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Résumé. *La Turquie dispose de 76 millions d'ha dont 24 sont cultivables. La surface en riz varie entre 50 et 60 000 ha selon les difficultés d'approvisionnement en eau et l'évolution relative des prix. La production nationale est insuffisante pour la consommation. La consommation annuelle par habitant est de 4 à 5 kg et la consommation totale avoisine 300 000 tonnes. Le riz peut être cultivé dans sept zones différentes. Toutefois, les principales régions de production sont celles de Marmara, Thrace et Mer Noire. Les variétés cultivées sont essentiellement d'origine italienne (Rocca, Baldo, Ribe...). Quelques variétés nouvelles et des variétés locales plus anciennes poussent bien. Les contraintes abiotiques et biotiques en Turquie sont la température de l'eau et le froid à la période des semis, la sécheresse, la salinité, les maladies et les mauvaises herbes. Les principaux objectifs de l'amélioration variétale sont les hauts rendements, la résistance aux maladies et la qualité des graines. L'objectif de la Turquie est de devenir autosuffisante aussitôt que possible.*

Abstract. Turkey has 76 000 000 ha total land area and approximately 24 000 000 ha of this land is cultivable. The average rice growing area varies between 50 000 and 60 000 ha. It fluctuates from year to year due to shortage of irrigation water and instability of market prices. The domestic production is not enough for consumption. Thus Turkey imports some rice every year. Rice imported increased depending on the decrease in local production in the last years. Rice consumption per capita is 4 to 5 kg and total milled rice consumption is about 300 000 t. Rice can be cultivated in seven geographical regions in Turkey. However, the main rice growing areas are Marmara, Thrace and the Black Sea region. Mostly Italian varieties (Rocca, Baldo and Ribe) are cultivated. Some new developed and local varieties are grown as well. Abiotic and biotic constraints of rice in Turkey are cold water, cool weather temperature, drought or water shortage, salinity and alkalinity, disease and weed. The main objectives of varietal improvement are high yield, lodging and disease resistance and high grain quality. Rice production objectives in Turkey are to increase yield per unit area, to expand the area under rice cultivation, to reach self-sufficiency and to reduce rice imports as much as possible.

Introduction

Turkey is one of the most favored countries in terms of agricultural production due to the following factors: good ecological and climatological conditions, land property and a rich crop pattern. Turkey's population is of 65 million inhabitants, 45% of whom live in the countryside and agriculture is very important for feeding this rapidly increasing population as well as for contributing to national development efforts.

Turkey's total land area is of 76 960 000 ha, including approximately 24 000 000 ha of cultivable land (Table 1). The average rice growing area varies between 50 000 and 60 000 ha yearly.

Table 1. Total land and agricultural land areas in Turkey (000 ha)

Years	Total land	Arable land	Vineyards	Fruit orchards	Olive groves	Permanent pastures	Forests	Other land
1970	76760	24790	847	1044	740	10800	18723	20016
1980	76960	25350	820	1386	813	10100	20199	18292
1990	76960	24650	580	1583	866	12000	20199	17090

I – Rice production and consumption

The rice production area varies yearly between 50 000 and 60 000 ha in Turkey depending on the available irrigation water and market prices (Table 2). The rice growing area in Turkey, which was more than 70 000 ha in the early 1980s and reached 77 000 ha in 1982, drastically decreased afterwards. Two factors caused this decrease in rice production after the mid 1980s. In the first place, a shortage of irrigation water subsequent to the drought period which prevailed between 1985 and 1994. Secondly, there were some limitations on rice importation before 1984, such as taxes and funds. These were lifted or their amount reduced in 1984 making easier rice imports at lower costs. As production costs were higher than that of imported rice, a number of farmers abandoned rice cultivation on account of shortage of irrigation water or of high production costs. Moreover, in some areas, rice cultivation was forbidden during the drought period so that the available water could be used for irrigated crops, such as cotton, maize and vegetable. However, the rice growing area started to increase again in 1995: from 41 000 ha in 1994 to 58 000 in 1995; and more than 60 000 ha was expected in 1996. The slight increase during the last two years results from an increase in the rainfall providing more available irrigation water.

