RICE CULTIVATION IN ITALY UNDER THE THREAT OF CLIMATIC CHANGE

Marco Arcieri – Vice President ICID
WHERE DID RICE COME FROM?

The exact origin of rice is not well known. However, domestication of rice is one of the most important developments in history. It has probably fed more people over a longer period than any other crop.

Several theories state that the plant could have been originating on the slopes of Himalayas, on the island of Java or in the area of the Cambodian lakes, between 15,000 and 8,000 years ago.

Some excavations have shown that in China, around seven thousand years ago, rice was cropped and consumed. Fossil remains found in the valley of the Yang Tze river confirm that three to four thousand years ago in that region rice fields were already a reality.

Successive finds found in India show that around 1,000 BC the local populations fed on rice.
FROM ASIA TO EUROPE

From the Far East rice began spreading to the West, arriving after millennia in Mesopotamia, where it was cultivated in the 4th century BC. It is undoubtedly the Greeks who make rice known to the West, arriving in Europe as a staple food for soldiers, after the expeditions throughout Asia of Alexander the Great.

As Plinius writes in the "Naturalis Historia" the cereal is also well known by the Romans, even though it was considered as a healing plant. Horace, for instance, in a famous satire tells of a doctor who prescribed a tea made out of rice.

From Palestine, from the West Bank and from Syria rice cultivation reaches Egypt, probably introduced by Indian populations and subsequently cultivated by the Arabs. The first information on the rice trade dates back to the 1st century A.D.
FROM ASIA TO EUROPE

The **Arabs** introduce rice cultivation also in *Algeria* and in *Senegal*, from where it will expand to the western part of the African continent. On the northern side of the Mediterranean, rice reaches the coasts of *Spain* and from there they introduce it to *Sicily*, where many Arab books describe with minuteness the various phases of the crop.
FROM ASIA TO EUROPE

Thus from GREEKS to ROMANS, throughout the ARAB domination and the later Medieval times, until the Renaissance period, rice is only referred to as a spice, as a medicament for different kind of pathologies or just for cosmetics purposes.

An account of the Dukes of Savoy expenditure dating back to 1300 records the purchase of rice for sweets making, whilst an edict of 1340 from the city of Milan reports the tax to be paid on rice as «spice that comes from Asia, via Greece». Still in 1371, rice is considered a spice and is called overseas rice or Spanish rice.
FROM ASIA TO EUROPE

Thus from *Greeks* to *Romans*, throughout the *Arab* domination and the later *Medieval* times, until the *Renaissance* period, rice is only referred to as a spice, as a medicament for different kind of pathologies or just for cosmetics purposes.

An account of the *Dukes of Savoy* expenditure dating back to 1300 records the purchase of rice for sweets making, whilst an edict of 1340 from the city of *Milan* reports the tax to be paid on rice as «*spice that comes from Asia, via Greece*». Still in 1371, rice is considered a spice and is called *overseas rice* or *Spanish rice*.

In Italy pheasants of the Middle Age apprehended from these Monks the art of irrigation and land reclamation, thus greatly contributing to its widespread diffusion among the first forms of Communes.

Rice experienced a real diffusion in Europe only through the *Middle Ages*, also as the result of the intense labour of hard-working monks.
FROM ASIA TO EUROPE

It is only between the XVth and the XVIth century that the *cultivation* of rice is finally taking place, improving nutrition and quality of life of European people. In many States, crops are protected by appropriate measures so that the seed is not to be exported.

In 1567, at the Antwerp market in Belgium, rice is equated with exchange coins such as precious fabrics and weapons.
FROM ASIA TO EUROPE

It is only between the XVth and the XVIth century that the cultivation of rice is finally taking place, improving nutrition and quality of life of European people. In many States, crops are protected by appropriate measures so that the seed is not to be exported.

In 1567, at the Antwerp market in Belgium, rice is equated with exchange coins such as precious fabrics and weapons.

In Italy rice cultivation develops at the end of XVth Century, where the first paddy field is established in 1468 by Leonardo Colto de 'Colti in Florence Duchy.

