<tr>
<td>HA-C-VW</td>
<td>Hyper-arid</td>
<td>Cool</td>
<td>Very warm</td>
<td>0.2</td>
<td>3 687</td>
</tr>
<tr>
<td>A-M-VW</td>
<td>Arid</td>
<td>Mild</td>
<td>Very warm</td>
<td>16.7</td>
<td>286 822</td>
</tr>
<tr>
<td>A-M-W</td>
<td>Arid</td>
<td>Mild</td>
<td>Warm</td>
<td>0.6</td>
<td>9 705</td>
</tr>
<tr>
<td>A-C-VW</td>
<td>Arid</td>
<td>Cool</td>
<td>Very warm</td>
<td>18.7</td>
<td>305 814</td>
</tr>
<tr>
<td>A-C-W</td>
<td>Arid</td>
<td>Cool</td>
<td>Warm</td>
<td>26.2</td>
<td>429 257</td>
</tr>
<tr>
<td>A-C-M</td>
<td>Arid</td>
<td>Cold</td>
<td>Mild</td>
<td>0.0</td>
<td>11</td>
</tr>
<tr>
<td>A-K-W</td>
<td>Arid</td>
<td>Cold</td>
<td>Warm</td>
<td>2.3</td>
<td>36 485</td>
</tr>
<tr>
<td>A-K-M</td>
<td>Arid</td>
<td>Cold</td>
<td>Mild</td>
<td>0.2</td>
<td>2 758</td>
</tr>
<tr>
<td>SA-M-VW</td>
<td>Semi-arid</td>
<td>Mild</td>
<td>Very warm</td>
<td>0.3</td>
<td>5 380</td>
</tr>
<tr>
<td>SA-C-VW</td>
<td>Semi-arid</td>
<td>Cool</td>
<td>Very warm</td>
<td>1.6</td>
<td>26 454</td>
</tr>
<tr>
<td>SA-C-W</td>
<td>Semi-arid</td>
<td>Cool</td>
<td>Warm</td>
<td>7.3</td>
<td>11 752</td>
</tr>
<tr>
<td>SA-C-M</td>
<td>Semi-arid</td>
<td>Cool</td>
<td>Mild</td>
<td>0.0</td>
<td>8</td>
</tr>
<tr>
<td>SA-K-W</td>
<td>Semi-arid</td>
<td>Cold</td>
<td>Warm</td>
<td>17.2</td>
<td>271 593</td>
</tr>
<tr>
<td>SA-K-M</td>
<td>Semi-arid</td>
<td>Cold</td>
<td>Mild</td>
<td>3.0</td>
<td>47 039</td>
</tr>
<tr>
<td>SH-C-VW</td>
<td>Subhumid</td>
<td>Cool</td>
<td>Very warm</td>
<td>0.0</td>
<td>344</td>
</tr>
<tr>
<td>SH-C-W</td>
<td>Subhumid</td>
<td>Cool</td>
<td>Warm</td>
<td>0.5</td>
<td>8 380</td>
</tr>
<tr>
<td>SH-K-W</td>
<td>Subhumid</td>
<td>Cold</td>
<td>Warm</td>
<td>0.8</td>
<td>12 248</td>
</tr>
<tr>
<td>SH-K-M</td>
<td>Subhumid</td>
<td>Cold</td>
<td>Mild</td>
<td>1.0</td>
<td>15 529</td>
</tr>
<tr>
<td>SH-K-C</td>
<td>Subhumid</td>
<td>Cold</td>
<td>Cool</td>
<td>0.0</td>
<td>33</td>
</tr>
<tr>
<td>H-C-W</td>
<td>Humid</td>
<td>Cool</td>
<td>Warm</td>
<td>0.3</td>
<td>4 682</td>
</tr>
<tr>
<td>H-K-W</td>
<td>Humid</td>
<td>Cold</td>
<td>Warm</td>
<td>0.0</td>
<td>395</td>
</tr>
<tr>
<td>H-K-M</td>
<td>Humid</td>
<td>Cold</td>
<td>Mild</td>
<td>0.0</td>
<td>419</td>
</tr>
<tr>
<td>H-K-C</td>
<td>Humid</td>
<td>Cold</td>
<td>Cool</td>
<td>0.0</td>
<td>53</td>
</tr>
<tr>
<td>PH-C-W</td>
<td>Per-humid</td>
<td>Cool</td>
<td>Warm</td>
<td>0.5</td>
<td>8 502</td>
</tr>
<tr>
<td>PH-K-W</td>
<td>Per-humid</td>
<td>Cold</td>
<td>Warm</td>
<td>0.0</td>
<td>48</td>
</tr>
<tr>
<td>PH-K-M</td>
<td>Per-humid</td>
<td>Cold</td>
<td>Mild</td>
<td>0.0</td>
<td>8</td>
</tr>
<tr>
<td>PH-K-C</td>
<td>Per-humid</td>
<td>Cold</td>
<td>Cool</td>
<td>0.0</td>
<td>19</td>
</tr>
</tbody>
</table>

Source: de Pauw et al., 2002.

### TABLE 7
Average annual rainfall during the last two decades

<table>
<thead>
<tr>
<th>Year</th>
<th>Average rainfall (mm)</th>
<th>Year</th>
<th>Average rainfall (mm)</th>
<th>Year</th>
<th>Average rainfall (mm)</th>
<th>Year</th>
<th>Average rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984/85</td>
<td>192</td>
<td>1989/90</td>
<td>223</td>
<td>1994/95</td>
<td>282</td>
<td>1999/00</td>
<td>148</td>
</tr>
</tbody>
</table>
FIGURE 7
Rainfall trends during the past two decades
Chapter 3
Farming systems

Some of the earliest food producing activities were probably closely connected with the utilization of the rivers and springs. Some of the springs in the Kermanshah region probably irrigated large areas. Ghanats or underground channels or galleries as a source of irrigation have apparently been used for a long time. It seems that, in general, climate, topography and the fact that wheat and barley are essential and form a major part of the diet of the peasants, have greatly influenced agricultural practices. Most of the earlier attempts at cultivation were made in the foothills and the less sloping parts of the uplands, where wheat or barley was the surest crop. Many of the stream valleys probably were not inhabited during ancient times because of malaria and other diseases. Some of the valleys were under irrigation mainly for growing vegetables and fruits.

Some form of agriculture has been practiced in Iran for many centuries and even thousands of years. There has been a historical transition from man as a food collector to man as a food producer. Early efforts, of course, were concentrated on livestock raising and probably only small plots were used for growing subsistence crops. Evidence is accumulating that at least part of this transition took place during the early Persian civilization, and in the fertile crescent of the Middle East, about 6,000 to 8,000 years ago.

In more modern times, before 1962, half the cultivable land of the country was in the hands of great land lords (khans) and was considered to be private property (melk). The domains of these landowners could be vast, extending to 20, 30 or 40 villages. Many villagers, especially those who cultivated the land, were serfs (roaya). Besides the vast holdings of the great landowners, some 20 percent of the cultivable land was owned by people of more modest means (the khordehmaelekin), who nonetheless would have cultivators working for them on their smallholdings. The remainder of the cultivable land was held in a kind of fiduciary ownership, either in ways that resembled a private trust (vaghf-e khass) or for
religious and public purposes (*vaghf-e amm*). The cultivators of arable land (*nasagh*) lived in rural settlements, together with landless people (*khoshneshin*), who would be artisans, traders, workers of various kinds and unemployed or unemployable people. The patterns of land ownership in Iran, and its associated social problems, necessitated a nationwide land reform to liberate the farmers from the bondage of serfdom.

An important change in the agricultural structure of Iran occurred after the passing of a land reform law in 1962. This limited the size of private holdings to 20 ha of irrigated land. As a result, large areas were distributed to landless labourers. In 1976, the bulk of the rural population, more than 60 percent, dwelt on smallholdings of less than 10 ha, but their contribution was no more than 20 percent of the marketed output of the agricultural sector of the economy. Tens of thousands of rural villagers, cultivators and wage earners were freed from exploitation by landlords or their middlemen, but they continued to be constrained in other ways. Many small landowners even experienced a decline in real income as their holdings diminished in size. Administrative and political difficulties, particularly the lack of managerial experience, limited the overall success of the scheme in terms of agricultural production.