Table 2. Rice production and imports in Turkey

Year	**Production area** (000 ha)	**Domestic milled production** (000 t)	**Milled rice imports** (000 t)	**Total milled consumption** (000 t)	**Rough rice yields** (t/ha)
1981	73	198	26	224	4.52
1982	77	210	21	231	4.55
1983	70	189	10	199	4.50
1984	64	168	85	253	4.38
1985	60	162	85	247	4.50
1986	55	165	86	251	5.00
1987	53	165	159	324	5.19
1988	51	158	91	249	5.16
1989	66	198	221	419	5.00
1990	46	138	191	329	5.00
1991	40	120	133	253	5.00
1992	43	129	265	394	5.00
1993	45	135	309	444	5.00
1994	41	120	200	320	4.94
1995	58	176	—*	—	5.10

(*) Data not available.

The total milled rice production varies between 150 000 and 200 000 tons which is not enough for domestic consumption. Rice consumption per capita is 4-5 kg in Turkey, and the total milled rice consumption is about 300 000 tons so that milled rice has to be imported to meet the total domestic consumption.

In the last decade, rice imports increased in Turkey according to the decreases in the domestic rice production. From 26 000 tons in 1981, they reached 309 000 tons in 1993 and sometimes more rice was imported than necessary.

The average rough rice yield in Turkey is 5 tons/ha. From about 4.5 tons/ha in the early 1980s, it slightly increased to 5.0 tons/ha after the mid-1980s.

1. Rice growing regions

Turkey has seven geographical regions and rice can be cultivated in all these regions (Table 3). However, the main rice growing regions in Turkey are the northwestern (Marmara-Thrace) and the northern parts of the country (Black Sea region).

The Marmara-Thrace region has the largest rice growing area and production, followed by the Black Sea region. Although the rice yields has been affected by drought in all the regions, the decreases were more

significant in some regions (e.g. the Mediterranean and Aegean regions). Rice production was forbidden in the Aegean region because of the shortage of irrigation water.

Rice cultivation in the micro- and macro-climatic regions of Turkey provides a fairly good income because rice allows a very high gross profit per unit area. And, as in these regions there is no alternative crop providing such high income as rice, rice growing still prevails. In regions where there are alternative high profit crops (e.g. cotton and maize) or in the case of a drop in rice prices or of water shortage, farmers prefer to grow other crops.

Table 3. Rice production in the geographical regions of Turkey

Geographical regions	Years	Area (ha)	Average yield (t/ha)	Production (000 t)	Area (%)	Production (%)
Marmara-Thrace	1989	31.694	5.3	167.80	48.10	50.20
	1995	31.274	5.0	157.60	53.60	53.40
Black Sea	1989	24.181	5.0	121.90	36.70	36.50
	1995	22.626	5.4	121.20	38.80	41.00
South-East Anatolia	1989	2.432	3.3	8.00	3.70	2.40
	1995	1.835	3.5	6.40	3.10	2.20
Central Anatolia	1989	1.041	3.9	4.10	1.60	1.20
	1995	907	4.0	3.60	1.60	1.20
Mediterranean	1989	5.955	5.0	29.70	9.10	8.90
	1995	1.119	4.0	4.50	1.90	1.50
East Anatolia	1989	518	3.8	2.00	0.80	0.60
	1995	547	3.7	1.90	0.90	0.60
Aegean	1988	4.300	4.7	20.10	8.60	7.70
	1995	23	4.2	0.09	0.04	0.03

2. Cultivated rice varieties

The Rocca variety occupies the largest growing area in Turkey, followed by Baldo. Local varieties are mostly cultivated in the South-East and East Anatolia regions.

