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Rice research strategies and future prospects under temperate conditions in Turkey

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Abstract. Rice production range between 150 000 to 200 000 tons milled rice in Turkey, but this production is not sufficient for domestic consumption. Rice import reached to 200 000 tons milled rice in 1992 and this amount has increased since than. Main objective of rice researches is to be self sufficient for rice. To increase rice production can be done with planting high yielding varieties, applying new plant production technologies and increasing rice production areas in Turkey. Rice is grown mainly in Marmara and Black Sea Region but it is also grown all regions of Turkey at the small quantities, thus, there is a potential to increase rice production area. Turkey is temperate country and rice growing period is short. Studies carried out so far have shown that co-operation with temperate countries is very important to breed new rice varieties. Hybrid rice breeding seems to be not applicable now, because of economic and climatic reasons. Biotechnological studies should be initiated to obtain transgenic rice for proper red rice and weed control in rice field.

Introduction

About 18 868 000 ha area is under cultivation and 13 710 615 ha of it is used for cereal production in Turkey. The most important cereal is wheat and it is grown at 9 450 000 ha, followed by barley (83 350 000), maize (515 000 ha), rye (158 000 ha), oats (137 000 ha) and rice (53 000 ha) (Anon. 1996). Stable food for Turkish people is wheat and wheat consumption is 200-250 kg per/capita, on the other hand, rice consumption is very low when we compare it with wheat consumption. If we look at the long term statistics, we can see that the trend for rice consumption per/capita is going up, however, trend for wheat consumption per/capita going down.

Rice production area ranges between 40 000 ha and 70 000 ha depending on the water ability and government policies, in the last 50 years. Total milled rice production change between 150 000 and 200 000 tons, and this production is not sufficient for domestic consumption, thus, Turkey rice import reached 200 000 tons in 1992, and this amount is more than that of domestic rice production. Since then, rice import of Turkey has continued to increase. Economic value of Turkey rice export is very low.

As it can be seen from given statistics above, there is need to improve rice production nearly %100 percent in Turkey.

I – Climatic conditions of turkey for rice production

Turkey is between 36 and 42 latitudes, and it is divided seven political regions. Rice is grown in every seven regions, however, Marmara especially Europe part of Marmara and Black see region are the main rice production areas respectively (See Table 1).

Important meteorological data of some rice growing cities in different regions is given in Table 2. As can be seen in Table 2, rice can be grown between May and October in Turkey. For Mediterranean and South East Anotolia region, it can be planted second half of April, but for the other regions it can be planted begin-

ning of the May because of the weather and water temperature. Rice should flower and pollinate latest at the middle of August. Otherwise it can not pollinate and mature, because after that time, temperature begins to decrease gradually all part of Turkey. If temperature decrease before pollination spikilet sterility increases because pollination is not occur at the low temperature. Decreasing of temperature after pollination is good for getting high yield, because rice plant is not under high temperature stress during seed ripening and seed ripening period can take long time. This is very important factor for getting high yield especially northern part of Turkey.

Table 1. Rice planting area, yield, production and their percentages in 7 regions, in Turkey, in 1998

Region	Planting Area (ha)	Yield (ton/ha)	Pady production (1000 ton)	Planting area (%)	Production (%)
Marmara	34 008	6.107	207.7	56	58.8
Blacksea	22 153	5.739	127.1	36.5	36.1
Southeast Anotolia	2 189	3.620	7.9	3.6	2.2
Mediterranean	916	3.920	3.6	1.5	1.0
Central Anotolia	870	4.860	4.2	1.4	1.2
East Anotolia	468	3.660	1.7	0.8	0.5
Aegean	120	7.000	0.8	0.2	0.2
Total	60 724	362.14	353	100	100

Source. Ministry of Agriculture and Rural Affairs Statistics, 1998

Because of limited rice growing period, Turkey rice breeding program aims to improve early cultivars. We can say that, if there is enough water to rice cultivation, high yield can be obtained from early rice varieties in every region of Turkey. But regions have different constraints as given below.

