Rice scenario in the European Union*

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Abstract

Rice is cultivated in the European Union on submerged land in the coastal plains, deltas and river basins on a total area of about 400,000 ha, all located in the Mediterranean countries. The average crop yields in the producing countries are included between 4.80 and 7.25 t/ha, according to the environmental conditions and water availability. Milled rice consumption ranges from about 6-18 kg/capita in the Mediterranean areas, where the crop is traditionally grown, to 3.5-5.3 kg/capita in the non-rice producing countries. In the European rice producing countries most of the consumed rice is from *japonica* varieties, while in northern countries is from *indica* types. Ecological conditions of rice cultivation are quite variable. They include climates ranging from temperate to sub-tropical, soils from fine-textured to sandy, pH from acid to basic and saline. European rice ecosystems are currently facing with numerous issues, such as unfavourable temperatures, water scarcity, biotic and environmental stresses, high production costs, which often result in a low return from rice production. Research, and particularly the one carried out with international programmes, is the most effective mean of addressing these issues. Significant progress in the sustainable development of rice production in Europe is expected through the introduction of high yielding varieties tolerant to abiotic and biotic stress and by applying rice integrated crop management systems (RICM).

Key words: European Union ; rice ; sustainable development ; integrated management ; constraints ; Medrice.

Subjects: vegetal productions ; economy and rural development.

Résumé

Caractéristiques de la production de riz dans l'Union européenne

Au sein de l'Union européenne, le riz est cultivé dans les zones inondables des plaines côtières, les deltas et les bassins pluviaux, soit une surface totale d'environ 400 000 hectares entièrement situés dans les régions méditerranéennes. Les récoltes moyennes dans les pays producteurs varient entre 4,80 et 7,25 tonnes à l'hectare, selon les conditions du milieu et les disponibilités en eau. La consommation de riz usiné varie de 6 à 18 kg/personne dans les régions méditerranéennes traditionnellement productrices, à 3,5 à 5,3 kg/personne dans les pays non producteurs. Dans les pays producteurs, la plus grande part du riz consommé appartient à des variétés *japonica*, tandis que dans les pays nordiques il s'agit de variétés de riz *indica*. Les conditions écologiques de la culture du riz sont très variables. Elles incluent des climats allant du tempéré au subtropical, des sols variant de structures fines à sableuses, de pH variant d'acide à basique et des sols salés. Les écosystèmes à riz en Europe sont fréquemment soumis à de nombreux aléas tels que des températures défavorables, la rareté de l'eau, des stress biotiques et environnementaux, des coûts de production élevés ; l'ensemble a pour effet de limiter à un faible niveau la rentabilité de la production de riz. La recherche scientifique, en particulier celle réalisée dans le cadre de programmes internationaux, est le moyen le mieux adapté pour faire face à ces facteurs. Des progrès significatifs dans le développement durable de la production de riz en Europe sont attendus à la suite de l'introduction de variétés à hauts rendements tolérantes aux stress abiotiques et biotiques et par l'utilisation des systèmes de gestion intégrée de production (*rice integrated crop management*, RICM).

Mots clés : Union européenne; riz, développement durable; gestion intégrée; contrainte; Medrice.

Thèmes : productions végétales ; économie et développement rural.

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During the last 10 years rice cultivation in the European Union has remained roughly unchanged at about 400,000 ha (*table 1*). The two top rice producers are Italy (224,000 ha) and Spain (117,000 ha). These two countries together contribute more than 80% of the total rice production in Europe. Some slight variations in the harvested area have been recorded in each country of cultivation, in relation to the market price or water availability. According to the last estimates in the 2006 season the global area of cultivation should record a slight reduction, with a moderate increase (about 4,000 ha) in Italy and a significant reduction in Spain (17,000 ha) because of limited water supply.

In most countries rice production mostly occurs in concentrated areas such as, the Po valley in Italy, the Rhone delta in France, the Tessaloniky area in Greece. In Spain and Portugal rice cultivation is scattered in several areas such as the Aragon area, the Ebro delta, the Valencia Albufera, the Guadalquivir valley in Spain, the Tejo and Mondego valleys in Portugal.

