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Summary. Soil levelling is done with towed leveller blades after the first ploughing under dry conditions. The laser controlled levellers are also used in large farms. Tillage may be done in Autumn or may be postponed until Spring under wet conditions, but generally begins early as possible.

The rice planting time varies from region to region in Turkey, it can be done after mid of April in the Aegean, Mediterranean, and Southeast Anatolia. The ideal period for rice planting in main rice producing regions, Marmara-Thrace and Black Sea, is May. The rice-growing period is 150-160 days from the beginning of May to mid-October.
Pre-germinated or pre-soaked seed is commonly used for direct seeding. Seed is broadcasted by hand or centrifugal broadcaster into standing water.
In general, nitrogen and phosphorus fertilizers are used for the rice crop in Turkey. The rice crop suffers from zinc deficiency in some areas as well, and the fertilizer rate is N_{150} P_{80} and 15 kg Zn ha^{-1}.
The most important weed in rice fields is *Echinochloa spp*. Also, some other species can be observed, such as *Cyperus spp., Scirpus spp,* and *Alismacea spp.* etc. These weeds may be controlled by appling hirbicides such as propanil, monilate, thiobencarb, bentazon, bensulfuron, bispyribac sodium, cyhalopob- butyl, and ethoxysulfuron.
Rice is harvested at 20 to 24 percent grain moisture content between 15 September and 30 October.
The constrains of rice crop in Turkey are; cold water and weather temperature, high temperature, drought or water shortage, salinity and alkalinity, rice diseases; (*Pyricularia oryzae, Helmithosporium oryzae*, and *Fusarium moniliforme*), micronutrient disorders (Zn deficiency), weed and red rice.
The main problems of rice cultivation in Turkey are; inadequate plot levelling, unsuitable weed control management, lack of suitable machinery, inefficient drainage systems, limited quantities of irrigation water, small farm size.

Key words. Rice, rice culture

I – Soil Preparation

1. Soil levelling

Land levelling allows maintenance of an uniform water depth within the basin and greatly facilitates subsequent management practices for stand establishment, weed control and field drainage for harvest. Precision levelling also improves water use efficiency in rice.

Precision levelling decreases the number of levees required and increases productive land area and machinery efficiency.

Use of more sophisticated herbicide techniques and widespread use of new-dwarf varieties, which are less vigorous in the germination phase, require perfect levelling with gradations of not more than 5 cm.

Levelling is done with towed leveller blades after the first ploughing under dry conditions. The laser control levellers are used in the large farms. Use of towed levellers, equipped with laser control, made easy levelling. Extension of the plot areas to more than 4 to 5 ha has made it possible to increase the yield as it reduces the are occupied by the levees. However, it has also added to the difficulties inherent in maintaining the level and in controlling the water inside the basins. Before sowing, the plot is levelled again as second levelling and final grading under water in order to prepare a good seedbed. This second levelling is conducted with a plane or towed grader blades.

2. Tillage

Field operations began with disposal of the straw by soil incorporation or removal from the field. The crop residues incorporation in the fall hastens straw decomposition and reduces the likelihood of algae growth and toxic gas formation in the following rice crop soil tillage dries rhizomes and other underground overwinting structures of perennial weeds. Tillage may be done in fall or may be postponed until spring under wet conditions, but generally begins as early as possible. This tillage is carried out in 20 to 25 cm depth with waldboard plough. Then the levees are erected, their size is 30 to 40 cm height and 40 to 50 cm length. After then, livelong is done and a shallow tillage is conducted with a disk harrow or a field cultivator.

Before flooding the field, the fertilizer and pre-emergence herbicide applications are done and incorporated into the soil with a spike-tooth harrow.

II – Planting time

The rice planting time varies from region to region in Turkey, it can be done after mid of April in the Aegean, Mediterranean, and Southeast Anatolia. The ideal period for rice planting in main rice producing regions, Marmara-Thrace and Black Sea, is May depending on the vegetative cycle of the rice varieties involved. The late varieties should be planted in the first part of May.

In Turkey the rice-growing period is 150-160 days from the beginning of May to mid-October. Thus, in order to obtain maximum yields and milling outturn, it is essential to sow and harvest rice on time.

III – Planting

Pre-germinated seed is commonly used for direct seedling. Seed is broadcasted by hand into the standing water. Some farmers also broadcast presoaked seed (ungerminated) with centrifugal broadcaster into water. For this, before planting, seed is soaked in water for 24 to 36 hours, drained for 18 to 24 hours, and then planted by centrifugal broadcaster. Generally, seed rate is 200 kg Per hectare for long-large grain size varieties and it is 170-180 kg Per hectare for medium grain type.

IV – Fertilization

In general, nitrogen and phosphorus fertilizer is used for rice crop in Turkey. Rice crop suffers from zinc deficiency in some certain areas as well. Applying some zinc sulphate, the farmers overcome this problem. Rice soils are rich in potasium or they have enough available potasium, therefore no potasium application is done for rice crop.