- ❏ Marmara Region; short growing period and early fall rains;
- ❏ Blacksea Region; short growing period, early fall rains, cloudy, humid and rainy days during growing, which brings high risk for blast infection;
- ❏ Southeast Anotolia; high temperature during pollination causes spiklet sterility, economic competion with cotton, wheat + second crop i.e maize, soybean;
- ❏ Mediterranean Region; high temperature during pollination causes spiklet sterility, economic competion with cotton, wheat + second crop or vegetables;
- ❏ Central Anotolia; short growing period, low water temperature and low night temperatur;e
- ❏ East Anotolia; short growing period, low water temperature and low day and night temperature;
- ❏ Eagen Region; economic competion with cotton, wheat + second crop or vegetables.

II – Research strategies

1. Plant breeding strategies

Turkey National Rice Breeding Program aims to improve varieties, which are:

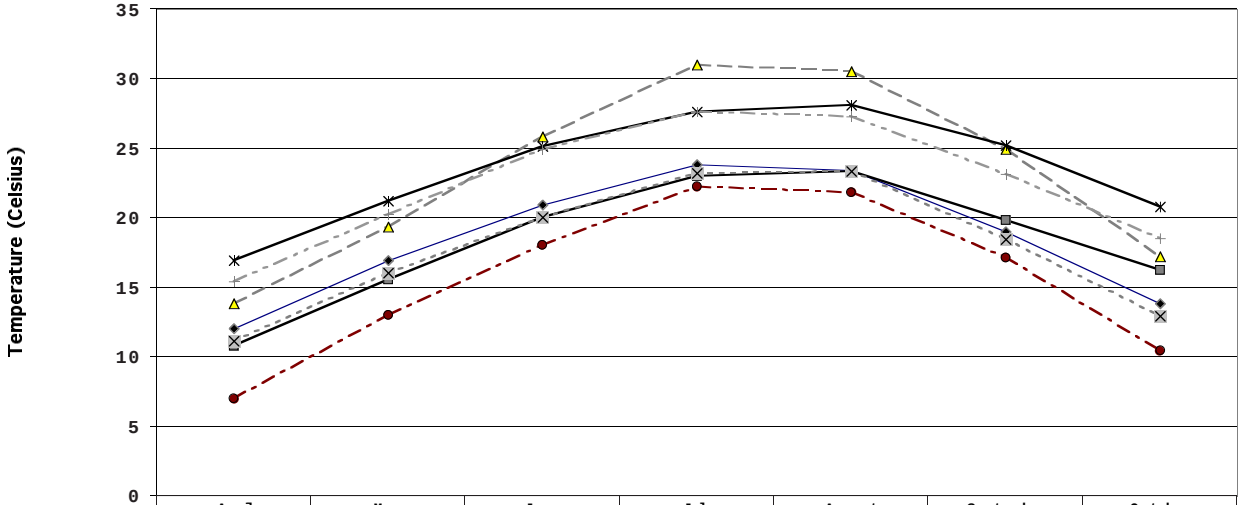
- ❏ early or medium to early (120-140 days),
- ❏ high yielding,
- ❏ lodging resistant for machine harvesting,
- ❏ resistant to blast and bakane disease,
- ❏ response to high nitrogen,
- ❏ long and translucent, with low or medium amiloz, grain type,
- ❏ high head yield.

Table 2. Long-term means of some meteorological data about seven cities in seven region