In 1475, two letters by Duke Galeazzo Maria S authorization to export 12 bags of sowing rice from Ferrara in Northern Italy. In this letter, he donates to the Duke of Ferrara seeds which he defined in a letter "interesting and deserving to be cultivated".
FROM ASIA TO EUROPE

It is after the brilliant intuition of the Dukes of Sforza in *Mantova*, Northern Italy that rice cultivation develops at the end of XVth Century, where "modern" paddy fields are established.

Galeazzo Maria and his brother Ludovico Sforza thought to exploit the frequent flooding of the *Po* River that occurred at the time.

But floods, at that time, also meant death and destruction. *Leonardo da Vinci* is world wide known for his contribution to the progress of science.

In the history of Italian rice growing, his contribution to the conceiving and the realization of gates and canals in order to drain the marshlands of the Po river plains during the 15th Century is considered as invaluable.
FROM ASIA TO EUROPE

In 1492 the course of human civilization changes, following the discovery of the New World by Cristopher Columbus. With him and his contribution to the history of navigation, the whole world became suddenly smaller and the modern age began. If the Americas are, nowadays, what we know, this is solely thanks to Cristopher Columbus.

In 1690, following the settlers, rice also arrived in US, in the Carolina State area, where the environmental conditions turned out to be favourable to its production and thus, it began its expansion throughout the American Continent.
**Rice is the second most widely consumed grain in the world**

**World Production (2005/06)**

1,6 billions tons

710 millions ha

<table>
<thead>
<tr>
<th>Crop</th>
<th>% arable land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>16%</td>
</tr>
<tr>
<td>Rice</td>
<td>11%</td>
</tr>
<tr>
<td>Maize</td>
<td>10%</td>
</tr>
<tr>
<td>Barley</td>
<td>6%</td>
</tr>
<tr>
<td>Sorghum</td>
<td>3%</td>
</tr>
<tr>
<td>Millet</td>
<td>3%</td>
</tr>
</tbody>
</table>

---

1 Canada Square, London E14 5AE, UK
Tel: +44 (0) 20 7513 1122
Fax: +44 (0) 20 7513 0630
E-mail: igc-fac@igc.org.uk
Web site: www.igc.org.uk
Rice is one of the most important cereal crops of the world. It is considered to be the main food for about half of the population of the world, especially in the eastern parts of Asia as in China, Japan, India, and so on.

Rice cultivation in the World

Source: FAOSTAT (Nov 07, 2018)
Rice is one of the most important cereal crop of the world. It is considered to be the main food for about half population of the world, especially in the eastern parts of Asia as in China, Japan, India.
**RICE CULTIVATION IN THE WORLD**

Asian Countries are the largest producers and exporters of rice in the world. *Italy* is the main producer and exporter of rice in Europe.

Italy is actually the largest rice producer in the European Union (EU): approximately from 2/3 to half of the European rice is produced in Italy. More than 60% of the national production is exported both towards EU countries (2/3 of the exported amount) and other Countries, mainly in the Mediterranean area and in Eastern Europe.

Although Italian rice represents a very small fraction of the world production, the volume of exports reaches 5% of total rice traded in the world.
RICE CULTIVATION IN ITALY

10 Country, Export Value of Rice - total (Rice milled equivalent) 2016

Source: FAOSTAT (Nov 09, 2018)
But over the past five years, rice consumption in the EU has increased by 5% as rice imports from Asia (Cambodia and Burma) increased by 171%.

Cambodian and Burmese rice imports in Italy alone have recorded a lack of placement of 67,000 tons of processed rice in the EU from the 2011/12 campaign to the 2016/17 one.
After a reduction in the second half of 90’s, cropping area has continuously been increasing in the past 10 years, since year 2000. Trends showed a constant reduction of the number of farms, while an increase of the extension of each farm has been witnessed.

The increase witnessed in the cultivated area, about 20% during the past ten years and until 2010, has exerted very positive effects on Italian economy as it enabled export of more than 60% of its production.