Table 4. Rice varieties cultivated in the regions

Region	Cultivated Varieties
Marmara-Thrace	Rocca, Baldo, Sürek-95, Ergene, Veneria, Trakya, Meriç, Ypsala, Serhat-92
Black Sea	Ribe, Krasnodarsky-424, Rocca, Serhat-92, local varieties
South-East Anatolia	Local varieties
Central Anatolia	Krasnodarsky-424, local varieties
Mediterranean	Rocca, Baldo, Ergene, local varieties
East Anatolia	Local varieties
Aegean	Rocca, Veneria, Baldo

II – Constraints of the rice crop

The meteorological data of two provinces (Edirne and Samsun) which represent two main rice cultivation regions, Marmara-Thrace and Black Sea, are given in Tables 5 and 6. In the Edirne province, the average temperature during panicle formation and at heading stages in July and August is 24°C. Low temperatures sometimes cause spikelet's sterility in this region. On the other hand, low temperatures at germination and seedling stages may cause poor stand establishment.

Table 5. Meteorological data of the Edirne province

	Rice growing period*						
	April	May	June	July	Aug.	Sept.	Oct.
Highest temperatures (°C)	22.6	26.4	31.9	33.7	33.7	28.9	22.1
Lowest temperature(°C)	4.1	8.4	12.6	15.6	14.2	10.6	6.2
Average temperature (°C)	13.2	18.0	21.9	24.2	23.8	19.9	14.0
Solar radiation (Cal/cm2)**	179.5	217.1	280.5	231.8	205.3	165.1	131.4
Rainy days	10.3	11.1	9.1	5.4	4.3	3.1	5.4
Total rainfall (mm)	42.6	74.9	47.7	24.5	21.9	19.9	33.4
Average relative humidity (%)	68.6	69.6	63.2	57.3	57.9	61.8	69.6

* The average of the data recorded in last 15 years (1980-1994).
** The average of the data recorded in six years (1985-1990).

Table 6. Meteorological data of the Samsun province

	Rice growing period						
	April	May	June	July	Aug.	Sept.	Oct.
Average temperature °C*	11.2	15.5	20.0	22.9	22.9	19.7	16.1
Total rainfall (mm)*	60.3	45.3	40.0	33.9	34.3	60.4	74.8
Average relative humidity (%)**	75.2	77.1	75.2	77.6	80.1	80.7	79.4

* The average of the data recorded in 52 years (1929-1980).
** The average of the data recorded in three years (1990-1992).

In the Samsun province, the average temperature is slightly lower than in Edirne, but the average relative humidity is higher in Samsun creating favourable conditions for blast infection in that region.

The meteorological data of the Diyarbakyr province representing the South-East Anatolia region appear in Table 7.

Table 7. Meteorological data of the Dyyarbakyr province

	Rice growing period*						
	April	May	June	July	Aug.	Sept.	Oct.
Average temperature (°C)	13.9	19.4	25.9	31.0	30.5	24.9	17.2
Highest temperatures (°C)	33.0	39.8	41.8	46.2	45.9	42.0	35.4
Lowest temperature (°C)	-6.1	0.8	3.5	9.1	8.4	4.0	-8.0
Average relative humidity (%)	62.0	55.0	35.0	26.0	25.0	30.0	46.0

* The average of the data recorded in 52 years (1936-1988).

The climate in Diyarbakyr is characterized by a high average temperature and low relative humidity during the rice growing period. This causes high spikelet sterility in the rice crop in South-East Anatolia.

1. Abiotic and biotic constraints

❒ **Cold water and cold weather.** Cold water especially supplied by waterpump from underground or from dams, affects the rice crop at the germination and seedling phases. It prevents a good stand establishment. Low temperatures cause damage to the rice crop at different stages of it development: at germinating, seedling, panicle formation, flowering, and pollination.

❒ **High temperatures.** High temperatures cause spikelet sterility in the southeastern part of Turkey where rice is grown in many micro-climatic regions.

