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in

Chataigner J. (ed.).
The new development in rice agronomy and its effects on yield and quality in Mediterranean areas

Montpellier : CIHEAM
Cahiers Options Méditerranéennes; n. 58

2001
pages Available

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=3400073>

To cite this article / Pour citer cet article

Silva L.M.M., Fatima Rodrigues C. de **New development in rice cropping systems and its effects on yield: A short appointment of the Portuguese situation [On-line]**. In : Chataigner J. (ed.). *The new development in rice agronomy and its effects on yield and quality in Mediterranean areas*. Montpellier : CIHEAM, 2001. p. Available (Cahiers Options Méditerranéennes; n. 58)



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New development in rice cropping systems and its effects on yield: a short appointment of the Portuguese situation

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Introduction

Rice (*Oryza sativa* L.) is one of the most important crops in Portugal, representing a staple food in the Portuguese diet. The average annual consumption *per capita* is 16 kg of white rice, the most high consumption in the European Union (EU). Production only covers one part of our needs and for that reason Portugal import about 150.000 ton per year of rice (mainly paddy and brown rice) from others origins, such as: Italy, Spain, France, Uruguay, Suriname, Argentina, Vietnam, India, among others. There are four potential rice production regions in Portugal: 1-Beira Litoral (Vouga, Mondego and Lis rivers); 2-Ribatejo e Oeste (Tejo and Sorraia rivers); 3-Alentejo (Sado, Mira and Guadiana rivers) and the last one 4-Algarve (Silves and Lagoa dams). The total rice surface depends on the quantity and quality of irrigation water available. The maximum area for rice production in Portugal permitted by EU is 34 thousand hectares (European Commission Official Journal, 30-12-1995), whoever during the last 4 years due to several reasons, mainly climatic factors, this value was not reached. Concerning to the total rice production area, the distribution is the following: 23% (region 1 - Beira Litoral), 32% (region 2 - Ribatejo e Oeste), 43% (region 3 - Alentejo) and 2% (region 4 - Algarve), respectively. Continuous rice cropping is practised, in this regions, with one crop per year (monoculture).

I – Region Description and Cultural Systems

At the farmer level the useful surface of rice terraces varies between 0,5 and 8 ha, concerning region 1 (Beira Litoral) and 4 (Algarve), and between 0,5 and 10 ha for the region 2 (Ribatejo e Oeste) and 3 (Alentejo).

The climatic conditions differ from region to region, for instance in the region 1 (Beira Litoral) and during rice cycle happens frequently early morning fog. The temperatures are more low in this region than in the others 2 (Ribatejo e Oeste); 3 (Alentejo); and 4 (Algarve). In October the rainfall starts normally in the middle of the month and in the others regions at the end of the month. Therefore seeding and harvest time change from region to region:

Region	Sowing date	Harvest date	Density of sowing (kg ha ⁻¹)
1	April	middle of September	170-180
2	May	first week of October	170-180
3	May	last week of October	180-190
4	May	last week of October	180-190

The methodology of sowing with pre-germinate seeds, directly on flooded terraces by farm tractor, airplane or by hand is used in approximately 95% of the total rice production area and only in 5% of the remaining area seeds are drilled on dry soil with sower.

Figure 1 – Distribution of rice production areas.



Relating to water management the methodology used is similar for all regions, so: two/three weeks after sowing water is removed in order to rice plants take root and simultaneously the herbicides are applied. One or two weeks before harvest, normally the farmers removed completely the water from fields.

Type, quantity and period of application of fertilizers are the same in the 4 regions. For pre-seeding 70-80 units of nitrogen are incorporated in soil (type 20-20-0 or 20-10-0). When beginning tillering 45-50 units of nitrogen and stem elongation 20-30 units of nitrogen are added by covering with ammonium nitrogen 20%.

Presently the varieties used in Portugal normally are originated from Italy and France. In region 1 (Beira Litoral) the varieties used should have a premature or semi-premature cycle, while in the regions 2 (Ribatejo e Oeste), 3 (Alentejo) and 4 (Algarve) also can be used varieties with semi-slow and slow cycles, for example Thaibonnet.