Region	Meteorological character	April	May	June	July	August	Septem.	Octob.
Marmara Edirne Province	Mean Temperature (°C)	12	16.9	20.9	23.8	23.4	19	13.8
	Mean Max. Temperature (°C)	18.6	23.9	28.3	31.3	31.3	26.8	20.5
	Maximum Temperature (°C)	33.5	36.4	38.4	41.5	40.8	37.8	34.1
	Mean Min. Temperature (°C)	6.8	11.5	15	17	16.8	13	9
	Minimum Temperature (°C)	-2.3	0.6	6.7	8	8	0.2	-3.2
	Rainfall (mm)	47.3	48.8	51.2	33.0	20.7	31.0	57.8
	Rainy Days	9.5	11.0	8.7	5.5	3.5	4.4	7.8
	Relative Humidity (%)	68	68	64	57	56	63	73
	Sunshine duration (h/day)	6.7	8.3	9.9	11.5	10.9	3.5	5.8
Black Sea Samsun Province	Mean Temperature (°C)	10.8	15.5	20	23	23.3	19.8	16.2
	Mean Max. Temperature (°C)	15.2	19.1	23.3	26.3	26.9	16.1	12.7
	Maximum Temperature (°C)	37	37.4	36.2	36.1	39.0	35.5	35.4
	Mean Min. Temperature (°C)	7.5	11.9	15.8	18.7	19.2	16.1	12.7
	Minimum Temperature (°C)	-2.4	2.8	7.8	13.4	12.4	6.8	3.3
	Rainfall (mm)	54.2	43.7	39.4	35.9	29.5	56.8	70.3
	Rainy Days	12.3	12.6	8.1	6.1	6.2	9.3	11.0
	Relative Humidity (%)	76	78	74	72	72	73	73
	Sunshine duration (h/day)	4.4	6.4	9.1	9.8	9.1	6.5	5.1
Southeast Anatolia Diyarbakır Province	Mean Temperature (°C)	13.8	19.3	25.8	31.0	30.5	24.9	17.2
	Mean Max. Temperature (°C)	20.4	26.5	33.3	38.2	38.3	33.2	25.4
	Maximum Temperature (°C)	33.0	39.8	41.8	46.2	45.9	41.0	35.4
	Mean Min. Temperature (°C)	6.7	10.9	15.8	21.5	20.8	15.6	9.4
	Minimum Temperature (°C)	-6.1	0.8	3.5	9.1	8.4	4	-8
	Rainfall (mm)	70.6	42.4	7.6	0.9	0.5	3.1	28.3
	Rainy Days	11.1	8.1	2.5	0.5	0.3	1.1	5.6
	Relative Humidity (%)	61	54	34	25	24	28	45
	Sunshine duration (h/day)	7.3	9.8	12.6	12.8	12.1	10.6	8.0
Mediterrane Adana, Province	Mean Temperature (°C)	16.9	21.2	25.1	27.6	28.1	25.2	20.8
	Mean Max. Temperature (°C)	23.3	28.1	30.9	33.9	35	33	28.9
	Maximum Temperature (°C)	36.7	41.3	42.8	41.5	45.6	42.7	41.5
	Mean Min. Temperature (°C)	11.0	14.9	18.9	21.9	22.4	18.9	14.6
	Minimum Temperature (°C)	0.1	7.1	9.2	11.5	14.8	9.3	3.5
	Rainfall (mm)	46.3	51.2	20.9	4.2	5.1	15.1	39.2
	Rainy Days	8.3	6.3	2.8	0.8	0.7	2.3	5.2
	Relative Humidity (%)	69	68	66	68	67	62	61
	Sunshine duration (h/day)	8	9.8	11.5	11.9	11.7	10.1	8.3
Central Anatolia Ankara Province	Mean Temperature (°C)	11.1	16	20	23.2	23.3	18.4	12.9
	Mean Max. Temperature (°C)	17.4	22.4	26.8	30.1	30.4	25.7	20.1
	Maximum Temperature (°C)	31.6	34.4	36.4	38.8	40	35.7	33
	Mean Min. Temperature (°C)	4.5	9.4	12.5	15.2	15.4	11.1	6.6
	Minimum Temperature (°C)	-7.2	-0.2	3.8	4.5	5.5	-1.5	-5.8
	Rainfall (mm)	33.6	80	30.6	12.7	8.4	18.6	22
	Rainy Days	10.1	11.9	8	3.3	1.9	4.2	6.3
	Relative Humidity (%)	57	57	50	42	40	46	56
	Sunshine duration (h/day)	7	9.1	11.1	12.5	11.9	9.7	7.4
East Anatolia Van Province	Mean Temperature (°C)	7	13	18	22.2	21.8	17.1	10.4
	Mean Max. Temperature (°C)	12.5	18.8	24.2	28.6	28.9	24.8	17.3
	Maximum Temperature (°C)	24	26.6	33.5	34.8	36.7	32.6	28.8
	Mean Min. Temperature (°C)	1.6	6.3	9.8	13.9	13.9	9.9	4.9
	Minimum Temperature (°C)	-17.5	-3.5	2.5	3.6	5	2.5	-14
	Rainfall (mm)	58	40.5	16.4	5.8	3.2	10	42.6
	Rainy Days	11.1	8.9	4.3	1.7	1.1	1.9	7.2
	Relative Humidity (%)	64	57	51	44	41	42	58
	Sunshine duration (h/day)	7.1	9.2	11.5	11.9	10.7	8.7	6.4
Aegean _zmir Province	Mean Temperature (°C)	15.4	20.2	24.9	27.6	27.3	23.1	18.5
	Mean Max. Temperature (°C)	20.8	25.8	30.4	33.1	33.2	29.1	24.2
	Maximum Temperature (°C)	32.8	39.5	40.3	42.4	42.7	38.7	35.9
	Mean Min. Temperature (°C)	9.9	14.2	18.3	21	21	17.4	13.7
	Minimum Temperature (°C)	0.2	4.3	9.5	11.2	11.5	5.8	3.6
	Rainfall (mm)	45.4	38	8.8	2.6	2.4	15.8	48.7
	Rainy Days	7.5	5.7	1.9	0.5	0.4	2	5.5
	Relative Humidity (%)	62	60	52	48	49	55	64
	Sunshine duration (%)	8.4	9.9	411.7	12.4	12.2	10.3	7.6