The 1979 Islamic Revolution brought with it new social and structural forces that further transformed the agrarian structure. The most spectacular change in the modes of agricultural production after the 1979 revolution was the establishment of *mosha* (collective ownership) cooperatives. In the private sector, on the other hand, the fall of many big agricultural enterprises coincided with the maintenance of the middle sector, the preservation of large state-owned farms, the incorporation of large private farms into the public sector, semi-public farm corporations and the dissolution of production cooperatives. Most of the small-scale production units belong to independent peasants. Independent peasant production units are the basis of agricultural production in most parts of Iran (Dewan and Famouri, 1964; Balali *et al.*, 2003).
Chapter 4
The fertilizer sector

FERTILIZER SUPPLIES
The production of fertilizers started in Iran in 1945, in a small factory near the city of Karaj. Within ten years it had reached a production potential of around 60 tonnes. The main products were single super phosphate (SSP), thermo phosphate, bone powder and potassium nitrate. It was in 1955 that 176 tonnes of mineral fertilizers were imported into the country by the government for the first time. Along with this importation, the private sector also purchased 305 tonnes of mineral fertilizer. Later, the sugar industry also started to import on its own behalf. In the 1960s there were more than 17 different types of mineral fertilizers used in the country including five different N-fertilizers, four P-fertilizers, three types of K-fertilizers and more than five varieties of mixed fertilizers.

In the 1970s, with the establishment of Razi Petrochemical Industries, the government banned imports by the private sector. This company produced mainly triple superphosphate (TSP), diammonium phosphate (DAP) and ammonium sulphate (AS).

PRODUCTION OF FERTILIZERS
The National Petrochemical Company manufactures a total of 1.8 million tonnes of urea and ammonium phosphates annually. After the revolution, at the initiative of Soil and Water Research Institute (SWRI) and as a result of soil testing, it became evident that a comprehensive plan for developing fertilizer production in the country was necessary. As a result, production by the private sector of fertilizers, including micronutrients, was promoted. This has led to the manufacture of a range of fertilizers since 1995. Over two hundred small manufacturers in different parts of Iran have been issued with permits to produce in total about two million tonnes of NPK compound fertilizers. Since 1995 many manufacturers have begun to produce micronutrient fertilizers such as zinc sulphate, copper
sulphate, manganese sulphate, iron sulphate and boric acid. Several plants have recently begun the manufacture of superphosphate fertilizers (SSP or TSP) in locations where high-grade rock phosphates are plentiful. Several production units are engaged in making various types of sulphur materials such as sulphur coated urea, whose local name is Sari fertilizer, etc.

The 200 private fertilizer manufacturing units employ some 40 000 workers, directly or indirectly. However, the total number of plants that have good production capability, with an annual production capacity of a hundred thousand tonnes of quality fertilizers, does not exceed five in all, the others being small-scale producers. Total production from the sector reaches only about 0.5 million tonnes annually. Due to unstable demand and purchasing programmes, many manufacturers are facing problems with production and schedules.

In view of these problems, in 2001 the Organization of Professional Fertilizer Producers (OPFP) was established at the initiative of some active manufacturers. The objective is to coordinate and direct the members’ activities so as to meet the demand quantitatively and qualitatively. At present some 80 percent of the manufacturers claim membership of the organization.

The total production of mineral fertilizers between April and September 2004 by all production units amounted to 1 314 thousand tonnes (Table 8). Of this total, 979 thousand tonnes were produced by the state-owned industries, a reduction of 5 percent compared with last year. The private sector produced 336 thousand tonnes, an increase of 28 percent in comparison with last year.

In 2004, 57 percent of mineral fertilizers, 80 percent of pesticides, and 100 percent of seeds were produced nationally, by both the public and private sectors.

**FERTILIZER CONSUMPTION**

Figures 8 and 9 show trends in fertilizer consumption during the past four decades.

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Production of mineral fertilizers, April to September 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fertilizer</strong></td>
<td><strong>Production ('000 tonnes)</strong></td>
</tr>
<tr>
<td>Urea</td>
<td>777</td>
</tr>
<tr>
<td>Ammonium phosphate</td>
<td>151</td>
</tr>
<tr>
<td>AN</td>
<td>103</td>
</tr>
<tr>
<td>AS</td>
<td>13</td>
</tr>
<tr>
<td>Different fertilizers</td>
<td>261</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1 304</td>
</tr>
</tbody>
</table>

Chapter 4 – The fertilizer sector

The improvements in fertilizer use are recorded in Table 10.

The development in recent years of the importation and consumption of potassium fertilizers, starting from almost zero, may be noted.

The predicted fertilizer use in 2004/05 is shown in Table 11.

DEMAND AND SUPPLY

Domestic fertilizer production cannot meet the total demand (Table 12). Additional supplies are provided by imports by the private sector. For example, in the period from April to September 2004, imports by the

### TABLE 9

<table>
<thead>
<tr>
<th>Zone Name</th>
<th>Number</th>
<th>Irrigated</th>
<th>Rainfed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>1</td>
<td>239</td>
<td>61</td>
<td>300</td>
</tr>
<tr>
<td>Caspian Coastal Plain</td>
<td>2</td>
<td>262</td>
<td>107</td>
<td>369</td>
</tr>
<tr>
<td>North Western</td>
<td>3</td>
<td>264</td>
<td>183</td>
<td>447</td>
</tr>
<tr>
<td>Central Zagros</td>
<td>4</td>
<td>323</td>
<td>101</td>
<td>424</td>
</tr>
<tr>
<td>Khuzestan</td>
<td>5</td>
<td>228</td>
<td>78</td>
<td>306</td>
</tr>
<tr>
<td>Arid Central</td>
<td>6</td>
<td>239</td>
<td>63</td>
<td>302</td>
</tr>
<tr>
<td>Southern Zagros</td>
<td>7</td>
<td>353</td>
<td>108</td>
<td>461</td>
</tr>
<tr>
<td>Southern Coastal Plain</td>
<td>8</td>
<td>41</td>
<td>10</td>
<td>51</td>
</tr>
<tr>
<td>Arid Southern</td>
<td>9</td>
<td>211</td>
<td>44</td>
<td>256</td>
</tr>
<tr>
<td>Khorasan</td>
<td>10</td>
<td>278</td>
<td>84</td>
<td>362</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>2437</strong></td>
<td><strong>839</strong></td>
<td><strong>3276</strong></td>
</tr>
</tbody>
</table>

The improvements in fertilizer use are recorded in Table 10.
The development in recent years of the importation and consumption of potassium fertilizers, starting from almost zero, may be noted.
The predicted fertilizer use in 2004/05 is shown in Table 11.

### FIGURE 8

Trends in fertilizer consumption changes during the past four decades

The development in recent years of the importation and consumption of potassium fertilizers, starting from almost zero, may be noted.
The predicted fertilizer use in 2004/05 is shown in Table 11.
private sector amounted to 275 thousand tonnes, of which 198 thousand tonnes were compound fertilizers and 52 thousand tonnes phosphate fertilizers. Based on the research carried out, the annual fertilizer needs in the country for the next 15 years is calculated and shown in Table 13.
### TABLE 11
Forecast fertilizer use in 2004/05

<table>
<thead>
<tr>
<th>Type</th>
<th>Type</th>
<th>Type</th>
<th>Type</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>('000 tonnes)</td>
<td>('000 tonnes)</td>
<td>('000 tonnes)</td>
<td>('000 tonnes)</td>
</tr>
<tr>
<td>Urea</td>
<td>1500</td>
<td>Compound (fertigation)</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>AN</td>
<td>150</td>
<td>S coated urea (SCU) + 1 % Zn</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>AS</td>
<td>150</td>
<td>SOP</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>DAP</td>
<td>350</td>
<td>MOP</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>TSP</td>
<td>300</td>
<td>Bio-organic sulphur</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>SSP</td>
<td>100</td>
<td>Zinc sulphate (granular)</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Golden biophosphate</td>
<td>25</td>
<td>Zinc sulphate (powder)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>P-solubilizer phosphate</td>
<td>50</td>
<td>Potassium magnesium sulphate</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>15-10-15 + 1 percent Zn¹</td>
<td>600</td>
<td>PGPR &amp; other biofertilizers</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>15-10-15 + 1 percent Zn²</td>
<td>125</td>
<td>Other micronutrients</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4200</strong></td>
<td></td>
<td></td>
<td><strong>4200</strong></td>
</tr>
</tbody>
</table>