Fertilizer rate is N_{150} P_{80} per hectare. Nitrogen is applied in three portions; the first part is at the preplanting, second part at the tillering, and the third part at the panicle initiation. All phosphorus is given at preplanting as basal application. Under irrigation with continuous flooding, nitrogen is applied in the form of ammonium sulphate or urea.

V – Water management

Rice is cultivated under continuous flooding irrigation with full water control. The sowing is done in 5 to 10 cm depth of water. This water cover is maintained for three to five days and then the plot is drained, leaving the soil saturated with water for a few days. As rice plants appear, the plot is flooded gradually until the water depth reaches 10 to 15 cm. Water is maintained, circulating slowly at that depth until most grains reach to the dough stage.

Water depth may decrease only on the occasion of top-dressing with nitrogen fertilizer or water may be drained for post-germinating herbicide application. Drainage at any time during early growing stage should not be done, it may stimulate the germination and growth of new weeds. Early drainage may also delay rice heading.

The timing of drainage for harvesting is critical, because residual moisture must be available throughout grain filling, but the soil should be dry enough at harvest to support heavy equipment. Draining too early results in incompletely filled kernels that break or crack in the harvester an produce low milling yield. Rice variety, soil type, and lateness of the season influence drainage strategy. In general, draining is done for harvesting at 30 to 35 days after flowering in Turkey.

VI – Weed Control

An array of grass, broadleaf and sedge weeds adapted to the aquatic environment must be controlled for optimum rice yields. The strategies integrating preventive weed control, crop or fallow rotation, appropriate water and fertilizer management and herbicides are widely used to control weeds in rice.

Watergrass (*Echinocloa spp*.) is the most competitive and difficult weed to control in Turkish rice fields. The principal grasses are *Echinochloa crus-galli, Echinochloa conunum*, and *Echinochloa oryzoides*. Annual and perennial sedges and broadleaf weeds also infest rice fields in Turkey. The most important sedges are *Cyperus difformis*, *Scirpus mucranatus*. and *Scirpus maritimus*.

The most important annual broadleaf weeds are *Alisma plantago-aquatica*, and *Butamus umbellatus.*

Good water management is an important factor in weed control in direct seeded flooded rice. Seeds are broadcasted into standing water. The water level is increased gradually as the rice grows. Because the field can not be flooded until seedlings are established, some weeds will grow along with the rice. After rice establishment, the water level should be raised as rapidly as possible without damaging young rice seedlings, then kept uniform and continuous. The shallow (lees than 2.5 cm), continuous flooding facilitates weed growth. When the soil surface is exposed to air. That creates an ideal condition for weed germination and growth.

Towed or mounted implements are used for the operation in herbicide application in large farm. Liquid formulations are distributed with boom sprayers 12 to 14 m wide, cone- or fan-shaped nozzles. Doses of 400 litres of water for hectare are used at a pressure of 3 to 100 bar.

The farmers use knasack sprayer or atomiser in herbicide application in small farm. The some farmers also mix herbicide with fertilizer and then, they broadcast the diluted product in the paddy.

In order to control the weeds the herbicide applications are done at the pre-emergence or post-emergence stages. The application at the pre-emergence stage is done in dry conditions before flooding. The post-emergence application is done into standing water or drained field.

The principal rice herbicides are used in Turkey are:

- **Propanil**: Propanil is a contact herbicide that can be applied at post emergence stage. It is effective against several grassy weeds.
- **Molinate**: Molinate is a selective herbicide for controlling *Echinochloa spp*.
- **Thiobencarb**: It is more effective on grasses and sedges.
- **Bentazon**: Bentazon is used for a number of broadleaf weeds and sedges.
- **Bensulfuron**: Bensulfuron controls many broadleaf weeds and sedges.
- **Bispyribac sodium**: This herbicide is recommended for *Echinochloa spp*. and sedges
- **Cyhalopob-Butyl**: It is used to control *Echinocloa spp* and *Digitaria paspaloides*.
- **Ethoxysulfuron**: Ethoxysulfuron controls broadleaf weeds and sedges.

The farmers should take into account the following points for a successful weed control.

- Herbicides should be applied at the right stage of weed and rice growth, before the weeds become too large.
- Application should be done at the right rate.
- The right herbicide should be selected.
- Water depth and flow management after application are an important aspect of successful weed control.

VII – Harvesting and threshing

Rice harvesting time varies from September 15 to October 30. Rice is harvested at 20 to 24 percent grain moisture content. Harvesting the grain too wet does not allow maximum kernel development and requires excessive drying costs. Harvesting the grain too dry increases the breakage during harvesting and milling. The recommended harvesting time is at 45 to 50 days after flowering. Early harvesting may reduce the field yield of paddy and head yield of rice owing to the presence of immature kernels. Late harvesting may also reduce yields because of grain shattering and lodging.

Rice is harvested in two ways in Turkey. In the firs way, the farmers cut the crop by hand with a sickle or reaper machine and then they leave it in the field to dry under the sun for a few days. After that, the sheaves of rice are carried to the threshing area. Threshing is done with combine or thresher.