Source. Türkiye iklim klavuzu (Çölaian, 1970)

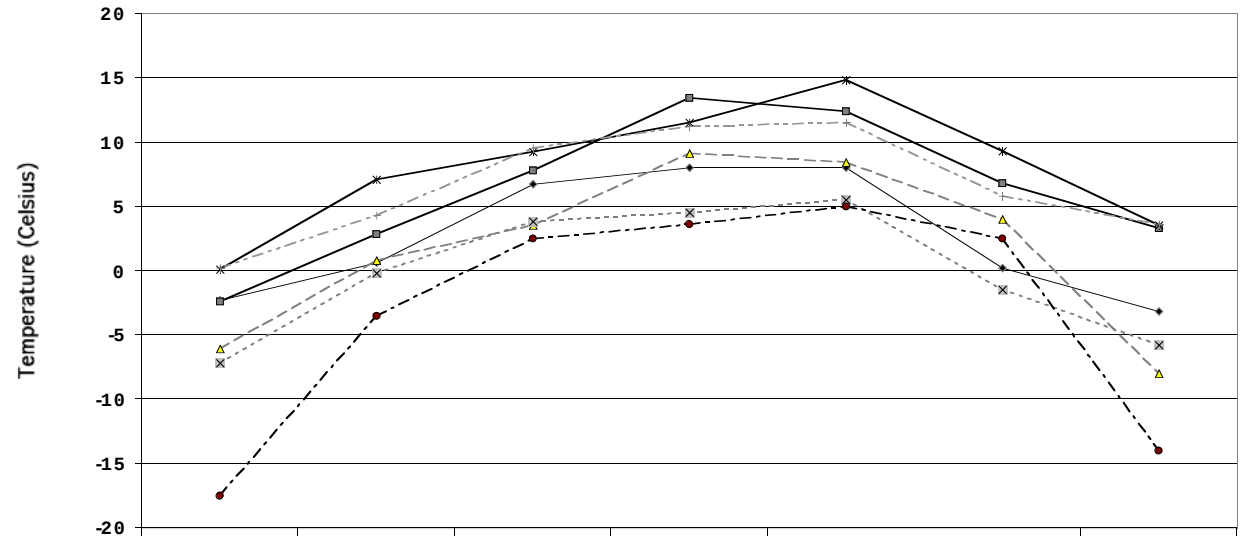
Figure 1. Mean temperature of seven cities in seven regions



