Première conférence internationale sur les systèmes de production rizicole biologique

Florine F. Mailly, . Umr Innovation Innovation Et Développement Dans L'Agriculture Et L'Agro-Alimentaire

Conference Folder

First international conference on organic rice production

Montpellier, France, 27-30 August 2012

French National Institute for Agricultural Research –Montpellier
Joint Research Unit Innovation and Development in agriculture and the agrifood sector

Scientific Committee

Manuel AGUILAR : Agronomist
INIA – Séville / Spain

Jean-Marc BARBIER : Agronomist
Inra – Montpellier / France

Stéphane BELLON : Agronomist
Inra – Avignon / France

Stefano BOCCHI : Agronomist
Université de Milan / Italy

Luiza CHOMENKO : Ecologist
Porto Alegre / Brazil

Sylvestre DELMOTTE : Agronomist
Inra- Montpellier / France

Marc DUFUMIER : Agro-economist
AgroParistech – Paris / France

Denis LAIRON : Human nutrition
Inserm- Marseille / France

Roy HAMMOND
Inra – Montpellier / France

Thomas Le BOURGEOIS : Weed scientist
Cirad – Montpellier / France

Robert LIFRAN : Economist
Inra- Montpellier / France

Santiago LOPEZ RIDAURA : Agronomist
Inra-Montpellier / France

Florine MAILLY : Agronomist
Inra - Montpellier / France

Patricio MENDEZ del VILLAR : Economist
Cirad- Montpellier / France

François MESLEARD : Ecologist
Université- Avignon / France

Jean-Marc MEYNARD : Agronomist
Inra - Directeur Département SAD – Paris / France

Jean-Claude MOURET : Agronomist
Inra – Montpellier / France

Christophe SOULARD : Geographer
Inra - Directeur UMR Innovation – Montpellier / France

Pablo TITTONELL: Agronomist
Cirad – Montpellier / France

Jacques WERY : Agronomist
MontpellierSupAgro – Montpellier / France

Organising committee

Sophie BURGEL
Inra - Montpellier / France

Brigitte CABANTOUS
Agropolis - Montpellier / France

Marie France CHAZALETTE
Cirad - Montpellier / France

Sylvestre DELMOTTE
Inra - Montpellier / France

Roy HAMMOND
Inra – Montpellier / France

Pascale LAJOUX CAUSSE
Cirad - Montpellier / France

Florine MAILLY
Inra - Montpellier / France

Eric MIGNARD
Inra - Montpellier / France

Christelle MONIER
Cirad - Montpellier / France

Jean-Claude MOURET
Inra - Montpellier / France

Annie ROSSARD
Inra - Montpellier / France

Christophe SOULARD
Inra - Montpellier / France

Nathalie VILLEMEJEANNE
Agropolis - Montpellier / France

Translated by: Mireille RENAUD-MALLET

This project is supported by Agropolis Fondation, Agropolis International, Cirad, Inra, Montpellier SupAgro, FranceAgriMer, Languedoc-Roussillon and Provence-Alpes-Côte d'Azur Regional councils, Agence Bio, Agence de l'eau Rhône-Méditerranée-Corse, parc naturel régional de Camargue, Centre Français du riz, Bio Camargue SA, Bio Sud (Sud Céréales) and Syndicat des riziculteurs de France et filière.

PREFACE

Organic agriculture has witnessed a considerable development worldwide during the last decade. In 2010, 37 million hectares on 1,578,000 farms were cultivated as organic agriculture. Rice growing is part of this process. It is in this context that the Joint Research Unit (Inra, Cirad, SupAgro) which works in the field of conventional and organic rice growing systems decided to organise in Montpellier the first international conference on organic rice production systems. This conference is aimed at scientists and all stakeholders in the production, processing and commercialisation chain : rice growers, professional organisations and their partners, collection, transformation and commercialisation companies, territorial managers, teachers, students and everyone interested at national and at international level by the themes of the conference. Six sessions have been organised aimed at achieving the following objectives that are to:

- assess actual knowledge of the functioning of organic rice production systems on different time and space scales
- identify innovations being undertaken and obstacles that block the development of these systems
- analyse the impact of different types of organic rice production on food quality and health and their contribution to the construction of the pillars of sustainable development
- analyse the impact of public policy and to propose guidelines

One hundred and twenty people from seventeen nations participate at the conference. Six main presentations and 46 other communications have been chosen to be presented in the different thematic sessions. Discussions evoked during these sessions can be prolonged during the field visit day organised on the 28th of August when rice growers and commercialisation chain and territory stakeholders will be encountered.

On behalf of the scientific committee and of the organisation committee of the conference, I hope that this conference will be a moment of rich exchanges of knowledge, know-how and professional experiences. This knowledge will be mobilised to implement rice production systems that are enriching for rice growers and stakeholders, equitable, autonomous, satisfying in quantity and quality consumer demands and preserving biodiversity.

Thanks to everyone!

Jean-Claude Mouret
Umr Innovation
Head organiser of the first international conference
on organic rice production

TABLE OF CONTENTS

PROGRAMME

COMMUNICATIONS

N.B. Communications are given by session according to the scheduled order.

INDEX

INDEX

INTRODUCTORY SESSION

Bases and Realities of Organic Farming

Mercier, Elisabeth[1]

[1] Agence Bio, France

Emerging in the 1920-1930s, organic farming is the result of **several schools of thought** concerned with respect for natural cycles and environments, as well as for living beings, and with the development of harmonious relationships between them. From the very outset, this kind of farming steered away from a move toward the specialization of farms and the quest for physical yields, to the detriment of environment quality and very often, with a transfer of added value downstream of the sector and growing dependency on purchases outside the farm. Over the years, techniques have been developed and more and more people were interested or got involved, producers, consumers, agronomists, physicians, nutritionists, etc, often engaged in NGOs.

Then, came the time for **public** acknowledgement. **In France**, this happened in **1980**, with the recognition "of farming without synthetic chemical products", then of "organic farming" over the following years, based on the approval of existing private technical specifications and their harmonization. In 1985, the "AB" logo was created (Agriculture Biologique=*Organic Farming*), a property of the French Ministry of Agriculture, the logo gave more visibility to the approach and fostered transparency for the benefit of the consumer. In **1991**, another step was taken at the **European level**, with the **implementation of a regulatory framework**, with regulation 2029/91 of June 24th, 1991 on plant productions and transformed products obtained from them; it was extended to livestock farming in 1999 with regulation 1804/99 of July 19th, 1999. The whole was codified and further spelled out in the regulation enforced on January 1st, 2009. **At the international level,** in June 1999, the commission working on the **Codex Alimentarius** within the FAO agreed to the main orientations on the production, transformation, labeling and commercialization of food products from organic farming. These orientations enable member countries to draft their own regulations based on the general principles, in consideration of their national specificities. The Codex considers organic farming as an **integrated system of agricultural production** (plants and animals) which favors management techniques rather than the use of production factors of external origin. In this regard, organic and mechanical cultivation methods are used rather than synthetic chemical products.

As per the guidelines given by the Codex, organic farming must contribute to the following **objectives**:

- Increase biological diversity throughout the system,
- Increase the biological activity of soils,
- Maintain long-term soil fertility
- Recycle vegetable and animal wastes in order to restore nutrients to the earth, thus reducing the use of non-renewable resources as much as possible.
- Rely on renewable resources in locally organized farming systems,
- Promote the proper use of soils, water and air, and reduce as much as possible all forms of pollution that cultivation and breeding practices could potentially cause,
- Handle farming products so as to maintain their biological integrity and preserve the essential qualities of the product at all stages, namely by paying close attention to the transformation methods,

- Be implemented in existing farms, after a period of transition whose duration is determined by factors specific to the site, such as for instance, the history of the soil, the type of crop and livestock that should be farmed.

Breeding in organic farming is based on the principle of a tight relationship between the animals and the farmland. This requirement of a relationship to the soil thus demands that animals should have wide access to free roaming in outdoor areas and that their fodder should consist of organic food, preferably grown on the farm itself. Regulations aim at ensuring high standards of animal well-being and refer to strictly defined veterinary care giving priority to natural alternative medicine. Whatever the products, be they plant or animal products, the aims of organic farming remain the same: implementation of environment-friendly practices, for a more harmonious occupation of rural areas, respect for the animals' well-being as well as achievement of high quality agricultural products.

All these principles are found in the European regulation with specific terms of implementation.

At the global level, organic farming is developing

The global surface of areas farmed according to organic principles and certified as such was estimated at **more than 37.3 million hectares at the end of 2010** (estimate based on data provided by the IFOAM and other organizations)**.** They represented 0.9% of farmlands in the 160 countries covered by the investigation. Moreover, areas of wild gleaning and apiculture have been assessed at 34 million hectares. **Close to 1.6 million farms certified as organic** were recorded in 2010. In some countries, no statistics are available, for example in China. Therefore, this figure is underestimated. Within 10 years, farmlands under organic cultivation and the number of organic farms have grown at more or less fast paces depending on the geographical area. The strongest growth paces were observed in Africa, in Asia and in Latin America, a zone where OF development really got started in the years 2000.

After an increase of 2 million hectares over 2009/2008, the global surface certified as organic (including conversion**) dropped by 168000 ha over 2010/2009 with evolutions** i.e.**:**

- An **increase** of 740 000 ha **in Europe** (+8% over 2010/2009) and 51600 ha in Africa (5%),
- A **drop** of 793 400 ha in Asia (-22), that is, 463 000 ha in China and -400 000 ha in India, and increases in several countries, including the Philippines and Sri Lanka, as well as a reduction of 160 000 ha in **Latin America** (-2%), i.e. -220 200 in Argentina and -50600 ha in Chile, but with increases in other countries.
- Near stability in **Oceania.**

France is the country where surfaces of organically-grown areas have increased the most in 2010 (+168 00 ha). It was followed by Poland (+154900 ha).

More than one-fourth of organic farms in the world are in India. Most of the time, these are small farms. The main organic crops are cotton, rice, soybean, tea and plants for perfume, aromatic and medicinal plants. In 2010, Indian surfaces dropped by 34%, mainly due to the reduction of surfaces devoted to cotton resulting from GMO contamination, from the obligation to apply a costly traceability system, keeping in mind that government subsidies to certification have been cancelled out. In some cases, producers continued to cultivate their farms with organic methods, but they are no longer recorded as organic because they do not have the means to invest in "TraceNet", the traceability system.

In some cases, the farmers continued to farm their lands organically, but are no longer registered because they did not have the means to invest in the "TraceNet" traceability system. According to international experts, the surface of organically grown areas should again increase in upcoming years.

The global organic food market was estimated at $60.9 billions in 2010, i.e. €45.4 billions. North-American markets represented 48% of the global organic market. Europe comes second with 43.9% in 2010 (40.6% for the European Union). **Organic farming** will continue to develop in many countries because it responds to a social demand, helps preserve natural resources (an essential heritage for the future), develops diversified agricultural productions and contributes to territorial planning.

This approach is at the heart of sustainable development.

All available studies highlight an **employment content** that is generally **higher** by 20 to 30% than in conventional farming. In France, recent analyses carried out along with the 2010 agricultural census showed an average discrepancy of 37%. The organic sector thus helped keep and create jobs throughout the territories, with enterprizes at a human scale, therefore more easily passed on. Moreover, to ensure organic production, farmers and transformers also need to implement strategies offering an alternative to synthetic chemical products. Therefore, they need to **innovate**. The will and desire to enhance the autonomy of farms and to foster direct contact with consumers is also a source of innovation in their commercial dealings.