The other major non-EU rice-producing countries in Europe or in the Mediterranean region are Egypt (660,000 ha) and Turkey (80,000 ha) (*table 1*) (*figure 1*).

In 2005 the average crop yield was quite variable as it ranged from 7.3 t/ha (Greece) to 4.8 t/ha (Portugal) in the EU and from 9.8 (Egypt) to 4.4 (Ukraine) in other non-EU and Mediterranean countries. In Egypt the average yield has increased dramatically in the past 20 years, from 5.7 t/ha, in 1985 to 8.2 in 1995 and 9.8, in 2005.

The ecological conditions of rice cultivation are quite variable. In Italy, the climate of rice production is temperate-continental, with a cold winter and warm summer and main rainfall occurring during the first stages of the crop growth (April-June) and the harvesting period (September-October) (FAO, 1996). In most of the other countries the climate is sub-tropical (Mediterranean climate) with a dry summer and warm, dry, clear days and long growing season. Rice is primarily grown on fine-textured, poorly drained soils with impervious hardpans and claypans that are not much suitable to other crops. A few of the soils are sandy in the surface horizon, but are underlain with hardpans. The pH can range from 4 to 8 and organic matter from

Table 1. Rice area (ha) and yield (tons/ha) in 2005 in Europe and other main Mediterranean countries (Food and Agriculture Organisation, 2007).

Tableau 1. Zones à riz (hectares) et production (tonnes/ha) en 2005 en Europe et dans les autres principaux pays méditerranéens (Food and Agriculture Organisation, 2007).

Country	Area (ha x 1000)	Yield (tons/ha)
EU countries		
Italy	224.0	6.17
Spain	117.0	7.23
Portugal	25.0	4.80
Greece	24.0	7.25
France	18.0	5.72
Hungary	2.8	3.41
Romania	1.2	4.18
Total¹ – Weighted mean²	412.0¹	6.40²
Other countries (non-EU and Mediterranean)		
Egypt	680.0	9.80
Russian Federation	145.0	4.50
Turkey	80.0	5.25
Ukraine	18.0	4.45

0.5 to 10%. In most coastal areas soils are saline or very saline (e.g. the Camargue in France, Ebro delta in Spain). In these conditions rice growing has virtually become a single crop business.

Rice is planted from early April to end-May and harvested from mid-September

to end October. During all or almost all cycle of cultivation rice fields are maintained flooded, mainly to protect the plant from the low temperatures, avoid fast temperature variations and limit weed growth. The level of the water varies over the cultural season. It is kept

Figure 1. Map of the main rice growing areas in Europe and other Mediterranean countries (cultivated area in ha x 1,000).

Figure 1. Carte des principales zones de production de riz en Europe et dans les autres pays méditerranéens (surfaces cultivées en hectares x 1 000).

at 5-7 cm during the first stages of the crop growth, in order to promote rice growth and root anchorage and at 10-15 cm after rice tillering, mainly to avoid pollen sterility effects caused by low temperatures during crop flowering. Throughout the rice cultivation season, water is usually drained away 2-3 times to improve crop rooting or allow fertilization and herbicide spraying. About 20-30 days prior to harvesting rice fields are completely drained to facilitate harvesting operations. In about 40,000 ha, mostly grown in Italy, seeds are drilled to dry soil in rows. Starting from the 3-4 leaf stage the rice is flooded continually, as in the conventional system. Most of the irrigation water comes from rivers (Po in Italy, Ebro and Guadalquivir in Spain, Evros in Greece, etc.) and lakes (Albufera in Spain). According to the different management conditions the water requirements over a cultural season varies considerably from 18,000 to 40,000 m³/ha.

Precision land grading, obtained with laser-directed equipments, is an agronomic practise that has greatly contributed to better water management, and consequently to increase crop stand establishment and improved weed control.

Seedbeds are frequently prepared by ploughing at about 20 cm in depth in autumn right after the harvest of the previous crop.