These exports have greatly counterbalanced imports of large quantities of food and feed products. In fact, Italy has become an important rice-exporting Country, considering that its domestic consumption hardly exceeds 40% of the total rice production.
**RICE CULTIVATION IN ITALY**

As a matter of fact, Italians do not eat much rice (about **8.5 kg/person** in 2000), but nevertheless Italy is famous for its exquisite dish *risotto*. A number of rice varieties have been developed for this purpose, like *Arborio* and *Carnaroli* CVs.

The most famous Italian yellow rice dish is *Risotto alla Milanese*.

According to tradition, the dish was invented during the construction of the famous Milan Cathedral at the beginning of 15th Century.

*Saffron* was used to colour the stained glass windows of the Cathedral, but was added to a risotto dish only as a joke.

It turned out to be delicious…
**Rice Cultivation in Italy**

Rice is thrown to the spouses while they leave the church, as a sign of good luck and prosperity.

A very common saying in Italy is: "Rice is born in water, but dies in wine".

The famous poet Giovanni Pascoli composed a poem about a rice dish, whilst famous composer Gioacchino Rossini wrote a famous Aria while waiting for a *Risotto* in his famous opera *Tancredi*.
RICE CULTIVATION IN ITALY

Rice cultivation in Italy is mostly located in the northern regions (Po river Valley) covering about 240,000 ha, which represents 1.4% of the total arable area (16,800,000 ha). Small areas are cropped in the Sardinia island and in Southern Italy, as well.
RICE CULTIVATION IN ITALY

Rice cultivation in Italy is mostly located in the northern regions (Po river Valley) covering about 240,000 ha, which represents 1.4% of the total arable area (16,800,000 ha). Small areas are cropped in the Sardinia island and in Southern Italy, as well.

It is highly specialized and represents 70-80% of the rice farming surface, although in the last years soybean and maize have been successfully and increasingly grown as annual rotation crops in rice fields.
RICE CULTIVATION IN ITALY

Rice cultivation in Italy is mostly located in the northern regions (Po river Valley) covering about 240,000 ha, which represents 1.4% of the total arable area (16,800,000 ha). Small areas are cropped in the Sardinia island and in Southern Italy, as well.

It is highly specialized and represents 70-80% of the rice farming surface, although in the last years soybean and maize have been successfully and increasingly grown as annual rotation crops in rice fields.

The usual production is approximately 1.5 million tons of paddy rice, whereas the average yield is about 6 to 7 tons per ha.
RICE CULTIVATION IN ITALY

Rice cultivation in Italy is mostly located in the northern regions (*Po* river Valley) covering about 240,000 ha, which represents 1.4% of the total arable area (16,800,000 ha). Small areas are cropped in the *Sardinia* island and in *Southern Italy*, as well.

It is highly specialized and represents 70-80% of the rice farming surface, although in the last years soybean and maize have been successfully and increasingly grown as annual rotation crops in rice fields.

The usual production is approximately 1.5 million tons of paddy rice, whereas the average yield is about 6 to 7 tons per ha.

In recent years, Italian rice cultivation has been going through a phase of great change, given the diffusion of alternative forms to traditional cultivation.
Emergence

Germination

Tillering

Heading

Ripening

5-10 d  15-25 d  25-45 d  15-21 d  30-46 d
Rice Cultivation in Italy

**High Thermal Demands**
Low temperatures can be very harmful, especially in the initial phases, as Italian environment is located at northern latitudes than usual range of cultivation of rice.

**High Water Requirements**
High water coefficient (600-800 g H₂O/g d.m. with soil permeability ranging 2-8 mm / d)
High consumption of H₂O in the paddy field: 1-6 l sec⁻¹ ha⁻¹ x 110 d = 1,000 to 5,000 mm

**Soil Requirements**
- No Peaty soils
- Harmful fermentations (subtraction of oxygen)
- No Sandy soils
- Excessive water consumption

12° C (MIN.) – 29°C (OPT.)

25° C (MIN.) – 30°C (OPT.)