¹ On MOP basis
² On SOP basis
³ Plus 500 000 tonnes of organic fertilizers

### TABLE 12
Projected demand and supply of fertilizers in 2004/05, ('000 tonnes)

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Demand</th>
<th>Domestic production</th>
<th>Public imports</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>1 888</td>
<td>1 430</td>
<td>211</td>
<td>1 641</td>
</tr>
<tr>
<td>AN</td>
<td>215</td>
<td>180</td>
<td>-</td>
<td>150</td>
</tr>
<tr>
<td>AS</td>
<td>148</td>
<td>20</td>
<td>56</td>
<td>76</td>
</tr>
<tr>
<td>DAP</td>
<td>413</td>
<td>280</td>
<td>-</td>
<td>280</td>
</tr>
<tr>
<td>TSP</td>
<td>423</td>
<td>5</td>
<td>238</td>
<td>243</td>
</tr>
<tr>
<td>SSP</td>
<td>80</td>
<td>40</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>Potassium sulphate</td>
<td>200</td>
<td>-</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>MOP</td>
<td>195</td>
<td>-</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Compounds (crops)</td>
<td>450</td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Compounds (orchards)</td>
<td>45</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Compounds (irrigation)</td>
<td>5</td>
<td>10</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Zinc sulphate powdered</td>
<td>50</td>
<td>4</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Zinc sulphate granulated</td>
<td>20</td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Sulphur coated urea</td>
<td>20</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Magnesium potassium sulphate</td>
<td>5</td>
<td>15</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Granular organic sulphur</td>
<td>53</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Microbial phosphate</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Azotobacter inoculant</td>
<td>2.5</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Chickpea <em>Rhizobium</em> inoculant</td>
<td>0.02</td>
<td>0.02</td>
<td>-</td>
<td>0.02</td>
</tr>
<tr>
<td>Bean <em>Rhizobium</em> inoculant</td>
<td>0.02</td>
<td>0.02</td>
<td>-</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4 220</strong></td>
<td><strong>2 222</strong></td>
<td><strong>621</strong></td>
<td><strong>2 843</strong></td>
</tr>
</tbody>
</table>

TABLE 13
Fertilizer demand and forecasted requirements up to 2017/18, ('000 tonnes)

<table>
<thead>
<tr>
<th>Fertilizer Yearly increase (%)</th>
<th>Nitrogen 4 %</th>
<th>Phosphate 3 %</th>
<th>Potash 4 %</th>
<th>Sulphur 10-25 %</th>
<th>Micro-nutrient 5-20 %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003/04</td>
<td>2 400</td>
<td>840</td>
<td>470</td>
<td>50</td>
<td>100</td>
<td>3 860</td>
</tr>
<tr>
<td>2004/05</td>
<td>2 600</td>
<td>900</td>
<td>500</td>
<td>100</td>
<td>100</td>
<td>4 200</td>
</tr>
<tr>
<td>2005/06</td>
<td>2 700</td>
<td>900</td>
<td>500</td>
<td>125</td>
<td>125</td>
<td>4 400</td>
</tr>
<tr>
<td>2006/07</td>
<td>2 800</td>
<td>950</td>
<td>550</td>
<td>125</td>
<td>125</td>
<td>4 600</td>
</tr>
<tr>
<td>2007/08</td>
<td>2 800</td>
<td>950</td>
<td>550</td>
<td>150</td>
<td>150</td>
<td>4 600</td>
</tr>
<tr>
<td>2008/09</td>
<td>2 800</td>
<td>950</td>
<td>550</td>
<td>150</td>
<td>150</td>
<td>4 600</td>
</tr>
<tr>
<td>2009/10</td>
<td>2 900</td>
<td>1 000</td>
<td>600</td>
<td>200</td>
<td>150</td>
<td>4 850</td>
</tr>
<tr>
<td>2010/11</td>
<td>2 900</td>
<td>1 000</td>
<td>600</td>
<td>200</td>
<td>150</td>
<td>4 850</td>
</tr>
<tr>
<td>2011/12</td>
<td>3 000</td>
<td>1 000</td>
<td>600</td>
<td>250</td>
<td>150</td>
<td>5 000</td>
</tr>
<tr>
<td>2012/13</td>
<td>3 000</td>
<td>1 000</td>
<td>600</td>
<td>250</td>
<td>150</td>
<td>5 000</td>
</tr>
<tr>
<td>2013/14</td>
<td>3 100</td>
<td>1 000</td>
<td>600</td>
<td>300</td>
<td>200</td>
<td>5 200</td>
</tr>
<tr>
<td>2014/15</td>
<td>3 200</td>
<td>1 000</td>
<td>600</td>
<td>300</td>
<td>200</td>
<td>5 300</td>
</tr>
<tr>
<td>2015/16</td>
<td>3 300</td>
<td>1 100</td>
<td>700</td>
<td>400</td>
<td>200</td>
<td>5 900</td>
</tr>
<tr>
<td>2016/17</td>
<td>3 500</td>
<td>1 100</td>
<td>750</td>
<td>500</td>
<td>250</td>
<td>6 200</td>
</tr>
</tbody>
</table>

1 Excluding organic and biological fertilizers, estimated annual use about 500 000 tonnes.

FERTILIZER USE BY CROP
In Iran there are no reliable records of the amount of fertilizer used by each individual crop, apart from wheat. The total amount of fertilizer used by province is known. Also the amount of fertilizer used on wheat is known. Based on this information, estimates of fertilizer use in 2001/02 on wheat, orchards and other crops are given in Table 14.

TABLE 14
Annual fertilizer use on different crops in 2001/02 (%)

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Wheat</th>
<th>Other crops</th>
<th>Orchards</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>43</td>
<td>40</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Phosphate</td>
<td>42</td>
<td>41</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Potash</td>
<td>24</td>
<td>59</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Macronutrient</td>
<td>40</td>
<td>45</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Micronutrient</td>
<td>47</td>
<td>47</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>42</td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>

Chapter 5
Fertilizer use recommendations and balanced fertilization

FERTILIZER USE RECOMMENDATIONS
Fertilizer recommendations for the major crops in selected provinces are shown in Table 15.

Some crop growers use higher levels of potassium, sulphur and micronutrients compared with the SWRI recommendations.

<table>
<thead>
<tr>
<th>Major producing province</th>
<th>Major crops</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Azarbajian</td>
<td>Potato</td>
<td>225</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Onion</td>
<td>250</td>
<td>120</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>50</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Fars</td>
<td>Wheat</td>
<td>180</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>230</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Cotton</td>
<td>150</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Gilan</td>
<td>Rice</td>
<td>100</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Golestan</td>
<td>Wheat</td>
<td>150</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Rape seed</td>
<td>160</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Cotton</td>
<td>175</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Hamedan</td>
<td>Alfalfa</td>
<td>50</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Potato</td>
<td>200</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Khorasan</td>
<td>Wheat</td>
<td>175</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>180</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Cotton</td>
<td>180</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Khuzestan</td>
<td>Wheat</td>
<td>180</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>180</td>
<td>125</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cotton</td>
<td>190</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Mazandaran</td>
<td>Rice</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Soybean</td>
<td>50</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>150</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>West Azarbajian</td>
<td>Sunflower</td>
<td>150</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Sugar beet</td>
<td>125</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>125</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>
The increased mineral fertilizer consumption in Iran during the 1980s and the first half of the 1990s brought with it an unbalanced use of primary nutrients. Phosphorus application rates were in excess of crop needs, resulting in the accumulation of phosphorus in major farming areas and causing the precipitation of certain micronutrients present in the soil, especially zinc and iron. The application rates of potash plus quantities released from the soil were lower than plant uptake requirements. Micronutrients were rarely applied. An improvement in the nutrient balance since the mid-1990s is indicated in Tables 16 and 17.