This approach is building the future.

Organic Agriculture's place in INRA's research programmes

Bellon, Stephane1

[1] Inra, France

Alternative rice cultivation systems around the world

Dufumier, Marc[1]

[1] Emeritus Professor at AgroParisTech, France

Rice is the second crop in the world in terms of production (672 million tons of paddy harvested in 2010[1]), slightly below corn, but it ranks first in terms of human food consumption. It is a major element of the food ration for a good half of humanity. It therefore seems legitimate to look into the question of whether organic rice production would be able to respond to the calorie requirements of an ever increasing part of the world population. An essentially self-pollinating plant, rice has been the object of a massal selection for several millennia, in very different regions and today, it is the crop with the largest variety of cultivars in the world[2]. Rice is thus cultivated on more than 154 millions of hectares upon the surface of the globe[1], in extremely varied agro-ecological and socio-economic conditions.
Today it is possible to distinguish four main types of rice cultivation systems[3], depending on the places where it is practiced and the means of production available to the farmers:

1) Rain-fed slash-and-burn rice fields in forest environments in wet inter-tropical areas:

Rice is sown at the beginning of the rainy season on plots whose forest cover has been pre-slashed with axes and machetes, then burnt during the previous dry season. Because of that previously shaded situation, the growth and development of rice plants can take place without too much competition from adventitious grass. Besides, the varieties selected by farmers are generally high and with a high tillering capacity, which enables them to easily cover any possible “weeds”. A short growing cycle and a capacity to develop dense and deep roots enables them to complete their development with limited risk of hydric stress on exposed fields. Mineralization of the humus accumulated in the soils and the cinders available on the surface supply the mineral elements required by the crop.
But the cleared plot can only be cultivated for a limited number of years, rarely more than two, because the occurrence of weeds and the time required for hoeing become too important on lands long exposed to light. The rate of humus on the soils can also decline rapidly because of its swift re-mineralization. Therefore, cultivation of the lands can only be temporary, so as to progressively restore the tree crown cover. Long-lasting forest fallowing is the means of fighting off weeds of rice (and of other associated cultures) by forcing them under the shade long enough for their grains to lose their germinating power before the new clearing campaign. It also helps restore the fertility of the soil surfaces thanks to mineral elements drawn from the depth by the tree roots, to biomass production through photosynthesis and the regular fall of leaves and other organic matter. Yields nonetheless remain limited to around one ton per hectare per crop cycle, which, given the duration and surfaces of forest fallows,

only supplies an average of 100 kg of paddy per hectare per year and cannot feed more than 30 inhabitants per tillable square kilometer.
This system of slash-and-burn rice cultivation is thus mostly present in the least densely populated wet inter-tropical areas: islands of Borneo and the Irian Jaya, Vietnamese high plateaus, mountain areas in Laos, fringes of the Amazonian forest, cliffs of eastern Madagascar, etc… Particularly adapted to the regions of dense forests where a deep shade can be maintained during several years, rice cultivation on slash-and-burn areas nevertheless quickly finds its limits in the more densely populated regions where frequent turnover of crop cycles and shortened duration of fallows lead to progressive savanization of ecosystems. The fight against grass and other weeds then becomes a major concern. Hoe weeding of rice is indeed a long and arduous process. It then becomes necessary to bury these "weeds" by means of plowing, which obviously entails the need for prior grubbing of the lands. Resorting to chemical herbicides can even become indispensable. Brazil is the country where this type of rainfed rice cultivation with plowing and use of herbicides is the most widespread nowadays.

2) **Lowland flooded rice fields**

Rice plants develop in the presence of a water bed whose origins vary (spate irrigation, accumulation of runoff into the lowlands, rainwater retention in casings surrounded by small dykes, etc.) and whose level is difficult to control. The muddy water retained in the rice fields generally contributes to the containment of weed proliferation because it is an obstacle to their breathing and photosynthesis. Transplant techniques or techniques of early direct sowing of more or less pre-germinated seeds are then implemented in order to allow rice plants to grow fast enough to keep emerging from the water bed. Rice fields otherwise make up sedimentation basins in which renewed soil fertility is insured by fertilizing elements conveyed by the flooding water: mineral salts from the alluvial deposits and organic matter carried by floods as well as runoff, nitrogen fixed by the spontaneous blue green algae, etc. Such systems enable farmers to practice a crop cycle on the same plots every year, with yields of one to two tons per hectare, without the need to add chemical fertilizers or to periodically let the lands fallow.

Flooded rice fields are otherwise often very complex agro-ecosystems hosting numerous edible plant and animal species: vegetables, fish, crabs, snails, ducks, etc… They can coexist with orchards and animal sties contributing organic matter. They are also often trampled by ruminants (bovine, bubaline, etc.) on free range grazing during the dry season. Sometimes, they are cultivated in rotation with other annual crops (soy, mung beans, various vegetables, etc.), and azolla[4] was introduced in them long ago as green manure in Vietnam. The small dykes themselves can host annual or tree species. All of these activities and productions made possible the setting up of human societies whose population density exceeds several hundred inhabitants per square kilometer.

The systems of flooded rice fields also have many variants among which one should highlight the system of “floating rice”, sown directly into the primary bed of some great rivers (Yang Tse Kiang, Red River, Mekong, Bramaputra, etc.) and the implantation of rice through transplanting in pre-sludged rice fields.
The technique of early direct sowing (several weeks before the flooding) prevails in the most readily flooded lowlands, where, due to the great cohesion of clayey soils, sludging would prove too time-consuming and difficult, but only cultivars with a strong and rapid stem elongation can then resist the extent and hazards of flooding. On the other hand the seed transplant technique is very widely used on alluvial terraces where loamy soils can be worked more easily and sludged by means of animal trampling or by plowing followed by harrowing.
This form of flooded rice cultivation is almost always seen with the use of animal traction to prepare the soils. It is still very widely practiced in the middle Mekong valley, the Gange valley and delta, the fringes of the Casamance and the eastern coast of Madagascar, regions devoid of major hydraulic construction projects for irrigation and drainage.

3) **Irrigated rice fields with perfect control of water:**

In rice fields where it has become possible to ensure perfect control of water levels thanks to structures capable of providing irrigation throughout the year and preventing unwanted drainage (dyking, drainage, etc…), it may be in the interest of farmers to grow the varieties with a high yield potential developed by the IRRI (International Rice Research Institute) and other national and international agronomic research centers. These varieties with short straw and erected leaves, resistant to lodging, have a relatively low tillering capacity but they can carry a large number of grains per panicle. They are also selected for their relatively short crop cycle and can be implanted at a high density so as to cover the available surface very quickly and rapidly take advantage of the light energy available for photosynthesis. Being non photoperiodical, they can be grown in various latitudes, at different seasons and included in several annual crop cycles whenever temperatures make it possible.

However, to fully express their genetic potential, these cultivars demand abundant fertilization and special protection against adventitious flora, pathogenic agents and predator insects. Thus, their use became possible and was generalized only in countries and regions where farmers could benefit from systems of credit and procurement in inputs (mineral fertilizers, phytosanitary products, etc…) that were particularly reliable and inexpensive.
But most countries of East Asia (Taiwan, continental China, Korea) and South East Asia (Indonesia, Philippines, Vietnam, Malaysia, etc.) were able to undertake the “green revolution” without major difficulty, in the places where farmers were in a position to work their lands directly and hold deeds of property that were safe enough for them to invest in the fertilization of their rice fields, with the certainty that they would reap the benefits in the long term. These regions where the varieties of the green revolution had been adopted the most rapidly are among the most densely populated areas, often with more than one thousand inhabitants per square kilometer. But the often inconsiderate use of chemical inputs quickly entailed negative effects on the farmers’ health (lung and skin diseases) and the quality of the

environment (water pollution, dwindling of fish resources, proliferation of pesticide-resistant insects, etc.)[5].

This is why the focus of "varietal improvement" and agronomic research was very quickly shifted toward the fabrication of varieties more tolerant or resistant to diseases and predator insects and toward the fine-tuning of integrated fight against pests.

Today, total control of water in irrigated and drained areas makes it possible to avoid the overly labor intensive transplant technique, and to directly sow pre-germinated seeds, directly in the mud, on perfectly even plots. The water level is then raised very progressively, along with the growth of rice plants, before the weeds have time to emerge. But the use of chemical herbicides in the early stages of growth and development of the rice is often necessary.

4) Moto-mechanized rice cultivation

In the United States of America, in the plains of Louisiana and South Carolina, where farms are very large, rice cultivation is now fully mechanized and motorized. Plowing is performed with cage-wheel tractors or disk plows pulled by powerful engines: rice is implanted by means of rotary seeders or very large width seeders. Chemical treatments are sprayed by plane and harvesting uses a combine. Relatively similar techniques also prevail in the Po valley, in Camargue and in some rice plains of Latin America. Thus, a single farmer can easily cultivate more than 100 hectares, with average yields of 5 tons per hectare. He therefore easily produces 500 tons of paddy per year, i.e. a thousand times more than the small Casamance (Senegal) farmer who is unable to transplant each year more than a half hectare, with yields often lower than one ton. True, production costs in terms of input and equipment are much higher than in Senegal; but if you consider that in the United States, nine tenth of the gross product are made up of costs and that only one tenth represents the value added by the farmer, work productivity (50 tons per active person and per year) nevertheless remains some hundred times higher than that of the small Casamance farmer. Subjected to "free trade" in a now international market, the latter therefore can only sell his rice in Dakar, if he agrees to a remuneration for his work that is one hundred times less than his American competitor!

So it is important to reassess the context in which the debate on transgenetic rice varieties is taking place. Varieties which received a gene of tolerance to herbicides could prove very efficient in areas of rain-fed rice fields undergoing savanization and in rice fields where direct sowing is practised with imperfect control of water. But what about the risk of this gene’s spreading to wild rice, itself in competition with cultivated rice[6]? Rice that has received the genes for resistance against destructive insects can be very interesting for all farmers involved in the “green revolution". Insecticide treatments indeed represent very important costs for these farmers who are otherwise already used to buying an important part of their seedlings. But the issue is on what would happen in case of proliferation of insects resistant to the toxins contained in the cultivated rice. So-called "Golden rice" enriched in b-carotene could be used in the most remote regions where poor farmers cannot have easy access to foods rich in vitamin A or in its precursor and can therefore easily catch xerophtalmia. We still need to understand which functions will be negatively impacted by the b-carotene synthesis and to check if that synthesis will not translate into lesser yields. This is compounded by the fact that the same farmers, often little or poorly involved in merchant exchanges, would not necessarily be able to renew their seed stocks through purchases on the markets.

Conclusion:

Ultimately, the question is: Rather than wanting to work exclusively on the selection of varieties with a high genetic potential for yield per unit of surface, which demand a lot of synthetic fertilizers and phytosanitary products, would it not be preferable to research the technical and socio-economic conditions that should be promoted so that each of the farming systems involved in rice cultivation could de facto increase its productivity within the overall agro-ecosystem in which rice is generally only one crop (albeit often a prevailing one) among others?

Bibliographic references

Abé Yoshio. (1995): *Terres à riz en Asie*. Typology essay. Masson; Paris.

Aubin Jean-Paul et Dagallier Jean-Cyril (1997) ; *Mechanization of rice production. Case studies. CIRAD* ; Montpellier.