20° C (MIN.) – 23°C (OPT.)
RICE CULTIVATION IN ITALY

In Italy, rice is a typical spring-summer crop. The usual crop rotation is maize, beet, vegetables. The soil is readily available for cultivation, as it "regenerates" the field from weeds of other crops. Repeated cropping is possible, in order to cut down the expensive costs required for soil preparation, but not more than for 5-6 years in a row since it might create weed problems. Attention needs to be paid after fodder crops, because of possible excessive organic substance (harmful fermentations).

TROPICS permanent rice fields (terraced), providing 2-3 crops a year. Transplant is usual, to shorten the cycle.
RICE CULTIVATION IN ITALY

SOIL PREPARATION

Rice in Italy is grown from April to October. At the end of winter a surface light ploughing (20-25 cm) is carried out with mold-board plough.

This eventually can be replaced by hoeing or digging on light, organic soils, in order to proceed to fertilization.

Just before sowing there can be a light tillage, organics harrowing and a surface levelling (with laser system).
**Rice Cultivation in Italy**

**Preparation of the Paddy Field**

Well-levelled fields, surrounded by embankments and served by a network of supply and drainage canals. Annual maintenance of canals and embankments is quite expensive.

In certain periods alternating dry and submerging is needed, providing continuous changes to the H\(_2\)O level. Usually rice is grown in shallow water (10-30 cm), depending on the height of rice and weeds.

Need to keep running water, because of the high demand for O\(_2\) of seedlings and roots. Need to have thermoregulation (avoid cold water).
Rice Cultivation in Italy

Sowing

Transplant (once widespread in Italy, today only in Tropical Countries), to shorten the cycle in cold environments, but it requires a lot of manpower. Seedlings produced in nurseries (1500 p./m², 1/10 final surface) to be transplanted to about 15 cm in height and with 8-10 plants / hole.

Direct sowing

• Broadcast seeding, on flooded rice paddy, usually with fertilizer spreader (with 2 impellers for better uniformity).
RICE CULTIVATION IN ITALY

SOWING

Transplant (once widespread in Italy, today only in Tropical Countries), to shorten the cycle in cold environments, but it requires a lot of manpower. Seedlings produced in nurseries (1500 p./m², 1/10 final surface) to be transplanted to about 15 cm in height and with 8-10 plants / hole

Direct sowing

• *Broadcast seeding*, on flooded rice paddy, usually with fertilizer spreader (with 2 impellers for better uniformity).

• *Seeding in rows* on dry rice paddy, to be submerged after the emergency, 65 cm between the rows.

140-200 kg/ha seed - 250-400 panicles/ m²

Early sowing is better for late ripening Cvs, but it can be risky for Cvs with high thermal requirement (ssp. indica)
RICE CULTIVATION IN ITALY

WATER MANAGEMENT

After emergence, at least 3 dry cycles are performed:
1. **Rooting** (with 2-3 leaves)
   - half of June
2. **Fertilization and weeding**
   - end of June
3. **Before harvesting** (ripening)
   - end of August

Water comes from collective irrigation systems, wells or alpine rivers. The water level must be continuously adjusted, according to thermal demands of the plant, but also against pests and weeds.

Water temperature has to be >12-14°C (April-May in North Italy). Before entering rice fields, it is heated by means of "caldane“, winding canal pathways exposed to the sun.
RICE CULTIVATION IN ITALY

Harvesting period in Italy:
Early cv's.  Half of September
Late cv's.  Mid-October

Yields:
6 - 6.5 t / ha of paddy rice with 13% humidity higher than the world average (4.0 t / ha)
higher than wheat (milled rice yield is 55%)

Dry paddy field (~ 2 weeks before harvest)
Harvesting - at 23-25% moisture
Drying - up to 13-14% of humidity
in dryers at 35-40 °C

In some areas
Manual Harvesting + grain separation

In specialized areas
Half-tracked or normal combine
with 3-5 m working bar and capacity of 1h / ha
RICE CULTIVATION IN ITALY
WEED MANAGEMENT

Localization of the cultivation of rice (north-west of the Po Valley), has always been linked to high water availability. Weed management has always been a major issue.