II – Evolution of rice production

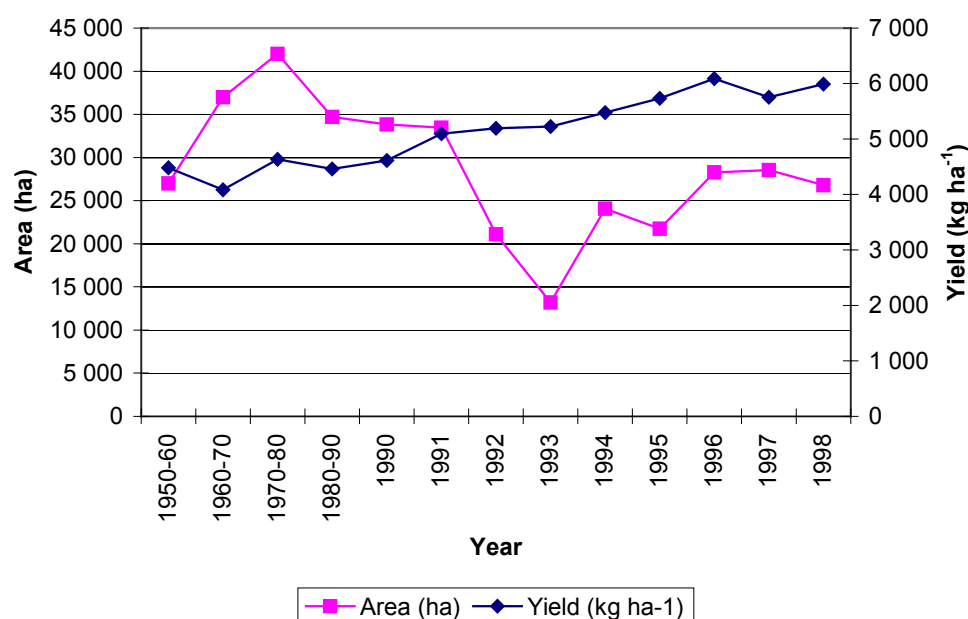
Before 1990 comparing the cultivated area (ha) and average crop yields (kg/ha) we can observe that almost often were above 4.636 kg/ha of paddy rice and after 1990 they increased due different factors, namely: a better choice of growing areas; a better water management and the availability of water in terms of quantity and quality, new cultivation techniques, crop nutrition, choice of varieties, weeds management and pests control.

Table 1. Area and yield of rice in Portugal, in the period from 1950 to 1998

Year	1950-60	1960-70	1970-80	1980-90	1990	1991	1992	1993	1994	1995	1996	1997	1998
Area (ha)	27000	37000	42000	34690	33824	33466	21118	13200	24051	21726	28278	28540	26781
Yield (kg/ha)	4481	4086	4636	4461	4614	5094	5195	5227	5478	5733	6091	5753	5987

Source: INE (Instituto Nacional de Estatística)

Figure 2.- Area and yield of rice in Portugal, in the period from 1950 to 1998



1. Rice cropping systems evolution

In the 50_s and 60_s the most common rice cultural practices used by farmers were characterized by a great dependence on manual labour because it was cheaper. Sowing was done directly on flooded terraces by hand, or by transplant. Fertilizer and chemical application, and harvest, among others, were performed manually. The traditional puddling method used was the cage wheel.

After 1970 until our days manual labour was gradually substitute by machinery.

Great developments in machinery technology in the last decade lead to the introduction of new rice cultural practices, such as: puddling with a kind of roller, minimum tillage, laser technology for leveling soil, airplane service for seeding and pest control.

2. Varieties

From 50_s to 70_s the most widely cultivated variety was “Chinês”. In the 80_s and 90_s other varieties became widespread and some of them are still cultivated nowadays: “Koral”, “Ribe”, “Ringo”, “Strella”, “Thaibonnet L/202”, “Onda”, and “Balila”. Presently the most important ones are: “Ariete”, “Koral” and “Thaibonnet”.

The criteria used by producers for choosing the rice varieties in Portugal are: adaptability, productivity, resistance to diseases and acceptability by industry.

One of the constraints in the development of rice production in Portugal is the fact that there is not any variety with commercial interest in Portugal. For this reason presently experiments are being carried out in fields with promissory lines of varieties in order to solve this problem.

3. Land preparation

Traditionally: puddling with cage wheel.

Presently: There are several tillage methodologies:

1. Riper-drainage + laser + moldboard plough + roller;
2. Ploughing + roller;
3. Laser + ploughing + roller;
4. Minimum tillage (Chisel plough + roller).

4. Weed management

Rice productivity can be seriously affected by three important weeds, namely: red rice, *Heteranthera* spp. and *Leersia oryzoides*.

Integrated management is required for effective control of this weeds. Measures to be used are the following:

1. use of certificated seeds;
2. cleaning machinery;
3. use of short-cycle rice varieties;
4. planting crop rice at high seed density;
5. crop rotation;
6. use of selective herbicides (glyphosate, cycloxydim, oxidiazon, etc.).

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