Fuller Dorian Q. and Kin Ling (2009): Water management and labour in the origins and dispersal of Asian rice. *World archaeology* 41 – 1; London.

Ducourtieux Olivier. (2009): *Du riz et des arbres : L'interdiction de l'agriculture d'abattis-brûlis, une constante politique au Laos*. Karthala/IRD; Paris.

Dufumier Marc (2000): Une riziculture aux multiples visages. *Biofutur* n° 203; Paris

Gourou Pierre (1984): *Riz et civilisation*. Fayard ; Paris.

Hossain M., Islam I and Kibria R. (1999): *South Asia. Economic development. Transformation, opportunities and challenges*. Routledge; London and New york.

de Laulanié Henri (2003) : *Le riz à Madagascar. Un développement en dialogue avec les paysans*. Ambozontany (Antanarivo) et Karthala; Paris.

Maurer J-L. (1986): *Modernisation agricole, développement économique et changement social : Le riz, la terre et l'homme à Java*. Presses Universitaires de France. Paris.

Pingali P.L.; Hossain M. et Gerpacio R.V. (1997)*: Asian rice bowls. The returning crisis?* IRRI-CAB International. New York.

Pingali P.L. et *a*l. (1994): Rice-wheat systems research in South Asia: Ecoregional emphasis and international collaboration: *Sustainibility of rice-wheat production systems in Asia* (edited by Paroda R.S. *et al*.). Regional office for Asia and the Pacific; FAO ; Bangkok.

Trébuil Guy et Hossain Mahabub (2004): *Le riz : enjeux écologiques et économiques*. Belin; Paris.

Organic rice growing: presentation of a mechanised farm in California

Lundberg, Jessica[1]
[1] Lundberg family farms, CA-USA

Organic rice growing: presentation of a non-mechanised farm in Madagascar

Ravelonirina, Edline

The communication will be followed with a report of Corinne Lalo, focused on the System of Rice Intensification (SRI).

SESSION 1

RICE PRODUCTION AT THE FIELD SCALE

Winter flooding of rice fields: an important option for weedy rice control

Fogliatto, S[1], Vidotto, F[1], Ferrero, A[1]

[1] Dipartimento di Agronomia, Selvicoltura e Gestione del Territorio, Università degli Studi di Torino, via L. Da Vinci 44, Grugliasco TO – Italy

Keywords

red rice, germination, winter flooding, seed bank

Introduction

Weedy rice (*Oryza sativa* L.) is one of the most problematic weeds of rice cultivation worldwide and is responsible for significant yield losses. Weedy rice control is often difficult mainly because of its close similarity with cultivated rice (Fischer & Ramirez, 1993). Weedy rice is spread on about 40-75% of the total rice area in Europe (Ferrero, 2003) and on at least 70% of the total rice area in Italy (Vidotto & Ferrero, 2005). The characteristics of this plant that make it so problematic are its competitive advantages over cultivated rice: fast growth, efficient use of nutrients, resistance to dry conditions, high tillering ability, early grain shattering, and high seed dormancy (Noldin et al., 2006). Some control techniques can act on seed dormancy stimulating weed emergences; these techniques are particularly useful in organic production. Winter flooding is a practice consisting of flooding rice fields from the start of autumn following rice harvest until the spring before tillage operations. The following studies aimed at evaluating the effectiveness of winter flooding of rice fields to reduce weedy rice infestations.

Methodology

A field study was conducted during 2005-2008 on two sites (Montonero and Sali Vercellese), northwest Italy. At Montonero three paddy fields of approximately 2.5 ha each were considered and managed differently: winter flooded where the field had never been winter flooded in the years preceding the experiment (OW1); winter flooded where the field had been winter flooded starting in the year preceding the experiment (OW2); field maintained dry during the winter period (DRY). The three differing techniques were applied consistently to their respective fields during the winter periods. The experimental design used at Sali Vercellese only included OW1 and OW2 treatments. At both sites before each rice harvest, the total number of weedy rice plants was counted in three zones (6x2 m^2) randomly chosen within each field. Immediately after harvesting and at the end of winter flooding, ten soil cores (12 cm diameter, from 2-4 cm depth) were taken from each zone. Weedy rice and rice seeds were removed from the surface of the cores and put in paper bags for drying. After drying, the hulls of all seeds were removed using forceps to distinguish weedy rice from rice on the basis of pericarp pigmentation. Weedy rice plants and seeds were expressed as plant and seed density per square meter. Seed reduction after winter treatment was calculated by comparing seed density assessed after winter to that recorded before winter.

In 2011 a further study was started to confirm the previous results and in particular to determine the variation of the weedy rice seed bank at a depth of 0-20 cm after winter flooding. In the same farm of the previous study, two different fields were considered: one that was flooded during winter, starting from autumn 2011, and another one that had never been winter flooded before. In these fields, 30 soil cores at 0-10 cm and 10-20 cm depth were taken both before and after winter flooding to determine the weedy rice seed bank. Each soil core was disaggregated and put in a tray to let the seeds germinate. Weedy rice seedlings were identified, counted and removed after emergence and distinguished from cultivated rice ones through the seed pericarp pigmentation.

Results and discussions

In the first study, weedy rice plant density ranged between 4.8 plants m^{-2} and 32.5 plants m^{-2} at Montonero, while at Sali Vercellese it was generally lower, with values between 2.5 plants m^{-2} and 20.0 plants m^{-2} (Table 1). These densities fall in the range of the infestation levels common for Italian rice fields. Weedy rice plant density was significantly affected by the winter treatment (flooding or dry) and its duration. In particular, plant density showed a steady decline in both OW1 and OW2 at both locations, while a more variable behavior was shown by the field kept dry during winter. At both sites, weedy rice seed density on the soil surface resulted in a considerable reduction approaching 100%, while overwintering in dry conditions showed a more limited reduction (from 26.6% to 77.7%). At Sali Vercellese, an almost complete depletion of weedy rice seeds was already observed after a single year of winter flooding. This strong seed reduction after winter flooding could have been due to different phenomena, such as germination promotion from submersion with a consequent seedling killing by low winter temperatures and seed predation by waterfowls which are attracted by flooded fields.

The weedy rice seed bank determination carried out in both flooded and dry fields, confirmed a reduction of seed density after winter flooding. In particular, the reduction in flooded fields averaged 98% while in the dry field the reduction was only 23%. In both fields, the seed reduction was most remarkable at a depth of 10-20 cm.

The results of these studies highlighted that winter flooding was highly effective in limiting weedy rice infestations in paddy fields, causing a considerable plant and seed density reduction compared to overwintering under dry conditions. However, the application of this technique as a weedy rice control mean cannot be easily generalized, mainly because water is not always available in winter season. In organic farming, winter flooding could be indeed a useful practice to mitigate weedy rice infestation which might be combined with other management techniques such as: the adoption of spring or autumn plowing as an alternative to minimum tillage to dilute the seeds through the soil profile, the application of the stale seed bed followed by harrowing or other light cultivations to destroy weedy rice seedlings and the adoption of rice rotation with non-flooded crops. When pre-planting treatments are insufficient to control weedy rice, additional interventions with cutting bars could also be applied to prevent weedy rice plants from dissemination.

Table1. Weedy rice plant density and seed reduction at the two locations in DRY, OW1 and OW2 fields and seed reduction in the seed bank study.

Years of winter treatment	**DRY**		**OW1**		**OW2**	
	Plant density (plants m^{-2})	Seed reduction (%)	Plant density (plants m^{-2})	Seed reduction (%)	Plant density (plants m^{-2})	Seed reduction (%)
Montonero						
1st	18.1a	26.6A	32.5b	99.9B	20.0a	100.0B
2nd	4.8a	77.7A	15.0b	98.6B	12.3b	99.4B
3rd	19.3a	31.3A	11.1b	100.0B	9.5b	97.6B
Sali Vercellese						
1st	-	-	20.0b	95.8	10.1a	99.9
2nd	-	-	8.9b	98.9	4.4a	97.7
3rd	-	-	7.9b	100.0	2.5a	99.9
Seed bank study 2011						
0-10 cm depth	-	0.0	-	96.1	-	-
10-20 cm depth	-	59.6	-	100.0	-	-

[1]Lower case letters refer to comparison of weedy rice plant density among the different treatments in the same year. Means sharing the same letter are not significantly different according to the Repeated Measure ANOVA; ($P \leq 0.05$).

[2]Upper case letters refer to comparison of weedy rice seed reduction percentage among the different treatments in the same year. Means sharing the same letter are not significantly different according to the Repeated Measure ANOVA; $P \leq 0.05$.

References

Ferrero, A, 2003. Weedy rice, biological features and control, in: Weed management for developing countries. FAO plant production and protection paper 120, Addendum 1, pp. 89-107.
Fischer, AJ, Ramirez A, 1993. Red rice (*Oryza sativa*): competition studies for management decisions. International Journal of Pest Management. 39, 133-138.
Noldin, JA, et al., 2006. Seed longevity of red rice ecotypes buried in soil. Planta Daninha. 24, 611-620.
Vidotto, F, Ferrero A, 2005. Modelling population dynamics to overcome feral rice in rice, in: Gressel, J., (editor), Crop ferality and volunteerisms. CRC Press, Boca Raton, pp. 355-370.

Non chemical methods available to fight off the weeds of rice in africa

Marnotte, Pascal[1], Le Bourgeois, Thomas [2], Rodenburg, Jonne [3]

[1]CIRAD UR Systèmes de culture annuels, F-34398 Montpellier Cedex 5, France, pascal.marnotte@cirad.fr
[2]CIRAD UMR AMAP, F-34398 Montpellier Cedex 5, France, thomas.lebourgeois@cirad.fr
[3]Africa Rice Center (AfricaRice), ESA, P.O. Box 33581, Dar es Salaam, Tanzania, j.rodenburg@cgiar.org

Keywords
Weeds, weeding, organic rice, Africa

Introduction

In sub-Saharan Africa, rice is grown according to a wide range of agricultural situations related to the management of water, from irrigated rice fields to rain-fed systems through lowland rice fields without control of the water input. In each of these situations, plant associations adapted to the conditions encountered grow beside the crop and cause losses due to the competition imposed by these plants (Johnson, 1997). Perennial species such as *Cyperus rotundus* or *Imperata cylindrica* in rainfed situations or *Bolboschoenus maritimus* and *Oryza longistaminata* in wet areas are the most difficult to eliminate because of the storage organs (tubers or rhizomes) that they produce. Parasite species such as *Striga* spp. in exposed areas or *Rhamphicarpa fistulosa* in wet areas can also feed directly on the rice roots and cause loss of yield.

The use of herbicides tends to become generalized over the large irrigated surfaces, such as on the shores of the Senegal or the Niger rivers. But for small rice producers, weed management still mostly relies on manual removal of weeds, a very labor intensive practice, in the order of 50 to 70 days per hectare. However, there is also a whole set of practices which could fit in with organic farming. They are presented in this summary.

Indirect methods of weed management

Limiting external inputs of seeds or organs of vegetative propagation is the base of weed management and this is achieved for example through the maintenance of canals in irrigated rice fields or through the cleaning of tools. Looking for food, herds graze plots after harvesting, it is a source of fertilization, but also carries a strong risk of dissemination of weeds because of the seeds transported by the animals or present in their excreta. Likewise, batches of rice seeds should not contain grains of weeds: some species such as *Rottboellia cochinchinensis* are already subjected to stringent control measures and seed lots containing grains of that species are rejected. The choice of vigorous rice varieties and a high density of seeds is one way of reinforcing the crop in the competition against the weeds (Saito *et al.*, 2010; Rodenburg & Johnson, 2009).