❒ **Drought or water shortage.** Rice grows under continuous irrigation with full water control and sometimes it suffers from drought or water shortage. The reasons for this are: (i) rice is sown in areas where its price is very high and profitable, although the amount of irrigation water needed for its cultivation may not be available, (ii) low water accumulation in dams or less water flowing down to the rivers due to low rainfall.

❒ **Salinity and alkalinity.** Salinity and alkalinity affect the rice crop in certain areas where a high level of salt can be found in the soil as well as in the irrigation water. But, this is not the most important problem affecting Turkish rice production.

❒ **Rice diseases.** The following fungal diseases cause damages to the rice crop in Turkey: blast (*Pyricularia oryzae*), brown leaf spot (*Helminthosporium oryzae*), bakanea, and foot rot (*Fusarium moniliforme*). The most important disease being blast. A heavy blast disease infection occurred in some rice growing areas in the northwest of Turkey (in Thrace) in 1995. This was the most harmful disease infection observed in this region in the last 25 years. It caused 20% yield loss in 25 000 ha of the rice growing area in the region. Some farmers left their crop in the field without harvesting. The reasons of this infection were heavy rainfall in July and August in 1995, excessive nitrogen application, late planting, high seed density, and cold irrigation water.

❒ **Weed.** The most important weed in rice fields is *Echinochloa spp.* Some other species can be observed, such as *Cyperus ssp.*, *Scirpus spp.*, and *Alismacea spp*. Weed is controlled with chemicals at pre-germinating or post-germinating stages.

2. Potentials of rice production

Compared with other temperate countries, such as Spain, Italy, Japan, South Korea, Turkey's rice yield, which is about 5 tons/ha, seems to be low. It may be increased through the adoption of developed modern rice varieties and new growing techniques used in the above countries with similar rice growing conditions.

Increasing the rice cultivation area in Turkey depends on irrigation water. Since the climate and the soil structure are suitable for rice cultivation in many micro- and macro-climatic regions, if the irrigated area is increased, it will be possible to increase the rice area as well. Some irrigation projects have been conducted, especially in South East Anatolia, and are intended to increase the rice area.

III – Rice research activities

The rice research program in Turkey was initiated in 1970 at the Thrace Agricultural Research Institute. Research on rice have been going on there since then. Until 1982, the institute concentrated its research activities on regional problems but, after 1982, a national rice research project was established and the Thrace Agricultural Research Institute became the coordination center of this project. Other research institutes, in Samsun and Diyarbakyr, have been taking part in this program. The agricultural faculties below are also concerned with rice research in Turkey.

- Thrace Agricultural Research Institute
  P.O. Box 16, 22100 Edirne, Turkey
  Fax: (90) (284) 2358210
- Black Sea Agricultural Research Institute
  P.O. Box 39 Fax: (90) (362) 2560561 Samsun, Turkey
- Southeastern Anatolia Agricultural Research Institute
  P.O. Box 72 Fax: (90) (412) 2238113 Diyarbakyr, Turkey
- Aegean University, Faculty of Agriculture
  Department of Field Crops
  Fax: (90) (232) 3881864 Bornova, Izmir, Turkey
- 19 Mayis University, Faculty of Agriculture
  Department of Field Crops, Kurupelit, Samsun, Turkey
- Çukurova University, Faculty of Agriculture
  Department of Field Crops, Balcali, Turkey

Their main research topics are as follows:

❒ **Thrace Agricultural Research Institute**, Edirne
- – Varietal selection and breeding: to develop new improved varieties with early maturity, short stature, and high yielding.
- – Agronomy: including plant nutrition, water management and cultural practices to maximize yields for the newly released varieties.
- – Plant protection: against weeds, diseases, and other pests.
- – Rice technology: to determine technological characteristics of promising new developed lines or varieties.

– Seed production: to produce pure seeds of the new high yielding varieties.
– Extension: to transfer new technologies to farmers, to introduce new varieties and improved production techniques through demonstration fields for farmers, and also, to train all extension workers and farmers to improve production through technology.