In Western Europe rice seeds are soaked in water for 24 hours before planting and then mechanically broadcasted in flooded fields. Unsoaked seeds may float on the water surface and distribute unevenly in the field. In most countries planting operation is carried out by ground equipments, in Spain frequently by airplane.

Fertilization is mostly carried out by supplying mineral fertilizers (100, 50, 100 kg/ha of N; P, K, respectively). Surveys carried out in north-west Italy pointed out that soil reaction of paddy soils is poorly related to the agronomic practises. As consequence of the massive use of fertilizers, in several sites the phosphorous content is very high, and could represent an environmental issue for surface water.

About 70% of the European rice area is planted with *japonica* varieties and the remainder with *indica*-type varieties.

Cultivation constraints

Rice productivity in European regions is affected by numerous constraints. Most of them are related to water availability, low temperature conditions and biotic and environmental stresses.

Main water problems are referred to a looming water shortage, uneven distribution, nitrate and pesticide pollution, waterlogging in heavy soils and the increasing costs of irrigation systems. The water problems can be tackled by developing more efficient water management strategies and providing new rice varieties that are more suitable for a reduced use of water (Ferrero, 2002). A consistent reduction of water consumption could be obtained by introducing short-cycle and high-yielding rices or profitable varieties that are suitable for discontinuous irrigation in all rice cultivation areas. These water management conditions could also contribute to the mitigation of methane emission due to rice field submergence. The new varieties should however also show a great capacity to suppress weed growth and tolerate soil salinity, as the cultivation in non-flooded conditions usually results in an increased competition of the weeds and a rise of soil salinity due to upward salt migration.

As rice plants originate from sub-tropical and tropical zones, they are easily damaged by low temperatures at any growth stage from germination to ripening (Kaneda and Beachell, 1974). Low temperatures at planting time, combined with the soil anaerobic conditions frequently result in a slow and poor crop establishment (Barbier, 1996). This in turn can result in a delay of the heading stage with a high risk of devitalization of the pollen cells at the meiosis stage. Furthermore rice will also be subjected to a cool autumn and this will result in poor ripening. Even high temperatures may result in spikelet sterility, which can vary according to the plant growth stage.

The constraints of the poor crop establishment could be overcome by planting rice in dry soil, whenever possible, and developing new varieties with early vigour and good tolerance to low temperatures during germination.

Rice is affected by the attack of weeds, diseases and insects. The failure to control these biotic stresses may potentially result in the complete loss of the yield (Oerke *et al.*, 1994). Noxious organisms are usually controlled with pesticides.

The use of pesticides, mainly herbicides, may result in the appearance of resistant species (Busi *et al.*, 2004), cause environmental pollution (Ferrero *et al.*, 2001) and risk disrupting the precarious balance of the natural enemies to pests. The most successful ways of tackling main issues in rice weed management currently rely on the application of integrated crop management practises based on combination of herbicides with appropriate agronomic practises, such as tillage, soil levelling, water management, fertilization, variety choice. Several research projects are also addressing these issues by developing rice cultivars that are resistant to pests and diseases, highly competitive against weeds, with allelopathic traits and tolerant to safe and wide spectrum herbicides (Ferrero and Tabacchi, 2002). The use of these varieties combined with prophylactic measures will be a sound strategy to prevent damage or their spreading to rice.

Lodging resistance has been a key target trait to rise yield potential and is associated with many component traits such as plant height, stem strength, thickness, etc. Lodging-resistant rice cultivars usually show slow grain filling when nitrogen is applied in large amounts.

Reduced or variable milling yield, grain fissuring, grain shedding and non-contemporaneous maturity are other important issues that can affect rice productivity. Most of these problems are also related to other agronomic constraints, such as cold temperature and lodging, but are sometimes closely linked to the genetic features of the rice varieties.