Certain varieties are noted for their resistance to parasite species, in particular cultivars of African rice (*Oryza glaberrima*) (Johnson *et al.*, 1997 ; Rodenburg et al., 2011). Transplanting in irrigated fields gives the crop an advantage over the weeds. Moreover, line transplanting makes it easier to perform manual clearing and spot the plants that need to be destroyed, namely species that look like rice (*Echinochloa* spp.), or mechanical weeding, as with the rotary hoe going through the lines. But these techniques are not widespread in Africa. Practising crop rotations always proves advantageous in the fight against weeds. This is namely the case when irrigated rice fields can alternate with rain-fed crops such as corn, peanuts or cotton, for instance to limit the development of perennial species such as *Bolboschoenus maritimus* (Cyperaceae) ou *Oryza longistaminata* (Poaceae).

Traditionally, in rainfed cultivation systems in Africa, long-term fallowing was used to manage the population of adventitious flora by reducing the soil's seed stock, but nowadays, demographic pressure and the sedentarization of villages are limiting this practice.

Direct methods of cover crop management

Plowing the plot entails burying the seeds of weeds, thus preventing them from germinating. Tilling the soil is also a way of fighting off perennial species by unearthing the tubers or rhizomes, which will dry up in the sun in the off-season.

Provided there is enough time in the crop calendar, the false-seed bed technique should be promoted to reduce the seed stock. Weed germination is achieved by tillage, then the germinated seedlings are destroyed by a second surface tilling. However, this practice demands speedy operations and is therefore related to mechanization, which is still not very widespread in Sub-Saharan Africa. In irrigated fields, punctual irrigation entails the emergence of weeds that are subsequently simply left to dry up.

Along with a good soil levelling in irrigated rice fields, water management is a key element in the fight against weeds: a water surface of about ten centimeter prevents the plant from germinating, even species such as *Echinochloa crus-galli* (Chauhan et Johnson, 2010). However, this practice is less efficient on some broadleaf weeds such as *Sphenoclea zeylanica* (Rodenburg et Johnson, 2009).

Improving soil fertility with organic fertilizers approved in organic farming (powdered manure, compost, etc.) would be a preferred method to reduce the population of parasite plants, *Striga* spp (Riches et al., 2005) or *Rhamphicarpa fistulosa* (Rodenburg et al., 2011), but it has been relatively under-investigated so far. The range of available weeding methods tends to ever widen, with the introduction of ducks into the rice plots. This practice, already widely used in Asia, has been introduced in France recently. The birds eat up the grains and seedlings of adventitious flora and limit the proliferation of weeds in rice fields.

Conclusion

Implementing these weed control methods also implies knowledge of the biology of weeds and the exchange of local experience, as made possible by the *Weedsbook* (AFROweeds) collaborative platform, presented in this conference (Le Bourgeois *et al.*, 2012). Giving up herbicides requires shifting from a simplistic paradigm of weeding, often limited to the application of pesticides, to a consistent management of cover crops taking into account all stages of the crop cycle. It must rely on three rules: 1/reduce the existing seed stock; 2/curb the proliferation of weeds; 3/support the crop in its competition against weeds. Unfortunately, discounting partial information on the effects of this or that weeding method listed here, there is no technical reference document on a comprehensive weed control system in organic rice production in Africa.

Bibliographic references

Chauhan, B.S., Johnson, D.E., 2010. Responses of Rice Flatsedge (Cyperus iria) and Barnyardgrass (Echinochloa crus-galli) to Rice Interference. Weed Science, 58(3): 204-208.

Johnson, D.E., 1997. Weeds of rice in West Africa, WARDA, Bouaké.

Johnson, D.E., Riches, C.R., Diallo, R., Jones, M.J., 1997. Striga on rice in West Africa; crop host range and the potential of host resistance. Crop Prot. 16, 153-157.

Le Bourgeois, T., Grard, P., Marnotte, P., Rodenburg, J., 2012. Improving weed management in ricefields in Africa through information sharing and support in weed identification: potential of the AFROweeds collaborative platform. 1st International Conference on Organic Rice Production Systems, from August 27 to 30, 2012, Montpellier France.

Riches, C.R., Mbwaga, A.M., Mbapila, J., Ahmed, G.J.U., 2005. Improved weed management delivers increased productivity and farm incomes from rice in Bangladesh and Tanzania. Aspects of Applied Biology, 75: 127-138.

Rodenburg, J., Johnson, D.E., 2009. Weed management in rice-based cropping systems in Africa. Advances in Agronomy, 103:149-218.

Rodenburg, J., Zossou-Kouderin, N., Gbèhounou, G., Ahanchede, A., Touré, A., Kyalo, G., Kiepe, P., 2011. Rhamphicarpa fistulosa, a parasitic weed threatening rain-fed lowland rice production in sub-Saharan Africa - A case study from Benin. Crop Protection, 30(10): 1306-1314.

Saito, K., Azoma, K., Rodenburg, J., 2010. Plant characteristics associated with weed competitiveness of rice under upland and lowland conditions in West Africa. Field Crops Research, 116: 308-317.

Integrated Duck (Aigamo) and Rice Farming in Directly Sown Dry Paddies
– Controlling weeds in deep water immediately after germination –

Furuno, Takao[1]

[1] Japan Rice-Duck Farming Society,Japan furuno@d4.dion.ne.jp

Keywords: Integrated duck and rice farming, directly sown dry fields, early deep water and submerging, labour saving in organic farming

Introduction

In integrated duck and rice farming (IDRF) thus far, almost mature, robust rice seedlings were transplanted to the paddy field and *aigamo* ducklings of roughly one week of age were released into the paddy fields 1 to 2 weeks after transplantation at a rate of about 20 per 1000m^2 (1/10 ha). The *aigamo* swim around between rice plants, eating weeds and insect pests, giving stimulation to the rice plants, and muddying the water, while their droppings becoming nutrients for the rice plants.

IDRF has thus been a technology that has had seedling transplantation (ST) as its premise. Almost all of what we call “organic rice farming” in Japan has ST as its premise.

Since 2003, in order to realize labour savings, I have been attempting to link IDRF with “dry-paddy direct sowing” (DPDS) This is quite difficult to do, but in 2011 I began to see the light at the end of the tunnel by submerging the newly germinated rice plants in deep water. Rice culture in East Asia is all carried out through ST, and so this technology has only just begun. I would very much like to receive advice from everyone who is growing rice in countries where direct sowing is carried out.

Methodology

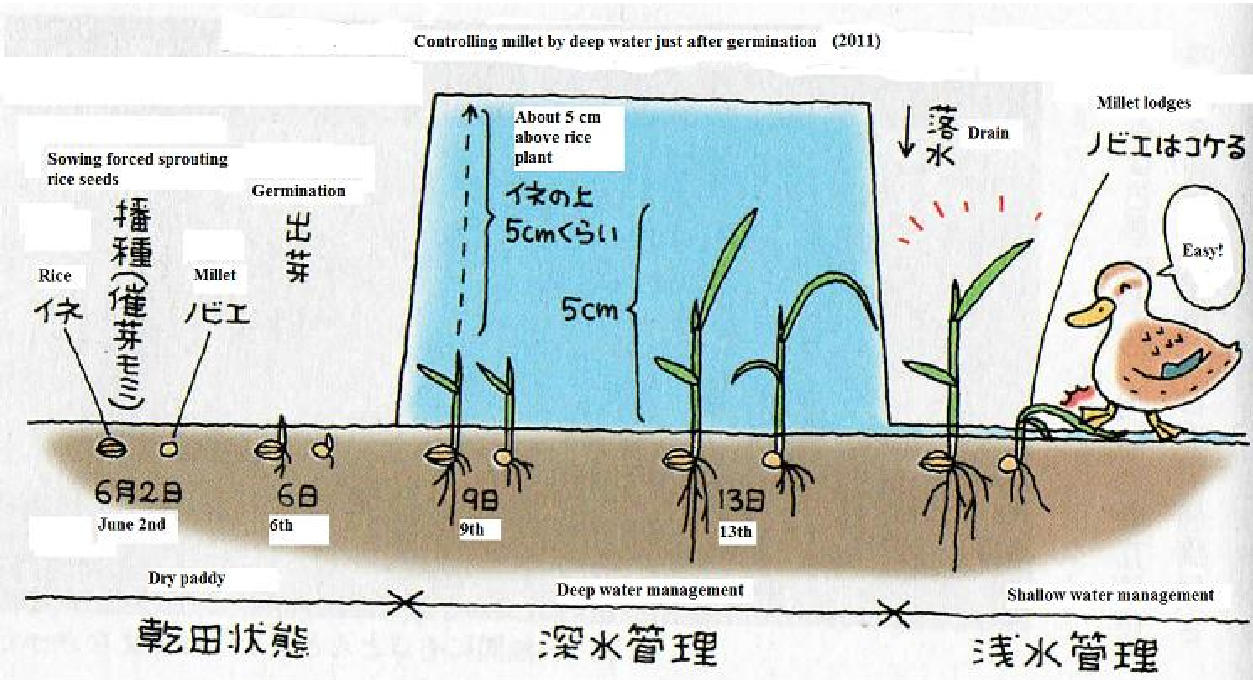
Directly sown rice culture is labour-saving when compared with ST rice culture. In direct sowing, however, since the rice plants and weeds start out together, strongly competitive weed plants, especially amphibious wild millets, are likely to overwhelm the rice plants. The main issue in directly sown organic rice is weed control. I have continued to struggle with this structural problem along with my friends, the *aigamo*.

From 2009, I worked with the agricultural machinery maker OREC Co., Ltd. on the joint development of an ‘early dry paddy intertillage weeding machine.’ In 2010, by use of a spiral rotor, it has become possible to carry out accurate and efficient inter-row weeding in a dry paddy in which the shoots of the rice plants have just begun to appear. Weed control between the rice hills was achieved by light ridging. In some paddies wild millet appeared between the rice hills.

In 2011, I completely changed my way of thinking and I am now engaged in a new endeavour. In my area, rice plants germinate about 4 to 7 days after direct sowing in a dry paddy. When germination was observed to have taken place all around the paddy, water was allowed into the dry paddy and the rice shoots are completely submerged to a depth of 5 to 10 cm. This condition was maintained for 3 to 4 days.

The water was then quickly drained from the paddy until a shallow depth of 0.5 to 1 cm of water remained. The wild millet almost completely lodged, but the rice plants stood up straight and firm. The roots of the wild millet were underdeveloped, but the rice put out strong roots. This stems from the difference in the size of the seeds.

20 *aigamo* ducklings per $1000m^2$ were then released into the paddies. The happy ducklings swam freely about between the rice plants, sown at 21 cm intervals, eating up the soft leaves of the weeds and insect pests. The *aigamo* do not eat wild millet plants, but being unable to develop roots due to submergence in deep water and having grown soft stems, they floated to the surface of the water after having been trampled and stirred up by the *aigamo*. This technology is adaptable not only to spot sowing and row sowing, but also to random sowing.



Results and discussions

Following the above, I increased the depth of the water in accordance with the growth of the rice plants and the *aigamo*. When the rice ears appeared in mid or late August, the *aigamo* were removed from the paddies.

