Saving water in rice cultivation through the introduction of innovative agronomic techniques

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The traditional low efficiency in the use of irrigation water for rice cultivation is an important handicap for the water management of the communities of irrigators in our country (which have an important diversity of crops to manage). Often, rice cultivation is associated with very traditional and peculiar practices that produce high water consumption. Although anoxic rice cultivation may be associated to the need to wash soil salts, some times it only responds to traditional management that has been cultivated in our home. This study seeks to develop an agronomic strategy for saving water in rice cultivation, allowing to increase the efficiency of water use by installing dripping irrigationd and determining agronomic changes necessary to optimize the production and management of the crop. These agronomic changes may vary from the selection of varieties better adapted to aerobic farming, to technological changes due to dry farming, to new strategies or products for weed, pests and diseases control, changes in the fertilization strategy, and even in the harvest of the crop.

Objectives

The main objective of the project is the introduction of agronomic techniques and innovative processes that allow the saving of water in the cultivation of rice. To achieve this general purpose, the following specific objectives have been developed:
-Determine the advantages and disadvantages of planting buried in the cultivation of rice. Introduce this system among the rice fields. Quantify the reduction of water consumption during the implementation of the crop. Incidence of this agronomic practice on seed dosing, weed control, fertilization and the impact on certain pests (quironomids, apple spit, American crab).
-Determine the advantages and disadvantages of irrigation by dripping in rice cultivation. Quantification of water consumption and system costs. Agronomic changes involved, especially seed dose, weed control in the cultivation and fertilization of the crop. Incidence on certain pests.
-Introduction of intermittent irrigation in the cultivation of rice. Complementarity with planting buried. Advantages and disadvantages of the irrigation system compared to that of flooding with free run-off. Quantification of water savings.
The proposals must allow the Catalan rice producer sector to be more efficient in the use of water. Saving water in Mediterranean Europe is increasingly necessary because it is becoming a scarce resource, both in quantity and quality.

Description of project activities

The project aims to introduce various agronomic practices in the cultivation of rice that entail water savings to a greater or lesser extent. The agronomic practices that have been evaluated are:
-Introduction of buried planting, which avoids flooding of fields before planting when there are enough salts;
-Introduction of localised irrigation in rice, which allows the cultivation of rice in soils and places other than the traditional ones linked to ancient coastal marshes and,
-Introduction of irrigation by intermittent flooding.
ACTIVITIES DEVELOPED IN THE DELTA DE L'EBRE
Determine the advantages and disadvantages of buried planting in rice cultivation. Introduce the

technique. Quantify the reduction of water consumption during crop implantation. Incidence on seeding dose, weed control, fertilization and the impact on certain pests (quironomids, apple spit, American crab).
ACTIVITIES DEVELOPED IN THE REGIONS OF GIRONA
The actions are structured in three broad areas that coincide in the three agronomic practices that are to be introduced:
The introduction of buried planting in rice. The planting will be carried out in a field to experiment and check the advantages of rice cultivation during the two years of the project. A comparison will be made with a field of traditional practice consisting of evaluating: real plantin dose, monitoring by comparison of germination, emergency and evolution of the first phenological stages.
The introduction of localised irrigation in rice. During the two years of the project, a dripping irrigation system will be implemented to specify the real possibilities of implanting this aerobic rice cultivation technique in the area.
The introduction of irrigation by intermittent flooding. The advantages of water savings and the other agronomic aspects of rice cultivation will be studied. In each of the three water-saving strategies, together with the testimonial plots listed in the traditional practices, the volume of irrigation water applied will be measured and the water content of the soil will be monitored continuously.