In the second way, rice is directly harvested with combine and the crop is dried to a storable moisture of 13 to 14 percent. For drying, mechanical dryers are used.

VIII – Contraints of rice crop

Abiotic and Biotic Constraints

***Cold Water and Weather Temperatures*:** Cold water especially supplied by waterpump from underground or dams, affects the rice crop at the germination and seedling phases. It causes

difficulties for a good stand establishment. Low weather temperatures give damage to rice crop during the different stages of development at germinating, seedling, panicle formation, flowering, and pollination.

***High Temperature*:** High temperature causes spikelet sterility in south-eastern part of Turkey. Rice is grown there in many micro climatic regions.

***Drought or Water Shortage*:** Rice is grown under continuous irrigation with full water control. Sometimes rice crop can suffer from drought or water shortage. The reasons for this problem are; (1) the farmers sow rice in excessive areas, when rice price is very high and profitable in the market. Thus, available irrigation water can not be enough for rice crop, (2) low water accumulation in the dams or less water flowing in the rivers due to low rainfall.

***Salinity and Alkalinity*:** Salinity and alkalinity affect the rice crop in some certain areas. The soil contains high level salt in those areas. Also, irrigation water sometimes contains high level salt. However, this is not very important problem in Turkish rice production.

***Rice Diseases*:** Some fungal diseases give damage to rice crop in Turkey. These are blast disease (*Pyricularia oryzae*), brown leaf spot (*Helminthosporium oryzae)* and bakanea and foot rot (*Fusarium moniliforme*). The most important disease is blast. A heavy blast disease infection occurred in some rice growing areas in north-western part 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 rice growing area of the region. Some farmers left their crop in the field without harvesting. The reasons for this diseases infection were heavy rainfall in July and August in 1995, excessive nitrogen application, late planting, high seed density, and cold irrigation water.

***Micronutrient Disorders*:** Only Zn deficiency has been recognised in the rice fields in Turkey. The other micronutrient disorders have not been observed. Zinc deficiency constrains considerably the rice crop in certain areas. However, applying Zn, the farmers solve this problem.

Weed: The most important weed in rice fields is *Echinochloa spp*. Also, some other species can be observed, such as *Cyperus spp*, *Scirpus spp*, and *Alismacea spp* etc.

IX – Main problems of rice cultivation

- Inadequate plot levelling
- Unsuitable weed control management
- Lack of suitable machinery
- Inefficient drainage systems
- Limited quantities of irrigation water
- Red rice
- Small farm size.

1. Inadequate Plot Levelling

Precise levelling of rice plot is essential for rice cultivation. Land levelling allows maintenance of a uniform water depth within the plot and greatly facilities subsequent management practices for stand establishment, weed control, and field drainage for harvest.

Although some farmers use laser levelling technology for levelling. In general, the farmers do not have suitable equipment for this operation. Thus, the levelling of rice fields is inadequate; this creates problems in water management and weed control.

2. Unsuitable Weed Control Management

The farmers apply herbicides sometimes late or in high dosage. Some of them do not select right herbicides, for example, they try to control broadleaf or sedge weeds with propanil. In general, they can not control all the weeds with one herbicide application. Thus, they have to apply the same or different herbicides two or more times.

3. Lack of Suitable Machinery

The most of the farmers do not have suitable equipment for rice cultivation. Small size farmers use the same machine utilised in the other crop cultivation.

4. Inefficient Drainage Systems

Poor drainage system has been the source of many problems in rice cultivation in Turkey. It causes a serious problem at the post-germinating weed control. When the water is drained in the rice field for weed control. It takes long time for full draining of all field surface. Thus, the farmer sometimes has to apply herbicide too late or later than normal time. It also gives damage to the crop due to excessive drying of the field and weed is getting older than normal herbicide application stage. Therefore, the farmer may control the weed using herbicide more then normal dose. It means more production cost.

Draining rice field for harvesting can not be done on time due to poor drainage systems. It causes late harvesting or difficulties for harvesting equipment. The poor drainage sometimes creates salinity and alkalinity problems in some certain areas as well.

5. Limited quantities of irrigation water

Irrigation water is the most limiting factor for expanding the area under rice cultivation. Although the land structure and climate are suitable for rice growing in many micro and macro climatical regions and the farmers are very eager to produce rice. Due to Shortage of irrigation water, it is not possible to expand rice cultivating area.

6. Red Rice

Rice is cultivated without rotation in some areas in Turkey. As long as the farmers find the water for rice irrigation, they continue growing rice. On the other hand, the rice farmers are not used to changing their seed with certified seed. Therefore, red rice became a great problem in Turkish rice production in the last years. The red rice reduces field and milled yields, and market quality of rice crop. Due to red rice problem, the farmers sometimes sell their product with very low price.

7. Small Farm Size

In general, the average farm size is very small in Turkey. The most of rice farmers have 2 to 3 ha. area for rice production. Only a few farmers have 100 to 200 ha. area. The small farmer can not save the money to make investment for rice cultivation equipment. Thus, they may not have suitable equipment for rice farming. They use unsuitable equipment or manpower for many operations. This increases production cost.