The fertilizer use efficiency (FUE) is based on two assumptions: a) fertilizers produced 50 percent more yield in comparison with control plots and b) yield concerns only the grain and edible parts of the products. It is also calculated based on the papers of Raun and Johnson (1999). The

### TABLE 16
<table>
<thead>
<tr>
<th>Years</th>
<th>Average amount of fertilizer used per year ('000 tonnes)</th>
<th>Ratio (N:P₂O₅:K₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-1969</td>
<td>110</td>
<td>100:68:07</td>
</tr>
<tr>
<td>1970-1979</td>
<td>630</td>
<td>100:75:01</td>
</tr>
<tr>
<td>1980-1989</td>
<td>1 500</td>
<td>100:83:01</td>
</tr>
<tr>
<td>1990-1999</td>
<td>2 200</td>
<td>100:70:08</td>
</tr>
<tr>
<td>2000-2005</td>
<td>3 000</td>
<td>100:55:18</td>
</tr>
</tbody>
</table>

### TABLE 17
<table>
<thead>
<tr>
<th>Year</th>
<th>Annual rainfall (mm)</th>
<th>Fertilizer use ('000 tonnes)</th>
<th>Agricultural production (million tonnes)</th>
<th>Nutrient ratio N-P₂O₅-K₂O+ micronutrient %</th>
<th>FUE¹ kg production /kg fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989/90</td>
<td>238</td>
<td>2 114</td>
<td>45.4</td>
<td>100-75-00+0</td>
<td>10.8</td>
</tr>
<tr>
<td>1991/92</td>
<td>314</td>
<td>2 608</td>
<td>62.5</td>
<td>100-70-00+0</td>
<td>12.0</td>
</tr>
<tr>
<td>1993/94</td>
<td>202</td>
<td>1 946</td>
<td>53.3</td>
<td>100-70-03+0</td>
<td>13.9</td>
</tr>
<tr>
<td>1994/95</td>
<td>282</td>
<td>1 933</td>
<td>54.7</td>
<td>100-63-01+0</td>
<td>14.2</td>
</tr>
<tr>
<td>1995/96</td>
<td>231</td>
<td>2 225</td>
<td>55.9</td>
<td>100-54-08+0.2</td>
<td>12.6</td>
</tr>
<tr>
<td>1997/98</td>
<td>314</td>
<td>1 942</td>
<td>65.0</td>
<td>100-43-06+0.5</td>
<td>11.8</td>
</tr>
<tr>
<td>1998/99</td>
<td>195</td>
<td>2 400</td>
<td>60.7</td>
<td>100-44-15+1.0</td>
<td>12.7</td>
</tr>
<tr>
<td>1999/00</td>
<td>148</td>
<td>3 100</td>
<td>57.0</td>
<td>100-50-14+1.2</td>
<td>9.2</td>
</tr>
<tr>
<td>2000/01</td>
<td>182</td>
<td>3 060</td>
<td>59.1</td>
<td>100-40-18+1.7</td>
<td>9.7</td>
</tr>
<tr>
<td>2001/02</td>
<td>254</td>
<td>3 275</td>
<td>71.3</td>
<td>100-51-15+1.5</td>
<td>10.9</td>
</tr>
<tr>
<td>2002/03</td>
<td>247</td>
<td>2 880</td>
<td>76.5</td>
<td>100-39-11+1.0</td>
<td>13.5</td>
</tr>
<tr>
<td>2003/04</td>
<td>243</td>
<td>3 100</td>
<td>77.2</td>
<td>100-50-15+1.0</td>
<td>12.5</td>
</tr>
</tbody>
</table>

¹ FUE = fertilizer use efficiency
FUE is higher in some parts of the country than in others. It is assumed that this is mainly due to a higher soil organic matter content or the optimal use of organic fertilizers, especially manure.

The figures in Table 17 indicate that rainfall has had a major impact on production. The same is probably true of improvements in other crop production practices. Crop yields have increased by more than 20 percent on average. The improvement in the nutrient balance is partly due to the implementation of fertilizer recommendations based on soil tests. Fifty soil-testing laboratories have been established.

The fertilizer use ratio of nitrogen (N), phosphorus (P₂O₅), potassium (K₂O), and micronutrients is targeted to improve to 100-50-40+4 percent micronutrients in 2010 provided that the materials are available for application and in time (Malakouti, 1996; Bybordi et al., 2000; Malakouti, et al., 2001 and 2004). A balanced application of fertilizers could improve the production levels by up to 60 percent (Malakouti; 1996; Harris, 1998; Hamdallah, 2000; Roy, 2001; Balali et al., 2003; Malakouti et al., 2004).
Chapter 6
Organic manures, biological fertilizers and micronutrients

ORGANIC MANURES
No exact figures are available for the production or use of manure in the country. Unofficial sources put the production of cattle and poultry manure at 31 million tonnes. It is estimated that about 30 percent of this amount is burnt as fuel by farmers who cannot afford other types of fuel. Out of the remaining 70 percent, part is just disposed of and the benefit of the nutrient and organic content is lost.

BIOLOGICAL FERTILIZERS
Currently some private companies are producing biofertilizers and compost. The municipal corporations of major cities too are involved in the production of compost and vermi-compost. There is no record of their production and sales.

In the context of increasing the yields of food crops by promoting balanced nutrient application, the production and application of biological fertilizers have been encouraged during the last four years. Three main private companies now produce biofertilizers. The main types of biofertilizers produced include: *Thiobacillus* (sulphur-oxidizing bacteria) along with zinc, Granulated Phosphate Solubilizing Bacteria and *Azotobacter* (a free living nitrogen fixer).

There are, however, distribution and marketing problems, especially in view of the limited shelf life of these materials. For example, one producer of *Azotobacter* inoculums produced two million one-kg packages of the material in three months, but unfortunately the company ran into problems of timely distribution and application. Another producer reports that more than 30 percent of its *Azotobacter* packages are still in the storage facilities of the company in Kerman.
MICRONUTRIENTS

Micronutrient deficiencies are a widespread health hazard, especially with regard to iron, vitamin A and zinc, particularly in developing countries.

The World Health Organization (WHO) announced in 1996 that the molar ratio of phytic acid to zinc (PA/Zn) should not exceed 25, otherwise the absorption through the digestive system of minerals, including zinc, contained in our diet, especially bread, becomes problematic. Three investigations on the level of body zinc among the young population in Iran indicate a serious problem of zinc deficiency. Research results indicate that a balanced application of nutrients (phosphate rates based on soil tests) and zinc sulphate on wheat fields lowers the PA/Zn ratio in the wheat grain and consequently improve the rates of absorption of minerals through the digestive system. Increasing the levels of grain phosphorus cause an increase in the phytic acid content. In general, unbalanced fertilization (high levels of phosphorus and low rates of zinc) increases the PA/Zn ratio while the application of zinc sulphate increases the concentration of zinc in the grain and decreases the level of phytic acid.

Investigations on the effect of zinc application on various wheat varieties have shown that, in addition to reducing the concentrations of phytic acid in the wheat grain, improved yields have been obtained.

To improve crop yield in the cultivated areas, gypsiferous soils must be supplied with sufficient micronutrients, particularly zinc. Among other options, utilization of mycorrhiza fungi or symbiotic bacteria, which do not need organic matter to survive, can be used to increase the amount of available P in such problem soils.
Chapter 7
Fertilizer distribution and services

COOPERATIVES
Rural farm cooperatives, employing agricultural specialists and technicians, can serve as effective organizations for promoting a sustainable system of agriculture. Farm cooperatives have always acted as lead groups for projects that are designed to improve farming in general, and the application of fertilizers, pesticides and herbicides in particular. Soil laboratories are serving a number of rural farm cooperatives like those of Sabzevar and Kerman.