❒ **Black Sea Agricultural Research Institute**
– Varietal selection and breeding
– Agronomy
– Extension
– Economy

❒ **Southeastern Anatolia Agricultural Research Institute**
– Varietal selection
– Agronomy
– Extension

In general, agricultural faculties are carrying out breeding, agronomy, technology, and fundamental studies on rice.

Number of researchers working on rice researches in each institute :
– Thrace Agricultural Research Institute: 4
– Black Sea Agricultural Research Institute: 3
– Southeastern Anatolia Agricultural Research Institute: 2

IV – Major achievements in rice research up to 1995

1. Varietal Improvement

After the rice research program had been initiated in 1970, many germplasms have been introduced from Italy, Bulgaria, Spain, France, Hungary, and Russia. Four Italian (Rybe, Rocca, Baldo, and Venerya), three Bulgarian (Plovdyv, Rodyna, and Ranbally), and one Russian (Krasnodarsky-424) varieties were released for different regions of Turkey.

As a result of our crossing program started in 1979, seven rice varieties were developed and they were released for different rice growing regions. The main traits of these varieties appear in table 8.

Table 8. The characters of developed varieties in Turkey

Variety name	**Maturity duration** (days)	**Plant height** (cm)	**Grain yield** (t/ha)	**1000 grain weight** (gr)	**Length husked grain** (mm)	**Appearance of milled rice**
Altinyazi	127	112	7.5	36	7.2	Translucent with white belly
Trakya	128	113	8.5	38	6.9	Translucent
Ergene	117	100	7.0	35	7.4	Translucent
Meryç	125	100	8.0	38	7.3	Translucent
Ypsala	125	110	8.2	40	7.8	Translucent
Serhat-92	128	105	8.0	34	6.8	Translucent with white belly
Sürek-95	135	100	8.0	35	7.3	Medium with white belly

2. Agronomic researches

In addition to breeding activities, some studies concerning production techniques have been conducted. The results of some studies which were carried out on production techniques in Turkey are given below.

❒ Rice planting time was determined for the major rice growing areas. Even though it varies according to different regions, rice can generally be planted after mid-April. In the main rice growing regions, it is sown in May.

❒ The appropriate fertilizer rates were determined for different rice cultivars. In general, fertilizer rate is N150 P80 kg/ha. Besides, it was found out that the rice crop gave better results if nitrogen was applied as NH^+ 4 form.

❒ The study on nitrogen application time showed that nitrogen should be applied in two or three portions using one of the following options:

1. 1/3 as basal, 1/3 at tillering stage, and 1/3 at panicle initiation.
2. 1/2 at tillering stage, and 1/2 at panicle initiation.
3. 1/2 as basal, and 1/2 at panicle initiation.

The results of this study indicate that the most critical stage for nitrogen application is panicle initiation. As mentioned above, a part of nitrogen application should absolutely be done at panicle initiation stage for a good yield.

❒ To determine the suitable rice harvesting time. The result of this study indicated that rice should be harvested 49 days after flowering in Edirne. When it was harvested 49 days after flowering, it gave high paddy and milled yield, less chalky and broken grains.

❒ Seed rates per unit area of the different rice cultivars were determined. The recommended rate is 200 kg/ha for long and large grain varieties such as Baldo, Rocca, Trakya, Ypsala, etc.

❒ Irrigation studies:

1. We compared continuous flooding and different alternatives of interval flooding irrigation. The highest yield was obtained by continuous flooding irrigation. It was followed by 3 days flooding and 2 days interval treatment.
2. A study was carried out on the amount of water given per area. It was found out that 1800-2000 mm water was necessary for a good yield. The height of standing water in a rice field should be 15 cm at the maximum vegetative stage.
3. The possibility of rice growing under sprinkler irrigation conditions was studied. The results showed that it was possible to obtain a considerable rice yield and save irrigation water under sprinkler irrigation conditions.

❒ Seed treatments to control bakanea and foot rot *(Fusarium moniliforme)* disease. A study on this subject showed that this disease could be controlled by applying some fungicide as seed treatment.