Rice farm organisation and production cost

The number of rice farms dramatically diminished in the last 25 years in all European countries. In Italy, for instance, the total number of farm decreased to one half in Italy and to one fifth in Valencia, Spain. In the same period the mean surface per farm showed an increase roughly proportional to the reduction of the number of farms (from 20 to 47 ha in Italy and from 1.9 to 4.7 in the Valencia area). The mechanization of roughly all operations of rice cultivation and the spread of monoculture led to the increase of the

Table 2. Producer price evolution of paddy rice from 1995 to 2003 (USD/ton) (Food and Agriculture Organisation, 2007).

Tableau 2. Évolution du prix du riz paddy chez le producteur de 1995 à 2003 (dollars US/tonne), (Food and Agriculture Organisation, 2007).

Country	1995	2000	2003
Italy	477	255	250
Spain	479	252	310
France	564	323	303
Egypt	207	167	169
USA	202	124	160
Brazil	193	124	92
Thailand	165	119	122
India	150	132	121

average farm dimensions. This trend is still continuing, driven by the reduction of the crop profitability, the increase of the working capacity per ha and the cost of the machinery (Finassi and Ferrero, 2004).

Such a result was achieved by adopting a particularly high level of mechanization; in farms with more than 30 ha there is a tractor every 12 ha and a combine harvester every 59.47 ha. Use of large combines, with a great working capacity, allowed to reduce the harvest period, but imposed to adapt the drying capacity in order to manage to carry out drying of the daily harvested rice. The harvesting time was considerably reduced, from 35-40 days in the 1950s to the current 20 days.

The cost of rice production in the European Union is generally much higher than that in most Asian countries. The high production costs are largely due to the high expenses related to water, fertilizers, crop protection products, seed, machinery, custom application, fuel and labour. The cost of production in Europe is about 280-320 euros/ton (AIDAF-VC/BI, 2003). The return from rice production showed a sharp reduction in the last 10 years. Since 1995 international rice prices started a marked declining process, while fertilizers, seed, crop protection products, custom application, fuel and labour started to have a significant increase. Since that time, in fact, the producer price of rice reduced in five years by about 50% or more in most rice producing countries (table 2). Starting from 2003 till 2006 the rice market has shown a trend to a recovery of the prices.

Rice consumption and market

Rice is not the staple food for most of the European population; nevertheless, rice consumption in the continent has increased in the last years due to immigration and diversification of the diet of the Europeans.

In the last two decades rice consumption has significantly increased in all Euro-

pean countries either rice producers (Southern Europe) or non-rice producers (Northern Europe). It is presumable that this trend will continue in the next years particularly in northern European countries (CEC, 2002).

In 2003 milled rice consumption ranged from 5.4 to 8.8 kg/capita/year, except in Portugal where individual consumption was 17.8 kg/capita/year (table 3). Rice consumption showed in the last two decades a remarkable increase in European importing (non-rice producing) countries too, where once rice used to be considered as a curious food or a luxury product. At present there are no significant differences in consumption patterns between rice producing regions and rice importing regions of Europe. In importing countries rice is now of interest for diversifying conventional diets and its consumption corresponds to a lower potato and cooked vegetable consumption.

In Southern European countries about 80% of the consumed rice belongs to *japonica* varieties (mainly medium and long A type) and 20% to *indica* varieties. Very often local and "specialty" varieties are gaining a significant importance for small and medium farms in local markets. For example, in Italy varieties like "Carnaroli" and "Vialone nano" have a

Table 3. Consumption of milled rice in European countries (kg/capita/year) (Food and Agriculture Organisation, 2006).

Tableau 3. Consommation de riz usiné dans les pays européens (kg/personne/an), (Food and Agriculture Organisation, 2006).

Country	1990 (kg/capita/year)	2004 (kg/capita/year)
EU rice producing countries		
France	4.1	5.4
Italy	5.7	6.0
Greece	6.1	8.8
Portugal	15.7	17.8
Spain	6.2	7.1
Romania	4.0	6.5
Hungary	7.3	7.2
Weighted mean^a	6.0	6.4
EU non-rice producing countries		
Germany	3.4	5.9
UK	3.7	4.3
Denmark	1.8	5.1
Poland	2.5	2.9
Weighted mean^a	3.3	4.1

^a Consumption values weighted on the population of each country.

good appreciation on local markets, also thanks to the promotion of their quality, through the attribution of APO (Appellation of Protected Origin) and the direct selling of rice by rice growers, who directly process their own rice production in the farm with small rice milling plants.