Currently more than 1,000 rural farm cooperatives have been organized across the country. They cover some 3 million hectares of farmland and claim more than 260,000 farmer members in more than 4,600 rural communities. Crop yields per unit area of farmland in communities that are served by cooperatives are often higher than the yields obtained in the adjacent farms, or in their provinces or the country as a whole. Moreover, the production of field and horticultural crops has increased considerably in those areas.

Central Organization of Iranian Rural Production Cooperatives
The Central Organization of Iranian Rural Cooperatives (COIRPC) aims at the development, extension and strengthening of the cooperatives thus improving marketing and developing rural cooperation services activities. The activities of this organization include teaching, training in management and other courses, personnel training, accounting, purchase and safe storage of produce by companies and cooperatives and their distribution to appropriate markets. This organization also supervises the construction of buildings and utilities such as storehouses, cold storage, shops, factories, offices etc. They organize exhibitions to introduce farmer produce to the market, provide technical assistance and support services. They deal with insurance, the economic supervision of other cooperatives
and provide technical and consultancy assistance concerning publicity and marketing.

The rural and agricultural cooperative network has 4,935 branches including the Rural Women’s Cooperatives, 340 units, 10,693 shops, and 11,794 units for the distribution of fuel. With around 5 million members, the network covers 98 percent of the villages of the country, with a population of approximately 25 million people.

**Farmers’ House**
The “Farmers’ House” was established in order to protect the right of the farmers. Comprising agriculturists, farmers and scientific personnel, it was created in order to represent farmers’ interest to relevant officials in the government. Farmers’ House endeavours to develop the agricultural sector in the political, social, economic and cultural fields. It aims to eradicate poverty in the rural sector by emphasizing the necessity of legislation and the prevention of the invasion of agricultural land by other sectors. It also aims to convert traditional agriculture into an advanced and sustainable agriculture, using appropriate modern technology with the rational use of agricultural inputs.

**AGRICULTURAL SUPPORT SERVICES COMPANY**
The Agricultural Support Services Company (ASSC) is responsible for providing and distributing mineral fertilizers, pesticides, seeds and improved plant varieties. It has played an important and vital role in increasing the quality and quantity of agricultural products. ASSC has distributed 3.1 million tonnes of mineral fertilizers annually on average during the past three years. This compares with an average of 2 million tonnes of mineral fertilizers in the decade prior to 1990. It also distributes pesticides and seeds.

**FERTILIZER PRICES AND SUBSIDIES**
**Prices**
The prices of fertilizers announced by the government in 2004 are shown in Table 18.
Subsidies
The Government of Iran has subsidized all mineral fertilizers for the past three decades. The amount of subsidy two years ago, when the total production was less than three million tonnes, was US$70 million. The subsidy was paid to the Iranian petro-chemical industry, to permit it to sell fertilizers at reduced prices. Due to an increase in the amount of fertilizer used, i.e. 3 276 and 3 700 million tonnes in the years 2002 and 2004 respectively, and the increased cost of fertilizers, the fertilizer subsidy given by the government now amounts to more than about US$200 million. The subsidy on fertilizer may contribute to the smuggling of fertilizers to neighbouring countries (Statistics and Information Technology Office, 2001/2004).

<table>
<thead>
<tr>
<th>Type of fertilizer</th>
<th>Price (Rial/kg)</th>
<th>Type of fertilizer</th>
<th>Price (Rial/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>450</td>
<td>Compound (irrigation)</td>
<td>428</td>
</tr>
<tr>
<td>AN</td>
<td>375</td>
<td>Zinc sulphate powdered</td>
<td>1 360</td>
</tr>
<tr>
<td>AS</td>
<td>425</td>
<td>Zinc sulphate granulated</td>
<td>1 360</td>
</tr>
<tr>
<td>DAP</td>
<td>640</td>
<td>Sulphur coated urea</td>
<td>520</td>
</tr>
<tr>
<td>TSP</td>
<td>515</td>
<td>Magnesium potassium sulphate</td>
<td>510</td>
</tr>
<tr>
<td>SSP</td>
<td>260</td>
<td>Granulated organic sulphur</td>
<td>465</td>
</tr>
<tr>
<td>Potassium sulphate</td>
<td>535</td>
<td>Microbial phosphate fertilizer</td>
<td>5 140</td>
</tr>
<tr>
<td>MOP</td>
<td>410</td>
<td>Azotobacter inoculant (Biofertilizers)</td>
<td>5 140</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>470</td>
<td>Chickpea <em>Rhizobium</em> inoculant</td>
<td>5 140</td>
</tr>
<tr>
<td>Compound (crops)</td>
<td>575</td>
<td>Bean <em>Rhizobium</em> inoculant</td>
<td>465</td>
</tr>
<tr>
<td>Compound (orchards)</td>
<td>645</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 US$ = 8 800 Rials (December 2004)
Chapter 8
Fertilizer research

Fertilizer research in Iran is carried out mainly by the SWRI. The research is carried out at different agricultural universities, which provide the SWRI with the data they require.

In 1995, the SWRI initiated the study of fertilizer application rates in relation to the levels of soil nutrients and crop needs/uptake. The result has been a tangible improvement of the N-P$_2$O$_5$-K$_2$O+ percent micronutrients ratio to 100-45-23+1.5 percent micronutrients. SWRI intends to achieve by 2015 a ratio of 100-45-35 for primary nutrients, to increase the use of sulphur to 500 000 tonnes and to increase the consumption of micronutrients to 4 percent of the total national fertilizer use level.

SWRI’s achievements in the balanced use of different mineral fertilizers have been instrumental in improving the soil fertility of major farming areas to such an extent that, despite the persistent droughts of the last few years, sustainable farming is now in evidence in some main regions. SWRI has contributed significantly to a reduction of the overuse of fertilizers, thereby reducing the pollution of rivers and underground water reservoirs.

The average yields per unit area of the three major crops, i.e. wheat, rice and sugar beet, have improved to the extent of 25 to 30 percent during the past five years.

Through SWRI’s efforts, for the first time in 2005, the state-guaranteed purchase price of wheat from the farmers will be determined by the protein content of the grain. In addition, SWRI’s efforts in the production and promotion of the use of enriched (biofortified) seeds are contributing substantially to the qualitative enhancement of crops.

SWRI’s research and its implementation have improved the balance of nutrition of horticultural and field crops. For example, there has been a substantial increase in the importation and consumption of potassium chloride and potassium sulphate, almost non-existent in Iran as late as
1998. Today, Iran is the largest consumer of potassium fertilizers in the West Asia and North Africa (WANA) region. By putting emphasis on the value of sulphur as a plant nutrient and soil amendment, SWRI’s research has been effective in initiating the consumption of elemental sulphur with *Thiobacillus* bacteria. This also provides an outlet for excess recovered sulphur produced by the oil and gas industry.

Researchers have actively assisted in the establishment of 65 soil and plant analysis laboratories by the private sector.

Finally, thanks to SWRI’s efforts, a High Council of Health has been formed, headed by the President of Iran.

Most of the research is in the following fields.

**Plant nutrition**
- The relationship between plant nutrients and fruiting.
- The reasons for physiological problems in fruit trees.
- Explanation of calcium deficiency in fruits.

**Soils and land planning**
- Study of Zn, Mg and S levels in the soils of the country and their role in increasing or reducing agricultural production.
- Promoting balanced fertilization as a contribution to a sustainable land use system.
- Devising and implementing innovative methods for cost effective, systematic studies and land evaluation schemes to facilitate the collection of data relevant to advanced techniques such as remote sensing (RS) and the geographical information system (GIS), for the integration of different data on Iran’s soil resources.

**Efficient fertilization**
- Fertilizer recommendations, their types and use.
- Appropriate fertilizer nutrient application ratios.
- Use of the chlorophyll meter to identify nitrogen deficiency.
- Identification of critical and optimum levels of nutrients in soil and plants.
- Tailoring fertilizer application rates to the specific soil-plant needs of different regions.
Limiting the application of P-fertilizers to the specific soil-plant requirements of the different regions.