V – Actual program

1. Varietal improvement

A varietal improvement program is going on in the Edirne, Samsun and Diyarbakyr institutes. It aims to develop high yielding varieties with one or more of the following traits.

– High yield
– Lodging resistant for mechanical harvest
– Low spikelet sterility
– Disease resistance to blast and food rot
– Cold tolerance at different growing stages
– Early or medium early maturation (120-140 days)
– Long and translucent grain type
– High milled rice yield
– Low or medium amilose content and medium to high gelatinization temperature
– Response to high nitrogen rates

Short plant height (90-100 cm) and strong stem became an important target in our selection program in the last years. Because the farmers started to use combiners in rice harvesting. On the other hand, rice farmers are used to applying high nitrogen doses in Turkey. Thus, new developed varieties should have short plant height.

To reach these goals, three breeding procedures are used:

- **Hybridization.** Hybridization is done among local varieties or strains and local material is also crossed with an introduced one to incorporate genes for an improved plant type. About 100 single and multiple crosses are conducted annually. F2 is planted and harvested as bulk and F3 material is planted as bulk and harvested as single plant selection. Afterwards, the pedigree selection method is practiced. Over 1,500 pedigree lines (F4-F6) are studied annually.
- **Introduction.** In addition to the hybridization program, varieties or promising lines are introduced from other rice growing countries or institutes. First, this material is tested in an observation nursery, and then selected lines are included in the yield trials or are used in hybridization. The varieties or lines which are adaptable to our regions are released as commercial varieties.
- **Mutation Breeding.** A mutation breeding has been recently initiated to improve some characters of three commercial varieties such as Baldo, Ypsala, and Rocca in 1996. These varieties were treated with gamma rays to obtain early maturing, short stature, high yielding, high grain quality and disease resistant mutants. For this, 5000 seeds of each variety were treated with 25 and 30 grade gamma rays.

2. Observation nurseries and yield trials

Over 150 promising lines selected from segregating material or introduced from other sources are tested in an observation nursery every year. The selected lines from the observation nursery are included in the preliminary yield trials. Then, single location and multiple location yield trials are conducted. The selected most promising lines are tested in the National Registration Trial. About 200 lines are tested in yield trials annually. Promising lines also are evaluated under different stress conditions, such as drought, disease, etc.

3. Growing technology

Fertilizer experiments have been conducted to determine the fertilizer requirements of newly released varieties or promising lines.

4. Plant protection

A study has been carried out to find a chemical control mechanism for blast disease. Different fungicides have been used as seed treatment in this experiment.

5. Technology

Annually, the technological characters of all lines in preliminary and yield trials are examined in the technology laboratory.

6. Seed production

Every year, breeder and foundation seeds of some commercial varieties are produced in Thrace Agricultural Research Institute. The amount of seeds produced are: breeder seed : 2 tons; Foundation seed: 50 tons. Foundation seed is given to state farms or private companies for multiplication.

7. Constraints of rice research

The constraints of rice research in Turkey are:

- To test breeding material under controlled condition. There are no facilities to test breeding material under controlled conditions for different stress, such as drought, disease, cold tolerance, etc.
- Lack of machinery for field experiments. Most of the field work is done by manpower which means high experiment cost.
- Inadequately trained persons as scientists, technicians, and assistants.

8. Rice production policy

- ❒ As mechanization is not as widely used for rice cultivation as it is for other crops in Turkey, manpower being employed instead, mechanization has to be gradually introduced.
- ❒ Rice yield per unit area has to be increased through new developed varieties and new growing techniques.
- ❒ The area under rice cultivation has to be expanded. Irrigation water is the most limiting factor for expanding the area under rice cultivation in Turkey. However, the land structure and the climate are suitable for rice cultivation in many micro- and macro-climatic regions and Turkey has the water potential allowing the expansion of irrigated areas and, hence, of rice cultivated areas.

Finally, Turkey's policy is to become self-sufficient in rice production or to reduce rice import as much as possible.

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