	April	May	June	July	August	September	October
Edirne	12	16,9	20,9	23,8	23,4	19	13,8
Samsun	10,8	15,5	20	23	23,3	19,8	16,2
Diyarbakır	13,8	19,3	25,8	31	30,5	24,9	17,2
Ankara	11,1	16	20	23,2	23,3	18,4	12,9
Adana	16,9	21,2	25,1	27,6	28,1	25,2	20,8
Van	7	13	18	22,2	21,8	17,1	10,4
Izmir	15,4	20,2	24,9	27,6	27,3	23,1	18,5

Month

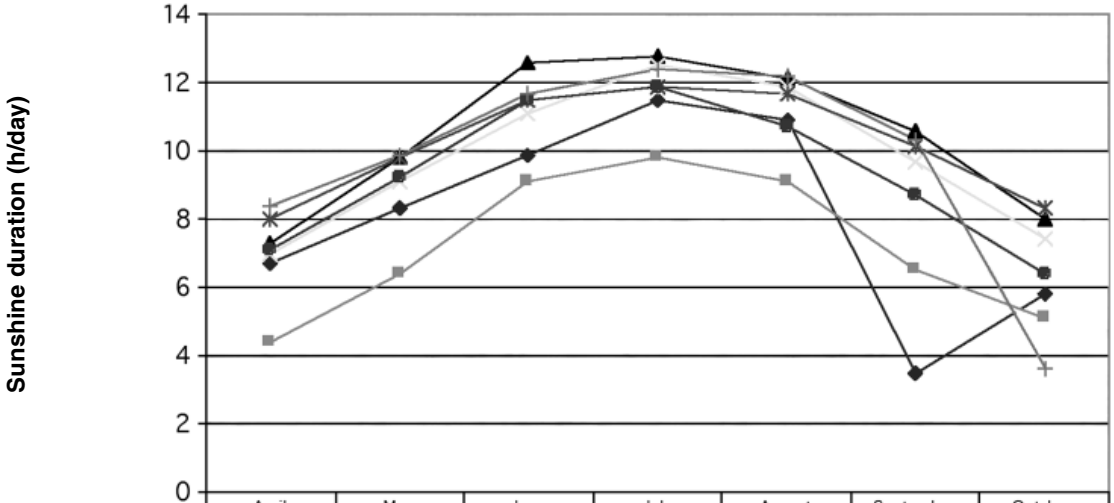
Figure 2. Lowest temperature of seven cities in seven regions



	April	May	June	July	August	September	October
Edirne	-2,3	0,6	6,7	8	8	0,2	-3,2
Samsun	-2,4	2,8	7,8	13,4	12,4	6,8	3,3
Diyarbakır	-6,1	0,8	3,5	9,1	8,4	4	-8
Ankara	-7,2	-0,2	3,8	4,5	5,5	-1,5	-5,8
Adana	0,1	7,1	9,2	11,5	14,8	9,3	3,5
Van	-17,5	-3,5	2,5	3,6	5	2,5	-14
Izmir	0,2	4,3	9,5	11,2	11,5	5,8	3,6