**Fertilizer application**
- Foliar application of nutrients, especially micronutrients such as zinc and Fe-EDDHA to deal with lime induced chlorosis and the proper method of application.
- Injection of nutrients into the stock of trees.
- Promoting split and foliar applications of fertilizers to increase the absorption efficiency of plant nutrients, optimizing the amount and frequency of fertilizer application according to the soil-plant needs.
- Improving plant nutrient uptake by practices such as the band application of fertilizers for field crops, localized deep placement of fertilizers mixed with farmyard manure in orchards and the acidification of irrigation water to reduce the pH in calcareous soils prior to fertilizer application.

**Environment and health**
- Improvement of public health through the fortification of wheat.
- Sharing with researchers and experts information regarding harmful contaminants such as nitrate and cadmium in vegetables, fruits, potatoes, onions, other agricultural products, and their presence in underground water.

**Biological and organic fertilizers**
- Research on the production of vermi-compost from agricultural residues for soil improvement.
- Technical information concerning the production of liquid humus fertilizer.
- Work on sulphur coated urea (SCU) *Rhizobium*, *Thiobacillus*, plant growth promoting *Rhizobium* (PGPR) and P-solubilizing inoculants, in collaboration with the Scientific Research and Industrial Organization of Iran (SRIO). The know-how is licensed
to the private sector for the mass production (more than 100,000 tonnes per year of biofertilizers).
- Endeavours to justify, obtain approvals and acquire funds for the further production of organic fertilizers, biofertilizers and micronutrients.

**Policies**
- Beneficial changes in national fertilizer policies.
- Encouragement and guidance of the private sector in the production of fertilizers.

**Communication**
- Provision of technical information concerning new fertilizers, for example on *citron*, a locally patented type of chelated iron fertilizer.
- Practical recommendations for farmers and fruit growers.
- Establishment of an on-line answering system to provide information to growers on the fertilizer needs of the field and fruit crops.
- Publication of relevant books, papers and recommendations.
Chapter 9
Fertilizer strategies and constraints

Iran’s objectives for the third millennium include:

- Determination of the production capability of the country’s soil and water resources.
- Increased yields of agricultural crops.
- Protection of the environment.
- Improved food quality.
- Monitoring changes in the quality of soil and water resources under intensive farming.

At present the unavailability of certain fertilizers when needed by farmers is a more serious constraint than their prices. The cost of fertilizers (even without subsidies) amounts to less than 7 percent of the total production costs. The capacity of storage facilities in consumption areas needs to be increased and the timing and supply of appropriate fertilizers need to be improved.

In order to improve yields, soil testing on a national scale is necessary, so that fertilizer rates can be based on soil and plant analysis data. This may involve support to private laboratories.

Subsidized mineral fertilizers are often traded by intermediate dealers, sold to farmers at inflated prices or even smuggled out of the country. It has been recommended that the subsidies should be concentrated on strategic crops such as wheat and on objectives such as improving the organic matter status of the soils, which has deteriorated drastically during the past 20 to 30 years (Malakouti and Balali, 2004).


**Moameni, A.** 2003. An appraisal of land resources of Iran: a contribution to a project on *Framework for Sustainable Agricultural Development Strategy in Iran* under the auspices of FAO. FAO Representation, Tehran, Iran.


**Pauw de, E. D., Gaffari, A. & Gasemi, V.** 2002. *Agro-climatic zone maps of Iran*. Seed and Plant Improvement Research Institute (SPIRI), Karaj, Iran.


Annex

The agro-ecological zones

Zone 1 – Central zone
Zone 2 – Caspian coastal zone
Zone 3 – North western zone
Zone 4 – Central Zagros zone
Zone 5 – Khuzestan zone
Zone 6 – Arid central zone
Zone 7 – Southern Zagros zone
Zone 8 – Southern coastal plain zone
Zone 9 – Arid Southern zone
Zone 10 – Khorasan zone

ZONE 1
Markazi
1. Major production:
   Cereals: wheat, barley, chickpea, beans.
   Industrial crops: oil seeds (sunflower, rape seed and soybean).
   Fruits: apples, apricots, grapes, pomegranates.

FIGURE A1
Major crop production in Markazi
Dry fruits: almonds, walnut, pistachios.
Other: flowers, alfalfa.

2. Total land under cultivation: 312 200 hectares (irrigated 86 400 and rainfed 225 800 hectares).

3. Total fertilizer use: 93 200 tonnes (N-fertilizers 56 300; P-fertilizers 23 500; K-fertilizers 3 100 and Compound-fertilizer 10 300 tonnes).

4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-45-12+1 percent Zn.

**Qazvin**

1. Major production:
   Cereals: wheat, barley, maize, chickpea, lentils.
   Industrial crops: sugar beet and oil seeds (sunflower, rape seed and soybean).
   Vegetables: potato, tomatoes.
   Fruits: melons, pears, apricots, peach, nectarine, cherries and grapes.
   Dry fruits: almonds, walnut, hazelnuts, pistachios.
   Other: alfalfa, olives.

2. Total land under cultivation: 308 thousand hectares (Irrigated 212.7 and rainfed 95.3 thousand hectares).

3. Total fertilizer use: 69 500 tonnes (N-fertilizers 42 300; P-fertilizers 20 600; K-fertilizers 2 300 and Compound-fertilizer 4 300 tonnes).

4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-51-09+1 percent Zn.

![FIGURE A2 Major crop production in Qazvin](image-url)
Qom
1. Major production:
   Cereals: wheat, barley.
   Industrial crops: cotton, oil seeds.
   Fruits: apricots, cherry, grapes, pomegranate.
   Dry fruits: almonds, walnut.
   Other: alfalfa.
2. Total land under cultivation: 149.3 thousand hectares (irrigated 148.8 and rainfed 0.5 thousand hectares).
3. Total fertilizer use: 25.8 thousand tonnes (N-fertilizers 17200, P-fertilizers 6500, K-fertilizers 700 and Compound-fertilizer 1400 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-41-07+1 percent Zn.

Semnan
1. Major production:
   Cereals: wheat, barley.
   Industrial crops: cotton, oil seeds (sunflower, rape seed and soybean)
   Vegetables: potato.
   Fruits: melons, apples, apricots, peach, cherry, grapes, pomegranates.
   Dry fruits: walnut, pistachios.
Other: alfalfa, figs, olives.
2. Total land under cultivation: 132 thousand hectares (irrigated 114.5 and rainfed 17.5 thousand hectares).
3. Total fertilizer use: 35.6 thousand tonnes (N-fertilizers 21 100, P-fertilizers 10 400, K-fertilizers 1 100 and Compound-fertilizer 3 000 tonnes).
4. N-P2O5-K2O+micronutrient-fertilizer ratios: 100-52-10+1 percent Zn.

**Tehran**

1. Major production:
   - Cereals: wheat, barley, beans.
   - Vegetables: tomato.
   - Fruit: apples, pears, apricots, black cherry, peach, nectarine, plums, cherry, grapes, pomegranates.
   - Dry fruits: walnut.
   - Other: flowers, alfalfa.
2. Total land under cultivation: 197.9 thousand hectares (irrigated 196.9 and rainfed 1 thousand hectares).
3. Total fertilizer use: 96 thousand tonnes (N-fertilizers 55 200, P-fertilizers 19 500, K-fertilizers 5 700 and Compound-fertilizer 5 600 tonnes).

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**FIGURE A4**

**Major crop production in Tehran**
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-38-15+1 percent Zn.

ZONE 2

Gilan
1. Major production:
   Cereals: wheat, barley, paddy rice.
   Fruits: cherry, oranges, sour oranges.
   Dry fruits: walnut, hazelnuts.
   Other: tea, olives, berry plant for silk worm production.
2. Total land under cultivation: 326.7 thousand hectares rainfed.
3. Total fertilizer used: 102 600 tonnes (N-fertilizers 69 100, P-fertilizers 9 500, K-fertilizers 17 300 and Compound-fertilizer 6 700 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-17-34+1 percent Zn.

Golestan
1. Major production:
   Cereals: wheat, barley, paddy rice.
   Industrial crops: cotton, tobacco, oil seeds (sunflower, rape seed and soybean).
   Vegetables: potato, tomato.