As a result, with the exception of places in the paddies where the paddy floor is high and therefore not completely submerged, wild millet did not appear and the rice ripened beautifully. The result was no better, but no worse, than the almost complete ST *aigamo* paddy technology. The *aigamo* ate all the weed plants such as *konagi (Monochoria vaginalis* (var. plantaginea)), *azena (Lindernia procumbens* (Krock) Borbas) and *urikawa* (*Sagittaria pygmaea* Miq.).

Deep water submergence is an almost universal technology that can probably be adapted widely to organic rice culture.

Weeding pratices on a Californian rice farm

Lundberg, Jessica[1]

[1] Lundberg family farms, CA-USA

Titre en Français:

Pratiques de désherbage sur une exploitation rizicole californienne.

Improve weed management in rice fields in Africa, through information sharing and support in weed identification: the potential of the AFROweeds collaborative platform

Le Bourgeois, Thomas (1), Grard, Pierre (2), Marnotte, Pascal (3) et Rodenburg, Jonne (4)

[(1)] Cirad, umr AMAP, TA A51/PS2, 34398 Montpellier Cedex 5, France, thomas.le_bourgeois@cirad.fr
[(2)] Cirad, umr AMAP, Institut Polytechnique de Hanoi, Viet Nam, pierre.grard@cirad.fr
[(3)] Cirad, ur SCA, TA B-102/02, 34398 Montpellier Cedex 5, France, pascal.marnotte@cirad.fr
[(4)] Africarice, p.o. Box 33581, Dar es Salaam, Tanzania, j.rodenburg@cgiar.org

Keywords
Weeds, rice, Africa, knowledge base, digital platform.

Introduction

Rice is one the main cereals consumed in Africa and consumption levels keep increasing over the years. Africa remains the main rice importer in the world, with a market representing close to one-third of the international rice market (FAO, 2009). Production increase generally results from an extension of cultivated surfaces and not from the resolution of certain major productivity constraints such as the management of aggressive bio agents, weeds, pests or diseases. Uncontrolled growth of weeds has been identified as causing very high production losses, reaching up to 100% in rain-fed rice in Western Africa (Akobundu, 1996; Johnson et al, 2004). These losses represent for the region an annual cost estimated at 2.2 million tons of rice, equivalent to 1.45 billion USD (Rodenburg & Johnson, 2009).
In Africa, lowland rice (33% of rice fields) is grown organically, without pesticides. This production system is particularly affected by weeding constraints, whereas irrigated rice fields are more affected by the problem of which herbicide to use and how to use it properly. This bad management of weeds is mostly due to a poor knowledge of species, their biology and means of control. This is the reason why the sharing of data and knowledge between the stakeholders involved in research, development and production, as well as the supply of information and tools for the identification of species regularly updated by the stakeholders themselves, all play a key role in the development of African farming.
When adopting an approach based on ecological intensification, all practices that contribute to reducing weeds must be taken into account, and access to diversified information then becomes all the more important. This paper presents the implementation of the AFROweeds platform (African weeds of rice) and the way it operates through a network of African and European partners. The promotion of adequate weeding practices and their adoption by stakeholders of the agricultural sector will open up access to enhance the productivity of African rice cultivation systems and contribute to the improvement of the region's food security.

Method

The aim of the AFROweeds project is to enable actors facing the same problem of weed control in rice fields in Africa, to work within a network and share their knowledge and data as well as provide the wider public with information available via a collaborative digital platform.
The tools making up that platform already existed independently, but they had to be improved to enable their interfacing. Thus, the project had two implementation stages:

- The first stage led to a concertation between all partners to define together the purposes and targets of the research. This work was carried out in a workshop and extended all along the project through the use of the collaborative space of the project's web site. A primary knowledge base was structured in a way that enabled local use by the partners (AfricaRice and Cirad).
- The second stage corresponds to the passage from the operation of individual local knowledge bases to the operation of local bases synchronized with a common networked knowledge base and to the fine tuning of identification tools.

Ongoing concertation between the partners of the project is one of its key elements. After reaching a common definition of the purposes and targets, each stakeholder must be able to propose new elements or modifications which are debated in the fora of the collaborative platform's various work groups.

Results and discussion

The AFROweeds project is based on the articulation of four types of complementary interactive digital tools: The web site (http://www.afroweeds.org) presents the AFROweeds project and gives access to resources available to the general public (French/English bilingual summary sheets on species, identification systems, bibliography, etc.). It also gives access to the collaborative work platform.

- The collaborative platform (http://www.afroweeds.org/network) is the communication hub for all members of the project. It enables them to work in a common space to share documents, wiki pages, web links to other sites of interests, discussions, photo albums, any questions or information relating to weeds of rice and how to manage them. Any document, text, photo or object put on the platform can be commented on by the other members. Exchanges or even additional information, are getting structured around a document, thus enabling its regular update. This way, it is possible to ask the community to identify an unknown species, starting from a photo album, or to improve the content of a technical sheet on weeding recommendation. Various summaries of weeding recommendations targeted per production system or based on major biological types of species are available and regularly updated. They deal both with conventional methods and methods available for use in organic farming. They are accessible through species summary sheets via hyperlinks.
- The composite picture identification system (http://www.afroweeds.org/idao), which allows any user to identify the weed and directly access its summary sheet
- The knowledge base in which all observations and information on species are managed and from which species summary sheets are automatically produced and made accessible to the general public from the web site, the platform or the identification system.

The knowledge base, originally operated locally, is now available for network use (permanent or on and off use) by several users. Thus, various local bases are installed at the partners' places and regularly synched to a general base. Eventually, local bases may be installed at partners who want to be able to interact with the data available in the general base. The project is currently at the end of phase two, in a period of test of the various tools and their interactions before being deployed with more partners wishing to get involved in the acquisition and updating of data and information. Through this series of interaction tools, information on the knowledge of weeds of rice and the management of irrigated rice can be managed, circulated, exchanged, commented on and solicited, thus progressively developing the information network linking all the stakeholders together, be they scientists, developers, suppliers, producers or decision-makers. This approach, initiated for African rice production, is intended to be extended and adapted to other rice production areas, depending on the needs of the stakeholders.

This project was financed by the European 2009 "ACP Science and Technology Program".
The authors of this paper would like to acknowledge and thank all national partners of the AFROweeds project.

Bibliographical references

Johnson, D.E., Wopereis, M.C.S., et al. 2004. Timing of weed management and yield losses due to weeds in integrated rice in the Sahel. Field Crop Research 85: 31-42.

Rodenburg J, Johnson DE, 2009. Weed management in rice-based cropping systems in Africa. Advances in Agronomy, 103, 149-218

Akobundu, I.O. 1996. Principles and prospects for integrated weed management in developing countries, Second International Weed Control Congress, Copenhagen, Danemark. 2: 591-600.

Fao. 2009. Rice Market Monitor, December 2009. FAO, Rome, Italy.
http://www.fao.org/es/esc/en/15/70/highlight_71.html.

Comparative study of the chemical and biological diversity of soil of two rice fields subjected to organic and conventional farming

Romani Marco[1], Beltarre Gianluca[1], Miniotti Eleonora[1,2], Said-Pullicino, Daniel[2]

[1]Rice Research Centre, Ente Nazionale Risi, Pavia, Italy. m.romani@enterisi.it

[2]Soil Biogeochemistry Team, Rice Agroecosystem & Environmental Research Group, University of Turin, Italy.

Keywords

Organic rice, soil organic matter, humification, microbial respiration, arbuscular mycorrhizal.

Introduction

Conventional paddy cultivation can lead to a reduction in soil organic matter quality and a consequent depletion in soil fertility (Sahrawat, 2003). The adoption of large-scale intensive cropping (continuous rice cultivation, without use of soil amendments) and the need to offset the consequential decrease in soil organic matter (SOM) have promoted cropping systems and management practices that ensure greater amounts of crop residues returned to the soil (Majumder *et al.*, 2008). However, the supply and decomposition of organic materials in rice fields, and the consequent nutrient bioavailability are markedly versatile and closely related to field management (Kimura, *et al.* 2004). Organic farming systems that in Italy concern over 10,000 ha of cultivated land are considered to be an alternative to conventional farming, and aim at enhancing agricultural sustainability and limit environmental impact. Few studies have actually compared the effects of organic and conventional farming on soil properties keeping all soil-forming factors equal (Renagold, 1988). This work reports soil biological and chemical data from a study conducted in two fields on adjacent farms, one organically managed and the other conventionally managed, within the Italian rice area near Pavia.

Methodology

The investigations were carried out on two farms in Pavia (Italy) with two different crop managements systems: (i) a 24,3 ha rice field under conventional farming with high-input continuous rice monocropping (45°12'55.13'' N, 9°7'42.23''E), and (ii) a 45,8 ha rice field under organic farming with 5-year crop rotation: rice-rice-soybean-corn-winter cereal (45°12'18.91'' N, 9°7'11.39''E). The latest was managed with organic method since 2 years before starting this experiment. The climate of the region is temperate with 465 mm of precipitation and an average temperature of 17.6°C during the cropping season (March-October). In both farms soil is classified as a Typic Hapludalf, coarse-loamy, mixed, mesic (Soil Survey Staff, 1992). In both fields, dry seeding was performed and flooding occurred at tillering stage. In the conventional farm, rice fertilization consisted in a 12:5:20 N:P:K mineral complex (375 kg ha^{-1}) applied before seeding and a 150 kg ha^{-1} of ammonium phosphate applied before tillering. Herbicide treatments included pendimetalin and oxadiazon at pre-emergence, and propanil and etoxysulfuron at post-emergence. In the organic farm, rice N fertilization consisting of cattle manure (1,9 : 0,7 : 1,5 N:P:K), poultry litter (3,9 : 1,8 N:P), horn and hoofs (14% N) (1500, 300, 420 kg ha^{-1}, respectively) and K-Mg sulphate (270 kg ha^{-1}) were applied. No herbicides were used. Soil sampling for the evaluation of chemical and biological properties was carried out in 2002 and 2007 at the end of the cropping season. In both years, the organic field was at the first year of the crop rotation programme. Rice plants (*Oryza sativa* L. cv. Baldo) were sampled just before flooding from both fields in June 2003 (second year of the crop rotation programme in the organic field) for morphological evaluation of arbuscular mycorrhizal fungi (AMF). The degree of root colonization by AMF was determined microscopically after cotton blue staining.