Today: chemical 100%
At least 2 products are used

• Max chemical input
• Very high costs

In the past: by hand labour (50-60’s)
= ~ 350 h / ha
RICE CULTIVATION IN ITALY

ORGANIC RICE

Organic farming continues its double-digit growth trend: in 2016 it has increased of 20% on food sales. As recent market research highlighted, there is a growing attention of consumers to food on the table: they want to know about the properties of raw materials, their origin, if they’re obtained as a result of sustainable production respectful of the environment.

Behind this desire for traceability, there is an increase in the demand for organic food products, safe from a human food point of view, but also respectful of the environment.

Recently, India, Pakistan and Thailand competed together with the export of almost all organic rice to Italy, with an increase of 38% in the few past years.

So in last years, many companies have introduced alternative techniques such as mulching, historically used to grow vegetables. This has been possible after the creation of biodegradable sheets, made of organic material, such as potatoes and corn. Films are laid out in paddy fields to prevent weeds’ growth, without using chemical products.
Rice Cultivation in Italy

Organic Rice

Mulch is provided by a special machine which is spreading the sheets and creating at the same time special holes, where rice seeds are released.

This way the rice seedling is able to grow, while the weeds remain suffocated under the covering film, which does not allow light to filter.

Organic rice cultivation, with its 12,500 hectares, only represents 6% of the area cultivated with organic rice, but about a quarter of the land is now under conversion.

In the next few years, mulching will cover about 10% of the organic rice area in Italy: it still represents a niche at a national level, but depicts a future aimed at environmental sustainability and quality product.
**Rice Cultivation in Italy**

**Main Constraints**

**Climate:** Meteorological conditions are a major limiting factor considering that the diurnal variations are mostly located in the northern part of Italy. During the flowering stage in April, strong diurnal variations can cause conditions that favor the development of blast and brown spot diseases. Furthermore, a sudden decrease of temperature or strong diurnal variations can occur during thunderstorms in August, causing spikelet sterility and more favorable conditions for blast attacks. Thunderstorms and wind during the ripening stage may cause severe lodging of the tallest varieties.

**Diseases:** Blast and brown spot are at present the main diseases, but they rarely cause great damage to the crop, depending on climatic conditions.
RICE CULTIVATION IN ITALY

MAIN CONSTRAINTS

CLIMATE: Moreover, a sudden decrease of temperature or strong diurnal variations can occur at flowering time, during thunderstorms in August, causing spikelet sterility and/or more favourable conditions for blast attacks. Thunderstorms and wind during the ripening stage may cause severe lodging of the tallest varieties.

DISEASES: blast and brown spot are at present the main diseases, but they rarely cause great damage to the crop, depending on climatic conditions.

WEED POPULATIONS remain one of the main limiting factors for rice production in intensive cultivation.
Rice Cultivation in Italy

Main Constraints

Climate: Moreover, a sudden decrease of temperature or strong diurnal variations can occur at flowering time, during thunderstorms in August, causing spikelet sterility and/or more favourable conditions for blast attacks. Thunderstorms and wind during the ripening stage may cause severe lodging of the tallest varieties.

Diseases: blast and brown spot are at present the main diseases, but they rarely cause great damage to the crop, depending on climatic conditions.

Weed populations remain one of the main limiting factors for rice production in intensive cultivation.

Others: red rice has become a main constraint in the last years since it remains in soils, especially in the case of monoculture.
RICE CULTIVATION IN ITALY

KEY CHALLENGES

• Improving quality of national productions in order to adequately meet requirements of a fast growing changing market.

• Raising rice productivity and making the farmer profitable, globally competitive and climate-resilient with the crop, by producing more with less resources.

• Coping with growing costs of agricultural inputs & declining of real farm incomes, due to instability of prices.

• Increasing global competitiveness under liberalized trade conditions.

• Improving small farm production efficiency by promoting ecosystem-based agriculture, within the context of sustainable intensification and climate change.
Rice Cultivation in Italy

Key Issues

Increased severity and frequency of extreme weather events, such as intense thunder storms and recently, strong typhoons.