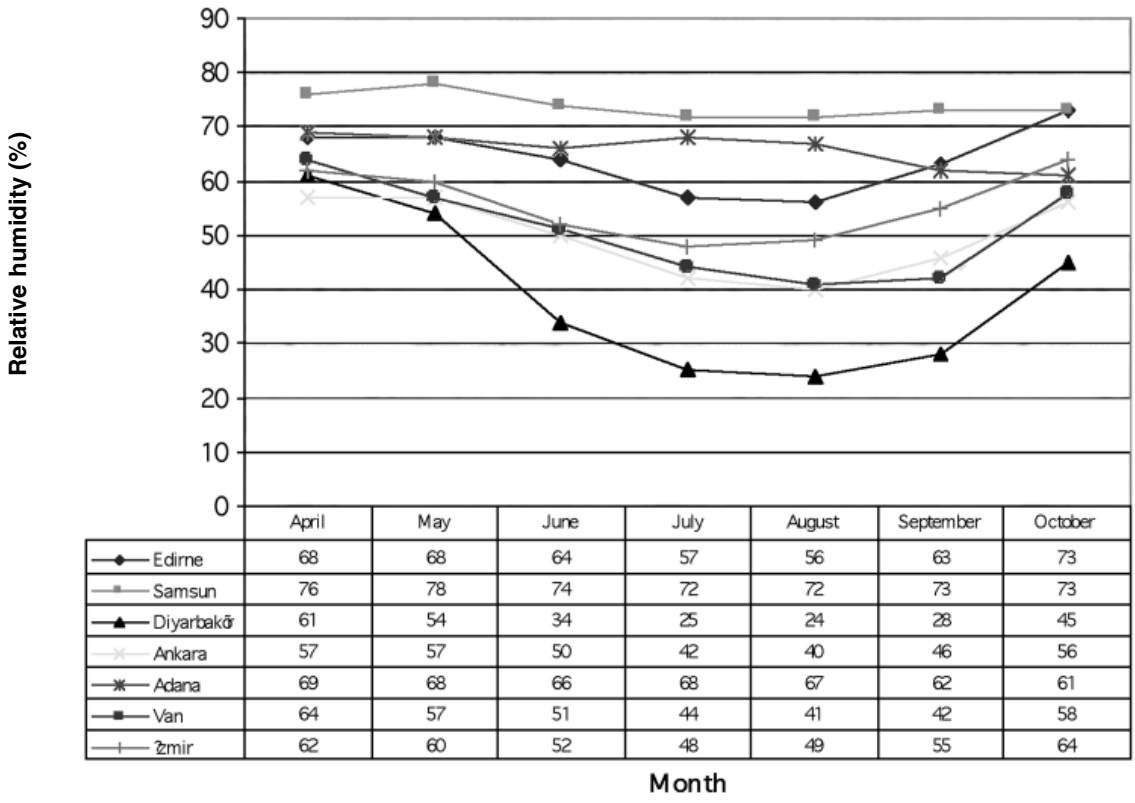
Month

Figure 3. Mean sunshine duration (h/day) of seven cities in seven regions



	April	May	June	July	August	September	October
Edirne	6,7	8,3	9,9	11,5	10,9	3,5	5,8
Samsun	4,4	6,4	9,1	9,8	9,1	6,5	5,1
Diyarbakõr	7,3	9,8	12,6	12,8	12,1	10,6	8
Ankara	7	9,1	11,1	12,5	11,9	9,7	7,4
Adana	8	9,8	11,5	11,9	11,7	10,1	8,3
Van	7,1	9,2	11,5	11,9	10,7	8,7	6,4
Izmir	8,4	9,9	11,7	12,4	12,2	10,3	3,6

Figure 4. Relative humidity (%) of seven cities in seven regions



	April	May	June	July	August	September	October
Edirne	68	68	64	57	56	63	73
Samsun	76	78	74	72	72	73	73
Diyarbakõr	61	54	34	25	24	28	45
Ankara	57	57	50	42	40	46	56
Adana	69	68	66	68	67	62	61
Van	64	57	51	44	41	42	58
Izmir	62	60	52	48	49	55	64

To obtain rice varieties, characteristics given above, Turkish Rice Breeding Program Introduces varieties/lines from different countries, and uses various plant breeding methods.

A. Cultivar/line introduction

Different rice varieties/lines have been introducing since the rice breeding project begin. Four Italian varieties (Ribe, Rocca, Baldo and Veneria), three Bulgarian Varieties (Plovdiv, Rodina and Ranballi) and one Russian variety (Krasnodarsky-424) have been released as a result of these studies. As it can be seen from released cultivars, all cultivars released as a result of adaptation studies are from temperate countries such as, Italy, Bulgaria and Russia.

IRRI materials also have been introducing since the beginning of the rice breeding project but, it has not been found any cultivars/lines adapted for Turkey conditions to release from IRRI materials so far. IRRI materials are only used in crossing program. Because of short rice growing period of Edirne, most of IRRI materials do not mature in Edirne. For example, IIRON-1998 was introduced in 1998, but, only 19 of them out of 63 matured. IRRI materials, generally need long rice growing period in Edirne conditions, but, we will continue to introduce some observation nurseries, thus, IIRON-1999 and IRFAON-1999 was introduced and planted this year. We are expecting to find some lines to initiate aromatic rice breeding program from IRFAON-1999.