FIGURE A5
Major crop production in Golestan
Fruits: water melon, peach, plums, oranges, tangerines.
Dry fruits: walnut.
Other: olives, medicinal plants.
2. Total land under cultivation: 664.9 thousand hectares (irrigated 339.2 and rainfed 325.7 thousand hectares).
3. Total fertilizer used: 179 300 tonnes (N-fertilizers 90 500, P-fertilizers 63 000, K-fertilizers 12 400 and Compound-fertilizer 13 400 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-69-19+1 percent Zn.

**Mazandaran**
1. Major production:
   Cereals: wheat, barley, paddy rice.
   Industrial crops: tobacco.
   Vegetables: tomato.
   Fruits: apples, peach, strawberry, oranges, tangerines, sweet lemon, sour lemon, pomegranates, kiwi, berry plant (for silk worm).
   Dry fruits: walnut, hazelnuts.
   Other: tea, medicinal plants, flowers.
2. Total land under cultivation: 488.8 thousand hectares (irrigated 282.9 and rainfed 205.9 thousand hectares).

![FIGURE A6](image-url)

Major crop production in Mazandaran
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-52-21+1 percent Zn.

ZONE 3

Ardabil

1. Major production:
   Cereals: wheat, barley, chickpea, lentils.
   Industrial crops: cotton, oil seeds.
   Vegetables: potato.
   Fruits: apples, black cherry, peach, pears, cherry, grapes.
   Dry fruits: walnut.
   Other: alfalfa.

2. Total land under cultivation: 582.4 thousand hectares (irrigated 188.2 and rainfed 394.2 thousand hectares).

3. Total fertilizer used: 81.1 thousand tonnes (N-fertilizers 50 800, P-fertilizers 27 300, K-fertilizers 1 600 and Compound-fertilizer 4 400 tonnes).

4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-55-06+1 percent Zn.

East Azarbaijan

1. Major production:
   Cereals: wheat, barley, chickpea, beans, lentils.
   Industrial crops: oil seeds (sunflower, rape seed and soybean).
   Vegetables: potato, onion, tomato.
Fruits: apples, pears, apricots, black cherry, peach, cherry, grapes.
Dry fruits: almonds, walnut.
Other: alfalfa, flowers.

2. Total land under cultivation: 1 142.6 thousand hectares (irrigated 355.5
and rainfed 787.1 thousand hectares).

3. Total fertilizer used: 88 300 tonnes (N-fertilizers 50 900, P-fertilizers
21 200, K-fertilizers 9 500 and Compound-fertilizer 6 700 tonnes).

4. N-P₂O₅-K₂O+micronutrient-fertilizer ratios: 100-45-26+1 percent Zn.

Kordestan

1. Major production:
   Cereals: wheat, barley, chickpea.
   Industrial crops: oil seeds (sunflower, rape seed and soybean).
   Vegetables: potato.
   Fruits: apples, apricots, grapes, strawberries.
   Dry fruits: almonds, walnuts.
   Other: alfalfa.

2. Total land under cultivation: 426 800 hectares (irrigated 30 500 and
rainfed 396 300 hectares).
3. Total fertilizer used: 49,000 tonnes (N-fertilizers 33,800, P-fertilizers 13,100, K-fertilizers 1,000 and Compound-fertilizer 1,100 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-57-07+1 percent Zn.

**West Azarbaijan**

1. Major production:
   - Cereals: wheat, barley, chickpea.
   - Industrial crops: sugar beet and oil seeds (sunflower, rape seed and soybean).
Fruits: water melon, apples, pears, apricots, black cherry, peach, cherry, grapes.
Dry fruits: almonds, walnut.
Other: alfalfa.

2. Total land under cultivation: 1,434.6 thousand hectares (irrigated 1,041.8 and rainfed 392.8 thousand hectares).

3. Total fertilizer used: 86,600 tonnes (N-fertilizers 54,600, P-fertilizers 14,400, K-fertilizers 1,200 and Compound-fertilizer 16,400 tonnes).

4. N-P\textsubscript{2}O\textsubscript{5}-K\textsubscript{2}O+micronutrient-fertilizer ratios: 100-32-12+1 percent Zn.

**Zanjan**

1. Major production:
   - Cereals: wheat, barley, chickpea, beans, lentils.
   - Industrial crops: sugar beet.
   - Vegetables: potato.
   - Fruits: apples, apricots, grapes, pomegranate.
   - Dry fruits: almonds, walnut.
   - Other: alfalfa, olives.

2. Total land under cultivation: 666.9 thousand hectares (irrigated 130.9 and rainfed 536 thousand hectares).

![FIGURE A11](image-url)

Major crop production in Zanjan
3. Total fertilizer used: 49 700 tonnes (N-fertilizers 27 200, P-fertilizers 15 300, K-fertilizers 2 600 and Compound-fertilizer 4 600 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-58-16+1 percent Zn.

ZONE 4
Hamedan
1. Major production:
   Cereals: wheat, barley, chickpea, lentil.
   Industrial crops: sugar beet, oil seeds.
   Vegetables: potato.
   Fruits: watermelon, apples, peach, plums, grapes.
   Dry fruits: almonds, walnut.
   Other: alfalfa, medicinal plants.
2. Total land under cultivation: 647.9 thousand hectares (irrigated 278.8 and rainfed 369.1 thousand hectares).
3. Total fertilizer used: 85 800 tonnes (N-fertilizers 34 000, P-fertilizers 35 000, K-fertilizers 6 600 and Compound-fertilizer 10 200 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-94-27+1 percent Zn.
Ilam

1. Major production:
   Cereals: wheat, barley, chickpea, lentils.
   Vegetables: cucumber.
2. Total land under cultivation: 225.2 thousand hectares (irrigated 52.2 and rainfed 173 thousand hectares).
3. Total fertilizer used: 42.6 thousand tonnes (N-fertilizers 23.4, P-fertilizers 15.3, K-fertilizers 0.6 and Compound-fertilizer 3.3 thousand tonnes).
4. N-P\textsubscript{2}O\textsubscript{5}-K\textsubscript{2}O+micronutrient-fertilizer ratios: 100-66-07+1 percent Zn.

Kermanshah

1. Major production:
   Cereals: wheat, barley, chickpea.
   Industrial crops: sugar beet, oil seeds (sunflower, rape seed and soybean).
   Fruits: apples, peach, grapes, pomegranate.
   Dry fruits: almonds, walnut.
   Other: alfalfa, figs.
2. Total land under cultivation: 746.8 thousand hectares (irrigated 170.7 and rainfed 576.1 thousand hectares).
3. Total fertilizer used: 108 100 tonnes (N-fertilizers 60 600, P-fertilizers 28 000, K-fertilizers 4 300 and Compound-fertilizer 15 200 tonnes).


**Lorestan**

1. Major production:
   - Cereals: wheat, barley, paddy rice, chickpea, bean, lentil.
   - Vegetables: cucumbers.
Fruits: apples, apricots, grapes, pomegranate.
Dry fruits: almonds, walnuts.
Other: alfalfa, olives, medicinal plants.
2. Total land under cultivation: 693.1 thousand hectares (irrigated 189.5 and rainfed 503.6 thousand hectares).
3. Total fertilizer used: 111 400 tonnes (N-fertilizers 70 100, P-fertilizers 32 900, K-fertilizers 2 100 and Compound-fertilizer 6 300 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-49-06+1 percent Zn.

ZONE 5
Khuzestan
1. Major production:
Cereals: wheat, barley, paddy rice, maize, beans.
Industrial crops: sugar beet, sugar cane, oil seeds (sunflower, rape seed and soybean).
Vegetables: tomato, cucumber.
Fruits: melon, watermelon, orange, pomegranate.
Dry fruits: almonds.
Other: alfalfa, dates, olives.

FIGURE A16
Major crop production in Khuzestan
2. Total land under cultivation: 980.1 thousand hectares (irrigated 623.1 and rainfed 357 thousand hectares).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-36-15+1 percent Zn.