Far more frequently recurring high temperatures, which raise incidences of drought, pests and diseases.

Growing proportions of rice cultivated areas have become drought-prone, while intense urbanization is diverting irrigation water for domestic use.

Water scarcity, especially, has become a serious production constraint in this part of Northern Italy, as almost 60% of freshwater flows directly to rice paddies.
Rice Cultivation in Italy
Management Practices

Alternative agricultural practices to improve soil fertility.
RICE CULTIVATION IN ITALY
MANAGEMENT PRACTICES

Alternative agricultural practices to improve soil fertility.

Multi-cropping rotations (rice-vegetables).
RICE CULTIVATION IN ITALY
MANAGEMENT PRACTICES

Alternative agricultural practices to improve soil fertility.

Multi-cropping rotations (rice-vegetables).

Soil sampling/analysis and site-specific nutrient management.
RICE CULTIVATION IN ITALY
MANAGEMENT PRACTICES

Alternative agricultural practices to improve soil fertility.

Multi-cropping rotations (rice-vegetables).

Soil sampling/analysis and site-specific nutrient management.

Balanced fertilization and use of organic fertilizers.
Rice Cultivation in Italy
Management Practices

Alternative agricultural practices to improve soil fertility.

Multi-cropping rotations (rice-vegetables).

Soil sampling/analysis and site-specific nutrient management.

Balanced fertilization and use of organic fertilizers.

Thorough land preparation and land levelling.
RICE CULTIVATION IN ITALY
MANAGEMENT PRACTICES

Alternative agricultural practices to improve soil fertility.

Multi-cropping rotations (rice-vegetables).

Soil sampling/analysis and site-specific nutrient management.

Balanced fertilization and use of organic fertilizers.

Thorough land preparation and land levelling.

Integrated Pest Management or IPM.
RICE CULTIVATION IN ITALY
MANAGEMENT PRACTICES

Alternative agricultural practices to improve soil fertility.

Multi-cropping rotations (rice-vegetables).

Soil sampling/analysis and site-specific nutrient management.

Balanced fertilization and use of organic fertilizers.

Thorough land preparation and land levelling.

Integrated Pest Management or IPM.

Harvest and post-harvest management.
RICE CULTIVATION IN ITALY

Climate change and price unpredictability represent severe challenges for producers and agricultural companies, called to adapt their production processes to the needs of the globalized world.

No increase of the rice cultivation area is expected in the nearest future; on the contrary, a decrease might probably occur if the rice price is going to decrease or production is going to be affected by globalization dynamics...

Thus, increase of rice yield can generally be expected by means of the introduction of new varieties with improved traits, such as disease resistance or tolerance, salinity and low temperature tolerance, reduced culm length and lodging resistance.
Rice is a highly demanding plant. Its cultivation requires a great availability of water as its lack can influence the normal growth of the culture conditioning yields in the final production.
Rice is a highly demanding plant. Its cultivation requires a great availability of water as its lack can influence the normal growth of the culture conditioning yields in the final production.

Traditional cultivation technique, such as the submersion system in the lowlands paddy fields, requires high volumes of water, ranging between 15,000 and 20,000 m$^3$ per ha, depending on the season.
Rice is a highly demanding plant. Its cultivation requires a great availability of water as its lack can influence the normal growth of the culture conditioning yields in the final production.

Traditional cultivation technique, such as the submersion system in the *lowlands* paddy fields, requires high volumes of water, ranging between 15,000 and 20,000 m$^3$ per ha, depending on the season.

But even though it is usually cropped as a plunging culture, it is not necessarily linked to this condition.
RICE CULTIVATION IN ITALY

Rice is a highly demanding plant. Its cultivation requires a great availability of water as its lack can influence the normal growth of the culture conditioning yields in the final production.

Traditional cultivation technique, such as the submersion system in the *lowlands* paddy fields, requires high volumes of water, ranging between 15,000 and 20,000 m$^3$ per ha, depending on the season.

But even though it is usually cropped as a plunging culture, it is not necessarily linked to this condition.