In Northern Europe long-grain varieties (long B type) are commonly preferred. In the United Kingdom and Scandinavian countries, for example, rice consumption include 85% of *indica* types which are mainly imported from the USA, Thailand, India, and Pakistan. To meet this demand a subsidy was granted the European Community in the late 1980s to encourage a larger production of long grain varieties in the European countries (Yap, 1997). All the varieties which were introduced are suited to temperate climatic conditions even if they are sometimes damaged by the low night temperatures, which occur particularly during the flowering period (Ferrero and Tabacchi, 2002).

Demand for scented rice varieties (Basmati-type). has shown a significant increase since the early 1990s, primarily in the UK and other European countries, because of a growing presence of Asiatic communities (Faure and Mazaud, 1996). It seems reasonable to expect a further increase in aromatic rice consumption in the years to come, throughout Europe, because of the increase in people migrating from far-east countries and the growing interest in ethnic cuisine. European consumption of Basmati rice is met entirely by imports from India and Pakistan. The increase of consumption Basmati-type varieties has also been favoured by a significant reduction of the import duties.

The enlargement of the EU resulted in a remarkable market increase of the rice grown in the area (Chataigner and Salmon, 1996). In 2006, the additional consumption due to the 10 new countries which entered the EU was about 250,000 tons, mostly from *indica*-type varieties, equivalent to about 10% of the total European production.

Since 1995, imports from third countries increased by about 30%, as a consequence of the Uruguay Round agreements.

Market liberalization for rice will be applied starting from 2009. Tariff reductions will be phased in with a 20% cut in 2006, 50% in 2007 and 80% in 2008. In the meantime a duty-free quota, based on

previous exports to the EU, has been established, with an increase by 15% each year until 2009, when all tariffs and quotas will be removed.

On 2003, EU Agriculture Ministers agreed on fundamental reforms to Common Agricultural Policy (CAP). Most relevant reform is the break in the link between subsidies and production. The primary aspects of CAP reform concerning rice are aimed at reducing the intervention price by 50%, and limiting the amount to 75,000 tons per year. These reductions are compensated by a subsidy devoted in part to environmental protection.

Rice quality

According to the "Regulation on the common organisation of the market in rice" (Council regulation No 1785/2003) main components of rice quality are grain shape, colour and integrity of the grain. Other important components are milling quality, cooking and processing behaviour, grain fissuring.

Rice varieties are grouped into different grain type categories upon three physical parameters: length, width and length and width ratio (*table 4*). The physical dimensions and weight are considered among the first criteria of rice quality that breeders consider when developing new varieties. Grain shape is one of the major aspects of rice quality as it is usually associated with specific cooking characteristics. In most varieties, cooked long grain rice is usually fluffy and firm, while

medium and short grain rice is soft, moist and sticky in texture. The demand among consumers in Northern Europe is higher for long grain rice.

According to the European regulation paddy rice of standard quality shall be sound and fair marketable, free of odour, with a wholly milled rice of 63% in whole grains (with a tolerance of 3% of clipped grains) and a maximum moisture content of 13%. Paddy should not show abnormal colour (green, chalky, striated, spotted, stained, yellow, amber).

Grain fissuring may result in important negative effects during technological processes. Grain fissuring is often due to overexposure of mature paddy to fluctuating temperature and moisture conditions. Cracks in the kernel are the most common cause of rice breakage during milling.

Milling degree is influenced by grain hardness, size and shape, depth of surface ridges, bran thickness and mill efficiency. Whole grain milling yield is the percentage of intact kernels to broken kernels after milling and separation. Producers are paid less for broken kernels than for whole.

Other specific quality traits are usually required for the production of processed rice such as parboiled, quick cooking or pre-cooked rice and rice flour. Rice parboiled for consumption as table rice, is generally a long grain variety. Medium grain rice is also parboiled, but it is more commonly ground into flour for use as an ingredient in food products (baked crackers, fried snacks).