Table 3. Cross breeding lines and their parents and parent origins

Released Cultivars Name	Female parent name and origin	Male parent name and origin
Ergene	Delta (France)	Zoria (Bulgaria)
Ipsala	Rodina (Bulgaria)	Delta (France)
Altınyazı	Baldo (Italy)	Ribe(Italy)
Meriç	Delta (France)	Akçeltik (Turkey)
Trakya	Baldo (Italy)	Komsomolsky (Russia)
Serhat-92	Rocca (Italy)	Krasnodarsky-424 (Russia)
Sürek-95	Rocca (Italy)	Rodina (Bulgaria)
Osmancık-97	Rocca (Italy)	Europa (Italy)
TR-475	Gritna (Italy)	Balilla-28 (France)
TR-635	Rocca (Italy)	1979-TR79-70-1 (Turkey)
TR-778	Plovdiv (Bulgaria)	Lido (Italy)
TR-788	Rocca (Italy)	Vialone-Nono (Italy)

B. Crossing program

About 100 cross are made regularly each year. Most of materials in crossing block are from temperate countries, such as Turkey, Italy, Bulgaria, Russia, France, Spain, Greece, Portaqual, and USA. Ergene, ipsala, Altınyazı, Trakya, Meriç, Serhat-92, Sürek-95, Osmancık-97, TR-475, TR-778, TR788, TR-635 rice cultivars was improved and released as a result of crossing program. Parents and origin of parents used to improve this cultivars are given in Table 3. As it can be seen in Table 3. All parents of released cultivars are from temperate countries.

C. Mutation breeding

Mutation breeding program was initiated to improve some characters of Ipsala, Rocca, Baldo and Sürek-95 rice varieties. Short, lodging resistant, translucent lines were obtained from this study. But they are not tested yet in yield trial, and selection for some characters is still undergoing

D. Hybrid rice

3 early japonica cms (Reimei, IR682776 and IR68283) and their maintainer lines introduced from IRRI to investigate possibility of improving hybrid rice in Edirne conditions. They were planted to multiply seed but we did not obtain seed in field conditions, because they are little late and maintainer lines did not give good polen to polinate cms lines. It seems that, seed production for A line and then next year make cross it with restorer line to get F_1 hybrid would be difficult and expensive because of low seed set. For this reasons three lines hybrid breeding has a lot of constrains in our climatic conditions.

Two early japonica TGMS lines (Norin PL 12 and IR 68948-4-12-3-7-B) were also introduced from IRRI to investigate two line hybrid breeding in Turkey climatic conditions. Both of them had good seed setting in Edirne conditions. There is no any important sterility. We expect that they will sterile in climatic conditions of South Anotolia or Mediterranean region because summer is hotter there than that of Edirne summer. They will be grown at the field conditions in these region next year. There will be chance to obtain cheaper and more efficient way of hybrid rice improvement, if they are sterile in that conditions.
In addition to these constrains mentioned above, there still some difficulties if we improved 3, or 2 lines hybrid. Because; rice is direct seeded in Turkey, and about 180 kg/ha seeds are used for rice production. This amount of seed will bring big cost for farmers. If hybrid rice varieties are used, rice planting method should be shifted from direct seeding to transplanting to reduce amount of seed used from 180 kg/ha to 20-30 kg/ha. This is also seems very difficult for Turkey.
From all these it seems that one line hybrid rice is the best way for improving hybrid rice for Turkey conditions, but this technology need to be improved more.

E. Biotechnology in rice breeding

Turkey rice breeding project has not begun yet to use biotechnology in rice breeding. This methods is seen expensive and there is not facilities laboratories, greenhouse etc. to apply this technology for this moment.