The development of rice cultivars with improved tolerance to cultivation under reduced water regimes (*upland* like), with turned irrigation, thus offers very interesting perspectives and represents a major objective of research in order to save water.
In recent years the repeated occurrence of particularly dry weather conditions has created conditions of water scarcity in Italy, with serious consequences on yields of the main irrigated crops, such as rice also.

The Cedrome Project (INCO -2005-015468), which has been conceived in order to «Develope drought-resistant cereals to support efficient water management in the Mediterranean area» is an example of these. It has funded by the European Commission and coordinated by the University of Leiden, the Netherlands.

An assessment of 7 Italian rice cultivars for the main agronomical, quality and phytosanitary traits was performed in a two year field trial, comparing the conventional agro systems with the upland similar.
RICE CULTIVATION IN ITALY

DRY CULTIVATION

Sowing is carried out on dry soil, burying the seed at a 2-3 cm depth. The water requirements are postponed of about 30 to 45 days. After this phase the cultivation remains flooded and water management is very much similar to a traditional paddy field.

The advantages of practicing a dry seeding can be so defined:

- less water (20% is required compared to conventional seeding);
RICE CULTIVATION IN ITALY

DRY CULTIVATION

Sowing is carried out on dry soil, burying the seed at a 2-3 cm depth. The water requirements are postponed of about 30 to 45 days. After this phase the cultivation remains flooded and water management is very much similar to a traditional paddy field.

The advantages of practicing a dry seeding can be so defined:

• less water (20% is required compared to conventional seeding);
• less emission combined in the atmosphere of water vapour and gas caused by fermentation;
The advantages of practicing a dry seeding can be so defined:

- less water (20% is required compared to conventional seeding);
- less emission combined in the atmosphere of water vapour and gas caused by fermentation;
- less mosquitoes and similar insects, thus lower herbicides in the ground;
Sowing is carried out on dry soil, burying the seed at a 2-3 cm depth. The water requirements are postponed of about 30 to 45 days. After this phase the cultivation remains flooded and water management is very much similar to a traditional paddy field.

The advantages of practicing a dry seeding can be so defined:

- less water (20% is required compared to conventional seeding);
- less emission combined in the atmosphere of water vapour and gas caused by fermentation;
- less mosquitoes and similar insects, thus lower herbicides in the ground;
- less nitrates and lower maintenance of the embankments.
RICE CULTIVATION IN ITALY

DRY CULTIVATION

Sowing is carried out on dry soil, burying the seed at a 2-3 cm depth. The water requirements are postponed of about 30 to 45 days. After this phase the cultivation remains flooded and water management is very much similar to a traditional paddy field.

The advantages of practicing a dry seeding can be so defined:

- less water (20% is required compared to conventional seeding);
- less emission combined in the atmosphere of water vapour and gas caused by fermentation;
- less mosquitoes and similar insects, thus lower herbicides in the ground;
- less nitrates and lower maintenance of the embankments.

This practice guarantees a favourable environmental impact because of the reduced water requirements, less energy demand and the lower incidence of weeds to fight against.
Under this water regime it was established that plants received 1/5 of the total water volume needed for conventional culture in submersion.

Water shortage caused a yield reduction of 40% on the average: this resulted from a decrease in the 1000 seed weight, tiller density and panicle sterility.

However, amongst others three cultivars showed a considerable good performance under water stress: cv. Eurosis, SIS R215 and Augusto showed very interesting yield and milling results, reaching values of about 80% compared to conventional culture, with highest values of WUE.
Moreover, the optical microscope analysis of the root system of plants under reduced water regime has highlighted a significant difference in the two growing conditions.

The roots grown in submergence expressed a total absence of fungal colonization, as compared to those in condition of dryness.

On the other hand, dry land conditions stimulated in rice roots a natural colonization with *Arbuscular Mycorrhizal* (AM) fungi, which are known to play a beneficial role in the general physiology of the plant.
ITAL - ICID

WORLD IRRIGATION FORUM

1-7 September 2019, Bali, Indonesia