Results and Discussion

The two soils analyzed showed the same granulometric composition but also different initial characteristics, particularly with respect to their organic C content and its distribution between organic matter fractions. Table 1 reports the changes in organic matter content and distribution among different fractions for both soils after 5 years of different management. Results evidence that 5 years of organic treatment resulted in a significant increase in organic C content (from 8.9 to 10.4 mg C kg^{-1}), probably due to crop rotation, incorporation of crop residues and manuring. Although this fresh organic matter input to the soil positively influenced TOC values, organic management had limited effects on humification processes. In contrast, conventional treatment, which was based on dry seeding, resulted in a decrease in soil organic matter content with a reduction of TOC values from 15.7 to 13.7 mg C kg^{-1}. The observed increase in total C in the organic treatment was probably due to a greater input of labile organic matter with respect to the conventional system, as evidenced by the decrease in humification ratio (HR) values after 5 years (from 34.5 to 30.8 %) and a relatively similar C content in humic and fulvic acid fraction (HA+FA). The slightly higher values of humification index (HI) obtained for organic with respect to conventional systems also suggests a greater presence of labile organic matter in the former. During these 5 years, organic management resulted in substantial organic matter turnover resulting in a the significant increase in the degree of humification (DH). In contrast, the reduction in HR values after 5 years of conventional management (from 43.6 to 36.9 %) was due to a significant decrease in both TOC (from 15.7 to 14.0 mg C kg^{-1}) and HA+FA content (from 6.8 to 5.1 mg C kg^{-1}). Organic matter turnover was also limited under this management, with DH values increasing only slightly. Changes in organic C content and turnover in the two treatments were further explained by data related to the soil microbial biomass and activity. At the beginning of the investigation the soil microbial biomass C (C_{mic}) was greater in the conventional treatment than in the organic one (0.6 and 0.4 mg C g^{-1} respectively), but after 5 years C_{mic} values decreased 3 and 2-fold in the conventional and organic treatment, respectively. Microbial respiration curves and respiratory quotients evidenced an enhanced microbial activity in the organic treatment. Over 5 years respiration rates and respiratory quotients increased for both treatments. In fact, quotients increased from 0.13 to 0.22 mg C mg^{-1} C_{mic} and from 0.06 to 0.14 mg C mg^{-1} C_{mic} for the organic and conventional treatments, respectively. These results confirm that the enhanced microbial activity under organic management, possible due to a significant input of labile organic matter, could be responsible for the greater organic matter turnover observed in these soils. In fact, with respect to the conventional treatment, soil samples from the organic treatment resulted in a significantly greater proportion of total C mineralized to CO_2. Mycorrhizal colonization was absent in all the sampled plots in conventional treatment, while it was responsible for 2.51% of the root length in the organic management system (Lumini et al., 2011).

Table 1. Characterization of organic fraction

Treatment	Year	TOC	TEC	HA+FA	NH	HI	DH	HR	C_{mic}
				mg C kg^{-1}			%	%	mg C g^{-1}
Organic	2002	8.9	5.7	3.1	2.7	0.9	53.3	34.5	0.4
	2007	10.4	5.2	3.2	2.0	0.6	61.3	30.8	0.2
Conventional	2002	15.7	10.4	6.8	3.6	0.5	65.8	43.6	0.6
	2007	14.0	7.4	5.1	2.3	0.5	69.1	36.9	0.2

TOC, total organic C; TEC, total extractable C; HA+FA, humic and fulvic acid C; NH, non-humic C; HI, humification index; DH, degree of humification; HR, humification ratio; C_{mic}, microbial biomass C.

Conclusion

The results show noticeable chemical and biological differences between the two treatments. In particular, after 5 years of organic treatments we observed an increase in the labile organic matter content and in the microbial activity. Therefore, we can say that during this 5 years of organic treatments the conditions of the soil showed a significant improvement. In conclusion, the organic management can be considered in order to increase the fertility of paddy soils.

References

Kimura, M. et al. (2004). Carbon cycling in rice field ecosystems in the context of input, decomposition and translocation of organic materials and the fates of their end products (CO_2 and CH_4). Soil Biol Biochem. 36, 1399-1416.

Lumini, E. et al. (2011). Different farming and water regimes in Italian rice field affect arbuscolar mycorrhizal fungal soil communities. Ecological Applications 21, 1696-1707.

Majumde, B. et al. (2008). Organic Amendments Influence Soil Organic Carbon Pools and Rice–Wheat Productivity. Soil Sci Soc Am J. 72, 775-785.

Reganold J.P. (1988). Comparison of soil properties as influenced by organic and conventional farming systems. American Journal of Alternative Agriculture 3, 144-155.

Sahrawat K.L. (2003). Organic matter accumulation in submerged soils. Advances in Agronomy 81, 169-201.

This work was financially supported by Regione Lombardia within the projects: SIC 2002, CEREALOMB 2003, RISOLOMB 2004.

Contribution to the economic study of soil fertilization with SRI rice production:Case of the use of Tananamadio compost and of Taroka in the rural county of Behenjy, Madagascar

Randrianarison Lara Basilisse

SRI Group Madagascar, groupementsrimada@moov.mg

Keywords

Rice, Taroka, Tananamadio Compost, Doses, Yield

Introduction

The country's rice production does not currently enable Madagascar to dispense with imports to satisfy domestic consumption. The SRI system (System of Rice Intensification), a cultivation method with high yield performance, can offer an alternative if all required conditions are respected. The use of fertilizers, in particular organic fertilizers, is one of its priority requirements in order to restore all elements removed from the soil and also to protect the environment. However, to maximize the yield while keeping an acceptable cost, an economic study is indispensable: this is the topic of our research.

Method

The experiment was centered on a trial of soil fertilization in SRI production, with increasing doses of two types of organic fertilizers: Tananamadio compost or CTM (organic fertilizer obtained from the collection and recovery of organic parts of household waste) and Taroka (organic fertilizer elaborated from useful and selected microbial stems, www.stoiagri.com)

	Taroka	**CTM**
pH	7.4	8.17
MO (%)	28	33
C/N	13.33	10.7
N (%)	1.17	1.32
P_2O_5 (%)	4.99	0.54
K_2O (%)	0.37	0.9

The experimentation was based on the classical SRI technical method, i.e.: pre-germinated seeds, line and square transplanting of young seedlings (2-leaf stage, i.e. an average of 8 days after sowing), spaced (33cm x 33cm) and stalk by stalk; early (10 days after transplanting) mechanical and repeated clearing (every 15 days) during the plant's vegetative phase, irrigation with minimal water input (2 to 4 cm) with occasional drying up (Henri de Laulanié, 2003; Patrick Vallois, 1996). For each of the fertilizers, the trial's modus operandi consisted in the use of 5 increasing doses, T1, T2, T3, T4, T5 in three repetitions. Doses recommended by the fertilizer suppliers are incorporated in the trial protocol: 20 t/ha for CTM and 1.5 t/ha for Taroka. Each treatment corresponds to a base plot. Plots with T1 treatment (without fertilizer addition) served as control plots for the trial. Variables measured are the various components of yield, i.e.: the number of plants per square meter (**Pl/m^2),** the number of panicles per tuft (**Pan/t**) (the tuft is made up of all the tillers shooting from a single plant), the total number of grains per panicle (**Gr/pan**), percentage of full grains per panicle (**%GP/pan**), weight of 1000 grains (**P_{1000G}).** Yield is obtained with the following formula: **YIELD= Pl/m^2** x **Pan/t** x **Gr/pan** x **%GP/pan** x **P_{1000G}** x **10^{-7}** with 10^{-7} as the conversion constant. The response curve of the rice to the two organic fertilizers is the curve representing the trend of the average of yields obtained depending on the dose of fertilizer used. Production cost is the value of all charges borne by the farm, namely expenses in manpower, seeds and fertilizers.

Results and discussion

Results

The table below represents the various yields obtained depending on the fertilizer dose applied:

Fertilizers	Treatments	Doses of fertilizer (t/ha)	Average yield in paddy (t/ha)
Tananamadio Compost	T1	0	10.20
	T2	10	12.32
	T3	15	14.61
	T4	20	14.23
	T5	25	13.43
Taroka	T1	0	14.83
	T2	1	17.71
	T3	1.5	18.18
	T4	2	17.11
	T5	2.5	13.99

The dose of organic fertilizer required to fertilize the soil for SRI production is determined at 1.25 t/ha for Taroka, instead of 1.5 t/ha as previously recommended by the supplier and 15t/ha instead of 20 t/ha for the Tananamadio compost. These fertilizers make it possible to respectively achieve yields of 18.08 and 14.6 t/ha. The ratio between the value of the production resulting from the fertilizer and the cost of the fertilizer used equals 3 for Taroka while it equals 2 for CTM. The cost of production of 1 kg of paddy (160 Ar per use of CTM and 82 Ar per use of Taroka) is relatively low compared to its selling price (660 Ar/kg). Farmers can then draw higher benefits when selling their production.

Discussion

Yields obtained on the control plots result mainly from the effects of practices associated with SRI: reduction of the vegetative stress due to transplant and to inter-plant competition, improved root development, increased robustness and improved sanitary conditions. The experimental site is characterized by a succession of rice and off-season crops which receive annual additions of organic manure such as compost. The added manure thus has a residual effect and influences the subsequent production of rice. The very high yield gap between the two control plots mainly results from the heterogeneity of soil fertility at the experimental site. Yield is reduced starting at a critical dose for the 2 fertilizers tested: this can be accounted for with various explanations, namely the excess of nitrogen in the soil which implies an excessive development of the vegetative parts of the plant to the detriment of grain production. The net added value per hectare is higher when using optimal doses of these two fertilizers (15 t/ha for CTM and 1.25 t/ha for Taroka). Farmers can then make up for all the expenses implied by this system and improve their technical and economic performance. In Madagascar, obstacles to a wider adoption of SRI at the farmer's level are obstacles common to all innovations and particularly to an intensification of work: lack of conviction that there is a real opportunity, that risk taking may pay back; the absence of real estate safety (presence of sharecropping) kills the motivation to invest in land, difficulties in selling the production (Report by the National Workshop SRI Group, Madagascar, 2010).

Bibliographic references

- BENITO, S.Vergara, Torolalana ho an'ny mpamboly vary, International Rice Research Institute (IRRI), 219 pages.

-Henri de LAULANIE, Le riz à Madagascar : un développement en dialogue avec les paysans : Éditeur Karthala, juillet 2003, Collection **:** Économie et Développement

-MAISONNEUVE et LAROSE, Le technicien d'Agriculture Tropicale, Le riz irrigué, CTA, 321 pages.

- Rapport Atelier national SRI, 2010, Le SRI à Madagascar, un levier de la sécurité alimentaire, de la croissance économique et du développement durable, Groupement SRI Madagascar, 32pages. (www.groupementsrimada.org)

-VALLOIS, Patrick, 1996, Discours de la méthode du riz- Rapport sur la nouvelle riziculture malgache SRI, Institut de Promotion de la Nouvelle Riziculture, 2ème édition-Antananarivo.

- BENITO, S.Vergara, Torolalana ho an'ny mpamboly vary, International Rice Research Institute (IRRI), 219 pages.

-Henri de LAULANIE, Le riz à Madagascar : un développement en dialogue avec les paysans : Éditeur Karthala, juillet 2003, Collection **:** Économie et Développement

-MAISONNEUVE et LAROSE, Le technicien d'Agriculture Tropicale, Le riz irrigué, CTA, 321 pages.

- Rapport Atelier national SRI, 2010, Le SRI à Madagascar, un levier de la sécurité alimentaire, de la croissance économique et du développement durable, Groupement SRI Madagascar, 32pages. (www.groupementsrimada.org)

-VALLOIS, Patrick, 1996, Discours de la méthode du riz- Rapport sur la nouvelle riziculture malgache SRI, Institut de Promotion de la Nouvelle Riziculture, 2ème édition-Antananarivo.

Influence of organic nutrient management in aromatic rice on productivity, nutrient concentration and economics

Singh, Y.V. * and Saxena, A.K.