Table 4. Grain type categories and other quality components of paddy rice.

Tableau 4. Catégories de grains et autres qualités des composants du riz paddy.

Grain shape				Other quality components of paddy rice (%)	
Type		Length (mm)	Length/Width ratio	Chalky grains ^a	1.5
Long	Long A	> 6.0	> 2.0 < 3.0	Grains striated with red ^a	1.0
	Long B	> 6.0	≥ 3.0	Spotted grains ^a	0.5
Medium		> 5.2	< 3.0	Stained grains ^a	0.25
Short		< 5.2	< 2.0	Amber grains ^a	0.05
				Yellow grains ^a	0.0

^a Percentage on wholly milled rice.

Options for sustainable rice productions

Rice is a good example of the multifunctionality of European agriculture in which production of quality food goes together with rural development and conservation of the environment. Submerged rice cultivation is fundamental for a sustainable management of the wet ecosystems (estuaries, river basins, albuferas, etc.) where the crop is grown. Many European rice fields are located in natural parks or environmentally protected areas. The future of rice in the European countries will most likely be related to the development of new varieties and environmentally and economically sustainable methods of production which allow to increase rice yield and quality by improving water and fertilizer efficiency and minimizing the use of crop protection products. One of the most effective means of meeting these goals is research. In the last four decades rice science has made considerable progress. Important advances have been made for instance by replacing traditional varieties with new varieties with better traits such as, for instance, dwarf size, improved nutrients response, shorter growing cycle, tolerance to pests and diseases.

Further achievements are expected in development of varieties tolerant to drought and salinity thanks to the recent success in rice genome mapping. Most existing high-yielding varieties have a potential yield that usually exceeds actual yield which is obtained by farmers. The gap reflects numerous deficiencies in crop management (Van Tran, 2001). In other areas of rice cultivation (e.g. Australia and Egypt) it has been demonstrated that much of this gap could be reduced by applying Rice Integrated Crop Management (RICM) systems (Clampett *et al.*, 2001). The development and dissemination of RICM systems in Europe could help lower production costs and minimize environmental impact of agricultural practices (Nguyen, 2002).

The adoption of hybrid rice technology would be another major step in raising the yield potential (Christou, 1994). Hybrid rice varieties, which are cultivated on a large scale since many years in China and are being developed in Egypt, have demonstrated to provide a yielding advantage of 15-20% over the existing high-yielding varieties. The adoption of these varieties

in the European countries, however, still need technologies to increase the F1 yield and lower, consequently, the cost of the hybrid seed. Promising results with these varieties have already been obtained in Spain and Italy.

A crucial aspect of the success in rice research is collaboration among the few scientist working in the European rice Centres. Sharing the research programmes is a valuable way to address the issue of the scarce financial resources and take advantage from the transfer of information and advanced research methodologies which result in a shortening the time needed to solve problems.

Numerous research programmes at a national or international level have been set up throughout Europe. They include main aspect of rice science from agronomic management to breeding, quality, environment and market aspects. Several research projects carried out in Europe and the Mediterranean regions have been fostered by Medrice, the FAO inter-Regional Cooperative Research Network on rice in the Mediterranean Climate areas. This organization was created in 1990, first under the name MedNetRice, to promote scientific exchanges among rice scientists working in the Mediterranean areas and in other regions with a Mediterranean climate. Thanks to the association to the "Centre international des hautes études agronomiques méditerranéennes" (Ciheam), the network has published a large number of technical documents, bulletins (*Medoryaze*) and proceedings of several seminars and conferences.

Research institutions from sixteen countries participate at present in Medrice: Bulgaria, Egypt, France, Greece, Hungary, Iran, Italy, Morocco, Portugal, Romania, Russian Federation, Spain, Turkey, the UK, the Ukraine, and Uzbekistan. Some of the important subjects considered in the collaborative research include resistance to blast, stem borers and diseases, quality and competitiveness of European rice, control of red rice, cataloguing of rice genetic resources in the region. ■

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