Final results and practical recommendations

The main results that have been reached within the framework of the project are:
BURIED OR DRY SEEDING
Dry or buried seeding allows a saving of water quantified by 8-10% compared to traditional irrigation system. The flood of the field occurs after the appearance of the root and emergency of the epicotile and the first leaf. Regarding traditional irrigation, it takes between 3 and 6 weeks less flood.
This system, apart from water saving, can imply a 30% seed savings. Dry seeding can avoid problems caused by chironomids while increasing the percentage of germinated seeds.
Dry seeding can slow the proliferation of apple snail in the affected areas of the Ebro Delta, and reduce the damage by ducks at the time of sowing.
Salinity is the most limiting factor when it comes to spreading dry seeding in rice fields. Occasionally, the flooding of neighboring fields increases the salt concentration in the soil by raising the level of the water table, so that this type of planting in these areas may not be possible.
Also, it should be noted that at the time of plantin, the soil can not have a degree of excessive moisture (which forms mud), since this does not allow the seed to be properly buried. On the other hand, in low-humid campaigns, the lack of moisture in the soil can cause poor germination / emergence of the crop. In these cases it may be interesting to make a watering before planting, or after planting, depending on the availability of water in the area, in order to facilitate the seed imbibition phase and a gemination of the homogeneous crop.
LOCALISED IRRIGATION
It is not necessary to flood the soil to cultivate rice. Rice grown in our conditions is a very sensitive species to water deficit and at the same time it maintains a very shallow root system (70-80% of the root system is less than 30 cm from the surface of the soil).
A depletion of 30% of the water reserve in the soil can already lead to reductions in the parameters that affect the productivity of the crop. In many places of the world, the scarce availability of water causes the change to localised irrigation systems as a response to this shortage. The implantation of dripping irrigation in the cultivation of rice is one of our goals in this project.
Dripping irrigation systems must be sized so that it can cover and wet the entire surface of the soil at a depth of 10-15 cm. This involves separations of the secondary pipes of 80-90 cm in our case. The most delicate moments are the initial stages, given that the crop has little root development and at this time a significant part of the irrigation can be to dampen the surface area correctly and not to fill the water requirements of the crop. Obviously, with these limitations, other irrigation systems (pivots, etc.) may be more appropriate at this initial stage, but the high rainfall probability in this month of May and June makes it easier to overcome these handicaps successfully.

The automation of the irrigation system is commercially possible with the use of humidity sensors in FDR type soils, allowing to start and stop the irrigation depending on the soil water content in the root zone. This automation is very efficient in fields where farmers have energy cost to irrigate.
Dripping irrigation reduces water consumption by 40-60% compared to the traditional flood system in our environmental conditions.
Despite this high water saving, it is necessary to take into account that some agronomic aspects need to be adapted to this irrigation strategy. Dry seeding adapts perfectly to the localized irrigation strategy, but once the secondary irrigation tubes are installed in the field, the passage of heavy machinery becomes impossible. In this sense it is not possible to perform herbicide applications for the control of weeds with the usual machinery and active substances.
INTERMITTENT IRRIGATION
The intermittent or "regons" irrigation is the most common irrigation system for rice in Southeast Asia where water does not reach the fields by gravity and it is necessary to pump the water. This energy cost is minimized with intermittent irrigation. Historically, in the Delta del Ebro this technique has been used in areas with difficulty in reaching the water channel.
These waterings are made when 30% of the water reserve is exhausted on the ground at 30 cm where most of the root density of the rice is concentrated. The determination of this moment can be decided with the installation of piezometers in the soil.
The irrigation criterion consists in flooding the field to reach a height of water in the 5-8 cm field, and stop watering until when water is about a cm below the surface of the soil. The most sensitive stages are the development of spike and flowering, and the most tolerant stages, apart from the maturation of the grain, is the establishment of the crop.
Rice fields, often found in muddy areas and with high organic matter content, have soils with a very low hydraulic permeability so each irrigation may last between 6-10 days depending on the phenological stage and the environmental conditions. With this criterion and depending on the pluviometric conditions, between 8 and 12 irrigations may be necessary in the Empordà fields. The rest of the agronomic management of the crop is not affected compared to traditionally flooded fields.

Conclusions

The implantation of the buried or dry seeding in traditionally rice cultivation areas, will depend the regime of rains during the planting weeks. Rain can difficult the planting with line seeders. When it is not possible, there is the alternative to plant it with flooded soil.
It was confirmed that water consumption of localised irrigation is at least half of the water consumption of traditional flood irrigation.
Rice cultivation with localised irrigation causes agronomic management problems. There are no authorised rice herbicides effective in non-flooded soils. There are no experiences of the effectiveness of its application through the irrigation system, since the irrigation tubes prevent the passage of the traditional machinery. Another problem is the difficulty of treating against Pyricularia when rice varieties sensitive to this fungus are grown. The ease of fertigation of the system is one of the clearest advantages of this irrigation system.
Intermittent irrigation requires intensive monitoring to determine the moments of irrigation, as well as well-leveled fields so that water can quickly flow.
The knowledge acquired during the project and the proposals that are derived from it must enable the Catalan rice sector to improve and be more efficient in the management of water use. Water saving in Mediterranean Europe is becoming increasingly fundamental because it is becoming a scarce resource, both in quantity and quality, and this will probably be a determining factor in the coming years in the agricultural sector.

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Farming practice
Water management

Territorial scope

Province	***County***
Tarragona	Montsià
Girona	Baix Empordà
	Baix Ebre
	Alt Empordà

Project dissemination *(publications, seminars, multimedia...)*

Jornada tècnica: Innovacions tècniques i gestió en el cultiu de l'arròs. Febrer 2017.
Jornada tècnica: Sembra en sec en arròs al Delta de l'Ebre. Maig 2017.

Notícia TV3: Proven tècniques alternatives del cultiu d'arròs. 27 Octubre 2016.

Pàgina web del projecte

Other project information

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