ZONE 6
Esfahan
1. Major production:
   Cereals: wheat, barley, rice.
   Industrial crops: sugar beet and oil seeds (sunflower, rape seed and soybean).
   Vegetables: potato, tomato.
   Fruits: apples, pears, apricots, black cherry, grapes, pomegranate.
   Dry fruits: almonds, walnut, pistachios.
   Other: alfalfa, flowers, dates.
2. Total land under cultivation: 333.5 thousand hectares (irrigated 303.9 and rainfed 29.6 thousand hectares).
3. Total fertilizer used: 191 500 tonnes (N-fertilizers 122 600, P-fertilizers 45 500, K-fertilizers 8 500 and Compound-fertilizer 14 900 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-40-12+1 percent Zn.

**Yazd**
1. Major production:
   - Cereals: wheat, barley.
   - Fruits: apricots, grapes, mulberry, pomegranate.
   - Dry fruits: almonds, walnut, pistachios.
   - Other: alfalfa, saffron, dates.
2. Total land under cultivation: 111 thousand hectares (irrigated 110.3 and rainfed 0.7 thousand hectares).
3. Total fertilizer used: 48 700 tonnes (N-fertilizers 26 100, P-fertilizers 13 800, K-fertilizers 2 300 and Compound-fertilizer 6 500 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-55-17+1 percent Zn.

**ZONE 7**

**Chaharmahal and Bakhtiyari**
1. Major production:
   - Cereals: wheat, barley, beans.
   - Fruits: apples, peach, grapes.
   - Dry fruits: almonds.
   - Other: alfalfa.
2. Total land under cultivation: 169.8 thousand hectares (irrigated 103.4 and rainfed 66.4 thousand hectares).
3. Total fertilizer used: 38 500 tonnes (N-fertilizers 25 600, P-fertilizers 9 400, K-fertilizers 1 400 and Compound-fertilizer 1 900 tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-40-09+1 percent Zn.

**Fars**
1. Major production:
   - Cereals: wheat, barley, paddy rice, maize, chickpea, bean, lentil.
   - Industrial crops: cotton, sugar beet and oil seeds (sunflower, rape seed and soybean).
   - Vegetables: potato, tomato.
Fruits: watermelon, apples, apricots, peaches, grapes, cherry, oranges, tangerines, lemons, sweet lemon, sour orange, pomegranate.
Dry fruits: almonds, walnut, pistachios.
Other: alfalfa, flowers, dates, olives, figs.

2. Total land under cultivation: 1,156.6 thousand hectares (irrigated 872.2 and rainfed 284.4 thousand hectares).


4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer: 100-38-11+1 percent Zn.

Kohkilouyeh and Boyerahmad

1. Major production:
   Cereals: wheat, barley, paddy rice, lentil.
   Fruits: apples, grapes, lemon.
   Dry fruits: walnut.
   Other: alfalfa.
2. Total land under cultivation: 194.2 thousand hectares (irrigated 57.1 and rainfed 137.1 thousand hectares).
3. Total fertilizer used: 27 800 tonnes (N-fertilizers 16 700, P-fertilizers 9 300, K-fertilizers 800 and Compound-fertilizer 1 000 tonnes).
4. N-P₂O₅-K₂O+micronutrient-fertilizer ratios: 100-57-07+1 percent Zn.

**ZONE 8**

**Bushehr**
1. Major production:
   Cereals: wheat.
   Vegetables: tomato.
   Fruits: oranges, lemons.
   Other: dates.
2. Total land under cultivation: 248 thousand hectares (irrigated 71.2 and rainfed 176.8 thousand hectares).
3. Total fertilizer used: 22.5 thousand tonnes (N -fertilizers 11.8; P-fertilizers 7.4; K-fertilizers 0.3 and Compound-fertilizer 3.0 thousand tonnes).
4. N-P₂O₅-K₂O+micronutrient-fertilizer ratios: 100-63-10+1 percent Zn.

**Hormozgan**
1. Major production:
   Cereals: wheat.
   Vegetables: onion, tomato, cucumber.
   Fruits: water melon, oranges, tangerines, lemons, sweet lemon, mango.
   Other: dates.
2. Total land under cultivation: 131.3 thousand hectares (irrigated 125.3 and rainfed 6.0 thousand hectares).
3. Total fertilizer used: 41.8 thousand tonnes (N-fertilizers 20.4; P-fertilizers 12.2; K-fertilizers 1.5 and Compound-fertilizer 7.7 thousand tonnes).
ZONE 9
Jiroft
1. Major production:
   Cereals: wheat, maize.
   Industrial crops: oil seeds (sunflower, rape seed and soybean).
   Vegetables: potato, tomato, cucumber.
   Fruits: watermelon, oranges, tangerines, lemon, sweet lemon, grapefruit.
   Dry fruits: walnut.
   Other: alfalfa, dates, flowers.
2. Total land under cultivation: 195.4 thousand hectares irrigated.
3. Total fertilizer used: 55.9 thousand tonnes (N-fertilizers 33.5; P-fertilizers 13.8; K-fertilizers 4.3 and Compound-fertilizer 4.3 thousand tonnes).
4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-44-19+1 percent Zn.

Kerman
1. Major production:
   Cereals: wheat, barley, maize.
   Industrial crops: oil seeds (sunflower, rape seed and soybean).

![FIGURE A19](image-url)

**FIGURE A19**
Major crop production in Jiroft
Fruits: apples, quinces, apricots, black cherry, peach, cherry, grapes, oranges, tangerines, pomegranate.
Dry fruits: almonds, walnut, pistachio.
Other: alfalfa, dates, figs, flowers, olives.

2. Total land under cultivation: 413.8 thousand hectares (irrigated 410.7 and rainfed 3.1 thousand hectares).

3. Total fertilizer used: 200.7 thousand tonnes (N-fertilizers 109.9; P-fertilizers 43.6; K-fertilizers 23.9 and Compound-fertilizer 23.3 thousand tonnes).

4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios: 100-43-31+1 percent Zn.

**Sistan and Baluchestan**

1. Major production:
   - Cereals: wheat, barley.
   - Fruits: apricots, grapes, oranges, pomegranates, lemons, banana.
   - Dry fruits: pistachios.
   - Other: alfalfa, dates.

2. Total land under cultivation: 119.9 thousand hectares (irrigated 109.3 and rainfed 10.6 thousand hectares).

3. Total fertilizer used: 46.6 thousand tonnes (N-fertilizers 21.9; P-fertilizers 18.9; K-fertilizers 2.0 and Compound-fertilizer 3.8 thousand tonnes).

4. N-P$_2$O$_5$-K$_2$O+micronutrient-fertilizer ratios in 2001/02: 100-82-15+1 percent Zn.

**ZONE 10**

**Khorasan**

1. Major production:
   - Cereals: wheat, barley, chickpea, beans, lentil.
   - Industrial crops: cotton, sugar beet and oil seeds (sunflower, rape seed and soybean).
   - Vegetables: potato, tomato.
   - Fruits: melon, watermelon, apples, pears, apricots, black cherry, peach, plums, cherry, grapes, mulberry, pomegranate.
   - Dry fruits: almonds, walnut, pistachio.
Other: alfalfa, dates, figs, barberry, sumac, saffron, berry for silk worm production.

2. Total land under cultivation: 1,576.1 thousand hectares (irrigated 1,042.5 and rainfed 533.6 thousand hectares).

3. Total fertilizer used: 329.7 thousand tonnes (N-fertilizers 178.6; P-fertilizers 105.5; K-fertilizers 16.4 and Compound-fertilizer 29.2 thousand tonnes).

4. N-P\textsubscript{2}O\textsubscript{5}-K\textsubscript{2}O+micronutrient-fertilizer ratios: 100-60-15+1 percent Zn.
Low rainfall and high temperatures in Iran necessitate irrigation and over half the cultivated land is irrigated. Water availability and salinity are major constraints. Iran has long been a major importer of wheat but in 2003 and 2004 domestic wheat production almost satisfied the national demand. Several governmental measures supported production of the crop and favourable rainfall after a drought was also a major factor. Yields of both irrigated and rainfed wheat are low by world standards. The intensification of production, in particular through a greater efficiency of fertilization and irrigation, is required in order to achieve a permanent reduction in the country’s dependence on wheat imports, even under less favourable climatic conditions.