2. Agronomic studies

Various agronomic studies were carried out to increase yield and production area and results of these studies were transferred to farmers. Agronomic studies will continue, Because there is potential to increase rice yield applying new production technologies. Personals from extension services are also trained about new production technologies every one-two years in Edirne.

3. Economic studies

It seems that, there is not any field crop which can compete with rice economically at the most of rice growing areas. Rice gives good yield and marketing can not be difficult because of low quantity of domestic supply. But, rice might not compete with cotton, vegetables, wheat and second crop in the same year i.e soybean or maize after wheat etc. in Southeast Anotolia, Mediterranean and Aegean region because of water shortage and lack of rice production technology. Some political decisions are also needed to support rice producer against cheap imported rice. Thus, more economic studies should be carried out to investigate possibility of extending rice growing areas against competitor crops and possibility of supporting rice producer with taking into account international agreements.

4. Plant protection studies

Barnyard grass, red rice, blast, bakane, helminthosporium and some insects causes economic loses at paddy fields in Turkey. Various plant protection studies were carried out and their results transferred to farmers, including seed treatment, pesticides application technique for controlling barnygrass, bakane, blast

etc. Blast caused big economic damage in 1995 and then 1997 in Europe part of Marmara Region. Before this years farmer did not know that blast could done such a devastating effect at the pady field. Farmers were trained about causes of blast and blast controlling techniques. Red rice also important problem especially at the rice growing area without rotation. Foundation seed and certified seed are also produced by Rice Research Project to increase yield and quality and reduce red rice infestation in paddy field.

5. Rice tecnology and quality studies

Selection is done according to Turkish consumer preference during plant breeding in the field and laboratory and there is not any study to improve rice variety for export. Demand for aromatic rice and indica type rice is also very low, thus, there has not carried out any studies to improve this type cultivar until 1999. National Rice Project has initiated aromatic rice studies in 1999 with introducing IRFAON-1999 to begin establishing germplasm for aromatic rice in Turkey. Main reason for initiating of this study is increasing trend for aromatic and indica rice demand and their high price in the world. Research activities and demand for enriched rice are not seen in Turkey. Because rice consumption is only 6-7/kg per capita.

III – Results and future prospects

The main objective of Turkey Rice Research Program is to be self sufficient country for rice. It means Turkey should increase rice production %100. There is not easy way to reach this objective. Thus, there has been a lot of research carried out and there is still a lot of thing should be done.

- ❏ Rice is mainly grown in 2 region but it is also grown every region at the various micro or macro ecologies with small quantities. Thus rice production area can be extended.
- ❏ Rice breeding studies are carried out only at the two Governmental institutes. The number of institutes should be increased and private sector should encourage to enter rice breeding and seed multiplication.
- ❏ Parents or origins of the most of released cultivars in Turkey are from temperate countries such as Italy, Bulgaria, France, Russia etc. Thus, material exchange and other co-operative studies should continue and intensify with temperate countries.
- ❏ Co-operation with IRRI especially to increase germplasm and to release their lines in south part of Turkey will be conuntinued.
- ❏ Good variations were obtained with mutation breeding, and this plant breeding technique will be continue to use.
- ❏ High quantity (180-200 kg/ha) of seed usage and climatic conditions are the main constrains for application of three line hybrid rice technology in Turkey. However, one line and two line (TGMS) hybrid rice technology can be seen more applicable respectively. But, there is a lot of work should be done to apply this technology for Turkey conditions.
- ❏ Biotechnology in rice breeding has not been used so far in Turkey. But it can be used to obtain dihaploid rice plants in the near future. It also can be used to produce transgenic rice. Roundup ready transgenic rice can be the very efficient way of controlling red rice and other weeds in rice field.
- ❏ More plant protection and quality studies should be done. Initiated aromatic rice studies can be intensify in following years.
- ❏ There is still gap between experiments and farmer yield, thus, there is possibility of increasing rice yield with extension and agronomic studies.
- ❏ There is some works to establish different crop associations. After establishing their rice association, it is expecting that farmer would be more active on the rice research strategies and rice policies in Turkey.
- ❏ There is also need to support rice farmers politically against cheap import rice.

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