Indian Agricultural Research Institute, New Delhi -110012, India
(Corresponding author: *E-mail:* yvsingh63@yahoo.co.in)

Introduction

In many countries including India, there has been increasing interest in organic production systems. In India, the growth in organic production is estimated at 15-20% annually and is expected to continue because of strong domestic and overseas demand and aromatic (*Basmati*) organic rice has a special place in this aspect. Organic farming systems are generally characterized by an ecological management system that aims to promote and enhance biodiversity, nutrient cycles and soil biological activity. Soil biological health is a central principle of organic agriculture and is vital to sustainable agriculture. Large quantities of organic matter are used in organic production systems as a source of nutrients while in integrated nutrient management (INM) and chemical fertilized production system receives low and imbalanced inputs and soil fertility levels decline gradually so that the sustainability of such farming systems are questioned. Organic agriculture is claimed to be the most sustainable approach in food production. With this background, an investigation was conducted to study the productivity, quality and economics in an organic rice-vegetable cropping system *via-a-vis* integrated nutrient management and chemical fertilized production system.

Keywords: Basmati rice, economics, nutrient concentration, organic nutrient management, rice productivity

Methodology

A field experiment was conducted at Indian Agricultural Research Institute, New Delhi, India during 2009-2011 to study the productivity, quality and economics in an organic rice-vegetable cropping system *via-a-vis* INM and chemical fertilized production system.The soil of the experimental plot was sandy clay loam with pH 7.8, organic carbon 0.76%, available nitrogen 398.5 kg ha^{-1}, available phosphorus 28 kg P ha^{-1} and available potassium 286.4 kg K ha^{-1}. The experiment was conducted as per the guidelines of International Federation for Organic Agriculture Movement (IFOAM). This experimental field was under organic cultivation since 2003 and during 2003-08 rice- wheat cropping system was followed. In this experiment irrigated transplanted rice was grown in wet season (June to November) followed by irrigated vegetables and wheat crop in dry season (November to April). Wheat and vegetables were sown/ planted using zero-tillage practice. The field experiment was laid out in split plot design where aromatic (*Basmati*) rice (cv. 'Pusa Basmati 1401') was grown in main plots and vegetables like cauliflower, broccoli, cabbage, garden pea, carrot and cereal crop wheat were taken in sub-plots. In organic crop nutrition four organic inputs viz. Blue Green Algae(BGA), *Azolla*, Vermicompost and Farm Yard Manure(FYM) were applied in rice crop in combination. This treatment was taken on the basis of results of six year field experimentation by Singh *et al.* (2011). In organic treatment, entire dose of FYM (5.0 t/ha) was applied as basal and vermicompost (5.0 t/ha) was applied in 2 equal doses as basal and at panicle initiation stage. BGA (2.5 kg/ha) and fresh *Azolla* (1.0 t/ha) were applied 3 days after transplanting. In INM, FYM (5.0 t/ha) was supplemented with chemical fertilizer (90 kg N/ha). In chemical fertilization, 120 N ha^{-1} was applied through urea and applied in three splits. Observations on plant growth, yield and nutrient concentration of rice were taken by standard procedures.

Results and discussions

Results revealed that the rice grain yield under organic management i.e. application of four organic inoculants (Blue Green Algae, *Azolla*, Vermicompost and Farm Yard Manure) was the highest in all the three years (4.46 to 4.72 t/ha) followed by the yield under INM (4.32 to 4.58 t/ha) and chemical fertilization (4.09 to 4.36 t/ha) (Table 1). The difference in yield was significant in second and third year of cropping. Productivity of vegetables like cauliflower, broccoli, cabbage and carrot grown under organic management using organic inputs viz. biofertilizers (*Azotobacter*), vermicompost and FYM gave *at par* yield as given under INM and chemical fertilization. Positive effects of use of BGA, *Azolla* and organic manures have been reported by Singh and Mandal (2000). Our findings are in agreement with the findings on organic cultivation of rice as well as other crops in different parts the world (Bhattacharya and Chakraborty, 2005; Singh *et al*. 2011). Micronutrients viz. Fe, Zn and Mn concentration and uptake in rice grain and edible portion of different vegetables increased significantly due to organic farming over INM and chemical fertilization. Similar results were reported by Bhattacharya and Chakraborty (2005). An increase in population of beneficial insects like spiders was recorded under organic farming as compared to INM and chemical fertilization. Significantly lower incidence of endemic pest like white backed plant hopper (WBPH) in treatments having organic management (2-4 larvae/ hill) was observed in rice compared to INM (8-10 larvae/ hill) and chemical (17-20 larvae/ hill) fertilization. Organic soils with higher functional diversity of micro-organisms, develop disease and insect suppressive properties and can help to induce resistance in plants (Fließbach et *al*. 2007). Highest net return was recorded with INM followed by organic management which was mainly due to higher cost of cultivation in organic management (Table 1). However, organic farming was found beneficial when produce was sold at premium price.

It was concluded that grain yield of aromatic rice with organic nutrient management was significantly higher compared to chemical fertilization. Concentrations of Fe, Zn and Mn in rice grain increased significantly due to organic management over chemical fertilization. Organic farming was profitable when produce were sold at premium price.

Table 1 Effect of crop nutritional practices on grain yield and economics of rice cultivation

Treatment	Rice grain yield (tonne / ha)			Cost of cultivation (Rs/ ha)	Gross return (Rs/ ha)	Net return (Rs/ ha)*	Net return (Rs/ha)**
	2009	2010	2011				
Organic	4.46	4.53	4.72	28500	90600	62100	84750
INM	4.32	4.38	4.58	23000	87600	64600	
Chemical(control)	4.18	4.09	4.36	22500	81800	59300	
C.D at 5%	NS	0.28	0.24				

1US Dollar = 50 Rupee (Rs) ; *at equal market price ; ** at 25% premium price

References

Bhattacharya, P. and Chakraborty, G. 2005.Current Status of Organic Farming in India and other countries. *Indian Journal of Fertilizers* 1(9):111-123.

Fließbach, A., Oberholzer, H.R., Gunst, L. and Mader, P. 2007. Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. *Agriculture, Ecosystems and Environment* 118: 273–284

Singh, YV; Dhar DW and Agarwal B. 2011.Influence of organic nutrient management on Basmati rice *(Oryza sativa)*-wheat *(Triticum aestivum*)-greengram *(Vigna radiata*) cropping system. *Indian J Agronomy*. 56(3):169-175

Singh, Y.V. and Mandal, B.K.2000. Rate of mineralization of *Azolla*, other organic materials and urea in water logged soils. Tropical Agriculture (Trinidad).77(1):119-122.

Rice cultivar development for organic farming, utilizing land race of a naturally organic rice production tract as donor parent, and adopting farmer participatory approach

Taliyil Vanaja[1*]. Mammootty, K.P. 1and Govindan, M. 1

[1] College of Agriculture, Padannakkad; Kerala Agricultural University, Kerala - 671 328, India. [*]vtaliyil@yahoo.com

Key words: Organic farming; Organic plant breeding; Sustainable Agriculture; Conventional plant breeding ; Land race

Introduction

At present, organic farmers depend upon organically produced seeds of conventionally developed varieties. The EU regulations 2092/91 on organic farming state that, in the long run organic farmers shall use organically produced seeds of organically developed varieties [1]. India being a developing country is among the countries lagging behind in organic agriculture. The area under organic farming in India is 41000 ha (0.03% to cultivated area)[2]. But India very much realized the need of organic agriculture from the damage caused to the ecology and unsustainable agricultural production through the conventional farming practices using chemical fertilizers and plant protection measures. The country has already started laying out strategies for intensive organic agriculture at central and state government levels. Rice is the staple food of India.Here we report development of a rice cultivar for organic farming, having organic varietal traits, utilizing a land race of a naturally organic rice production tract as donor parent.

Methodology

The experiment was started in 2003 at Kerala Agricultural University. The methodology adopted was organic plant breeding[1].Hybridization in all possible combination was carried out among five parents, namely 'Kuthiru', 'Orkayama'(land races from a naturally organic rice production tract), Jyothy, Jaya and Mahsuri (conventionally developed varieties using chemical fertilizers). Out of all possible cross combinations between these five rice genotypes, F_1 seeds were obtained only from six cross combinations. Growing parents followed by their hybridization, raising six thousand two hundred and ninety two F_2 progenies, and later all filial generations of selected progenies ,initial and preliminary yield trials were done under organic system. Only those progenies responding well to organic management were carried forward. Later, separate comparative yield trials under organic and conventional management practices were conducted to select out the genotype which perform best under both managements. Rice fields were cultivated as rain fed. As organic plant breeding is an emerging strategy, a farmer participatory breeding approach[3] was also integrated, in which farmers' fields being maintained as organic was selected as experiment site, farmers were invited for selection of promising progenies from filial generations along with scientists, and farmers' perspirations also were considered before deciding the final selection of promising progenies.

Results and discussions

Preliminary /Comparative/ Multi location trials revealed the higher performance of the hybrid derivative, Culture MK157 (Mahsuri x Kuthiru) for grain yield and straw yield under both organic and conventional managements(Data not given). As per the results of farm trials (Table 1) ,the average grain yield under organic management was 4.6 tones /ha which was 67 -93% more than check variety, which was conventionally developed. Under conventional management the yield was 4.2 tones/ha which was 16 -51% more than check variety .The straw yield of Culture MK 157 was 235-279% more than the check variety under organic management, and 92 -110% more under conventional management. As hypothesized in organic plant breeding[1], the quality traits of the culture is very good and out ranked the popularly consumed (based on cooking qualities) ,conventionally developed 'Jyothy' variety of Kerala. Culture MK 157 is characterized by good cooking qualities with volume expansion 68%, water uptake 270%, and kernel elongation 33% more than that of 'Jyothy'. Further, the culture has comparatively very good nutritive qualities with 121.8% more iron, 33.3% more protein, 33.6% more calcium, and 22.4% more potassium content than 'Jyothy' variety, which may be inherited from its male parent ,' Kuthiru', and may also acquired by organic development methodologies. In all organically maintained experiment fields of the culture, there was field resistance for most of the pests and diseases, and when evaluated for absolute resistance, the culture showed resistance to leaf folder and case worm, moderate resistance to gall midge, whorl maggot, sheath blight and brown spot. The culture possesses other organic traits like weed suppressive ability, long stay green index, increased rooting density leading to adaptation to organic soil fertility management (low input). As the major parts of the entire experiment was conducted in farmer's field adopting Participatory Plant Breeding[3], the emerging strategy in the area of plant breeding to integrate end user based participatory approach, which involves close farmer –researcher collaboration to bring about plant genetic improvement within a crop, the farmers are very much convinced about the yield potential, and suitability of newly developed rice culture to organic cultural practices. Besides its yield potential, considering its good cooking quality and taste, there is an immense requirement from farmers for the seeds. Further, farmer participation ensured revival of rice cultivation without much extension efforts. Before its commercial release, from 2008 onwards farmers started large scale cultivation of this culture under the supervision of breeder, and now the culture is in the pipe end of variety release in Kerala state of India.

References

1. Lammertz van Bueren, E.T. 2003. Challenging new concepts and strategies for organic plant breeding and propagation. *Eucarpia Leafy Vegetables* (eds. Th.J.L. van Hintum, A. Lebeda, D. Pink,J.W. Schut).
2. Narayanan, S. 2005.Organic farming in India Relevance, Problems and constraints. Occcasional paper-38.Department of economic analysis and research, National bank for Agriculture and Rural Development.pp:34.
3. Morris, M.L. and Bellon, M.R. 2004. Participatory plant breeding research: Opportunities and challenges for the international crop improvement system. *Euphytica* 136: 21-35.

Table 1. Pooled Grain yield of culture MK 157 with straw yield on parenthesis in Farm trials under organic and conventional managements

Culture/ variety*	Pooled yield under organic management [1] (t ha^{-1})	Pooled yield under conventional management [2] (t ha^{-1})
Culture MK 157	4.60 (7.76)	4.24 (10.46)
variety-Jyothy (Check)	2.1 (1.92)	3.10 (2.91)

* Culture is organically developed, Variety is conventionally developed

[1] Pooled over seven seasons & at eight locations – *rabi* 2007 to *rabi* 2010

[2] Pooled over four seasons & at five locations – *rabi* 2008 to *kharif* 2010

Nonchemical methods for rice crop insect pest management in Africa

Silvie, Pierre [1], Adda, Cyrille [2], Togola, Abou [2], Nwilene, Francis [3], Menozzi, Philippe [4]

[1]CIRAD UPR Systèmes de culture annuels, F-34398 Montpellier Cedex 5, France, pierre.silvie@cirad.fr
[2]Africa Rice Center (AfricaRice), 01 B.P. 2031, Cotonou, Benin, West Africa
[3] Africa Rice Center (AfricaRice), Oyo Road, PMB 5320, Ibadan, Nigeria
[4] CIRAD, UPR SCA, F-34398 Montpellier Cedex 05, France ; Africa Rice Center, 01 BP 2031, Cotonou, Benin

Keywords
Pest management, organic rice, Africa

Introduction
Various rice growing methods are implemented in sub-Saharan Africa. The type of method depends mainly on the irrigation possibilities: rainfed upland and lowland rice, irrigated rice. In the field, amongst the different factors that hamper crop growth and production, insects are often ranked after other constraints associated with water management, low soil fertility, weed infestation (at emergence), nematodes, diseases and birds (at harvest) (AfricaRice, 2011). During storage, Curculionidae species such as *Sitophilus oryzae* are known to be problematic, but an increase in seed production could also give rise to serious problems associated with lepidopterans such as *Sitotroga cerealella* (Togola et al., 2010). In Africa, the identity and diversity of rice pests and their natural enemies in Africa are well known at the field level (Brenière, 1982).
We conducted a survey to determine what nonchemical methods are currently available for managing rice insect pests in sub-Saharan African rice-producing countries (excluding Madagascar).

What has been published about organic rice in Africa?

A search in databases, including the Web of Science (online since 1975) and SCOPUS (since 1960), and the OvidSP platform (queries of AGRICOLA/1970, AGRIS/1991, CAB/1973, ECONLIT/1960 and PASCAL/1984), was carried out to highlight bibliographical references concerning organic rice. This search, using the expression 'ORGANIC RICE', was done on 27 March 2012. A boolean query with the added words 'AFRICA' or 'MADAGASCAR' was also conducted. Two hundred and three references were found when duplicate references were eliminated. Thirty of these concerned insects, mainly in Asia. No literature references on organic rice in Africa were found. The information gathered and presented in this short summary is thus derived from articles published by research experts on IPM in rice cropping conditions in Africa. Only insects causing crop damage in the field were taken into consideration, not those that infest stored rice.

Results on nonchemical pest management methods

Nonchemical management methods that were studied:

- The use of partially resistant varieties. There are indeed between-variety differences in the susceptibility to some pests such as termites (Agunbiade et al., 2009), the Cecidomyidae fly *Orseolia oryzivora,* which is often considered to be a serious pest (Williams et al., 2002; Nwilene et al., 2002) and stemborers (Nwilene et al., 2011). Tolerant varieties do not hamper insect development. Little is known about tolerance and resistance mechanisms except the work by Nwilene et al. (2009). The overcompensation capacities of some varieties, i.e. greater tillering, are involved.
- Strip-cropping rice with maize. Planting rows of rice between four rows of maize (all rows of equal width) leads to a reduction in attacks of stemborers such as *Maliarpha separatella* and

Sesamia calamistis on the rice crops (Nwilene et al., 2011). Diversion of *Sesamia* stemborers towards the maize crop is the suggested mechanism.

- The application of plant extracts such as neem (*Azadirachta indica*) oil has been studied and recommended for controlling termites (Nwilene et al., 2008a).
- Regular weeding and the use of the entomopathogenic fungus *Metarhizium anisopliae* result in lower termite population and damage in rice field (Togola et al., 2012).
- The management of habitats in the immediate vicinity of plots could be carried out by two different approaches: (i) preserving the diversity of natural enemies, predators or parasitoids: planting *Paspalum scrobiculatum* (Poaceae) along the edges of rice crop fields enables the development of *Orseolia bonzii* (Cecidomyidae), which does not harm rice crops. This species is a substitute host of *O. orseolia* parasitoids such as *Platygaster diplosisae* and *Aprostocetus procerae* (Nwilene et al., 2008b); and (ii) eliminating host plants or rice ratoons that facilitate the development or survival of some pests like Diopsides flies (Togola et al., 2011) or gall midges (Williams et al., 2002).

Habitat management on a broader landscape scale has not been studied in Africa. This is of considerable research interest, in line with the studies carried out in Japan by Takada et al. (2012) on the bug *Stenotus rubrovitattus* (Miridae), pests of seeds.

Hence, if certain rules are actually fulfilled, e.g. with respect to organic fertilization or crop rotations, several techniques are potentially available for organic rice production in Africa.

References

[1] Africa Rice Center (AfricaRice), 2011. Boosting Africa's rice sector: A research for development strategy 2011-2020. Cotonou, Benin.

[2] Agunbiade, TA, et al., 2009. Resistance status of Upland NERICA rice varieties to termite damage in Northcentral Nigeria. *Journal of Applied Science* 9, 3864-3869.

[3] Brenière, J, 1982. Estimation des pertes dues aux ravageurs du riz en Afrique de l'Ouest. *Entomophaga* 27 (H.S.), 71-80.

[4] Nwilene, F, et al., 2002. Reactions of differential rice genotypes to African rice gall midge in West Africa. *International Journal of Pest Management* 48, 195-201.

[5] Nwilene, F, et al., 2008a. Efficacy of traditional practices and botanicals for the control of termites on rice at Ikenne, southwestern Nigeria. *International Journal of Tropical Insect Science* 28, 37-44.

[6] Nwilene, F, et al., 2008b. Parasitoid biodiversity conservation for sustainable management of the African rice gall midge, *Orseolia oryzivora* (Diptera: Cecidomyidae) in lowland rice. *Biocontrol Science and technology* 18, 1075-1081.

[7] Nwilene, F, et al., 2009. Antixenosis component of rice resistance to African rice gall midge, *Orseolia oryzivora*. *International Rice Research Notes* 34, 1-5.

[8] Nwilene, F, et al., 2011. Effect of intercropping maize and cassava with Upland NERICA rice varieties on stemborer attacks in Southwestern Nigeria. *Journal of entomology* 8, 417-48.

[9] Takada, MB, et al., 2012. Multiple spatial scale factors affecting mired bug abundance and damage level in organic rice paddies. *Biological Control* 60, 169-174.

[10] Togola, A, et al., 2010. Présence, populations et dégâts de l'alucite des céréales *Sitotroga cerealella* (Olivier) (Lepidoptera, Gelechiidae) sur les stocks de riz au Bénin. Cahiers Agricultures 19: 205-209. doi: 10.1684/agr.2010.0398.

[11] Togola, A, et al., 2011. Sédentarisation des populations des mouches Diopsides dans les agro-systèmes rizicoles au Bénin. *Tropicultura* 29, 101-106.

[12] Togola, A, et al., 2012. Effect of upland rice varieties and cultural practices on termite populations and damage in the field. *Journal of Applied Sciences* (in press). doi: 10.3923/jas.2012.

[13] Williams CT, et al., 2002. African rice gall midge research guide. Bouaké, Côte d'Ivoire: West Africa Rice development Association, and Wallingford, UK: CAB International, 28 p.

Appendix Table 1 The main rice pests and nonchemical management methods

Physiological stages (from Brenière, 1982)	Families and species	Nonchemical pest control methods and efficacy[a]	References
Herbaceous state (nursery or 1st month)	Coccinellidae (*Chnootriba similis assimilis*, *Epilachna reticulata*) Pyralidae (*Nymphula depunctalis*)		
Root pests	Termites	Varietal tolerance (+) Neem seed oil (++) Regular weeding (++) *Metarhizium anisopliae* (++)	[2] [5] [12] [12]
	Scarabaeidae (*Heteronychus* spp.) Nematodes		
Tillering			
Foliage	Arctiidae (*Diacrisia scortilla*) Hesperiidae (*Parnara* sp., *Borbo* sp.) Noctuidae (*Spodoptera* spp.) Pyralidae *Marasmia trapezalis*		
	Hispidae (*Hispa unsambarica*, *Lema* spp., *Trichispa sericea*)	Varietal tolerance (+)	
Sheaths and stems	Cecidomyidae (*Orseolia oryzivora*)	Varietal tolerance (++) Parasitoid conservation (++)	[4,7] [6]
	Diopsidae (*Diopsis apicalis, D. thoracica*)	Ratoon elimination (++)	[11]
	Crambidae (*Chilo zacconius*)	Strip-cropping (maize) (++)	[8]
	Pyralidae (*Eldana saccharina*, *Maliarpha separatella)*		
Heading	Crambidae (*Chilo zacconius*)	Varietal tolerance (+)	[4]
Stemborers	Noctuidae (*Sesamia calamistis, S. nonagrioides botanephaga*, *S. nonagrioides penniseti*, *S. poephaga*, Pyralidae (*M. separatella*, *Scirpophaga* spp.)	Strip-cropping (maize)(++)	[8]
Ripening			
Stemborers	Noctuidae (*Sesamia* spp.)		
	Pyralidae (*Maliarpha separatella*, *Scirpophaga* spp.)	Varietal tolerance (+)	[4]
	Pentatomidae, Lygaeidae		
Sucking insects	Delphacidae, Jassidae	Varietal tolerance (+++)	

[a] +, ++, +++: low to high efficacy

Assessment of risks related to the treatment of seeds against soil-borne insects on rain-fed rice in Madagascar and biological alternatives to synthetic molecules

Ratnadass, Alain[12], Randriamanantsoa, Richard[1], Douzet, Jean-Marie[1], Rakotoalibera, Haingo[1], Andriamasinoro Victor[1], Rafamatanantsoa Emile[1] & Michellon, Roger[1]

[1]URP SCRiD, Université d'Antananarivo-FOFIFA-CIRAD, BP 230, Antsirabe 110, Madagascar

[2]Current address: Cirad, UR HortSys, 34398 Montpellier, France (ratnadass@cirad.fr)

Keywords

Rain-fed rice, white worm, seed treatment, direct sowing, cover crop

Introduction

The Scarabaeidae beetles are a major constraint of rain-fed rice in Madagascar because of the attacks to the crown (tissue shredding) by the adults of certain species (black beetles, in particular, H*eteronychus spp:* Dynastinae) or attacks to the roots by the larvae ("white worms", essentially Melolonthinae and Dynastinae)[1 ; 2 ; 3].

Such attacks result in losses by the order of 40% at Lake Alaotra [4], 50% on the average and up to 90% in the Vakinankaratra highlands. [2 ; 5]. Direct sowing systems on cover crops (DMC) which have demonstrated for some twenty years their capacity to reduce soil damage and improve the productivity of rain-fed rice fields in Madagascar can result, depending on the situation, in further deterioration or in a reduction of the attacks compared to plow-based conventional systems [6 ; 2 ; 3 ; 7]. The treatment of seeds with systemic neo-nicotinoïd insecticides is an efficient solution for the short term [4 ; 5], but there is the question of its sustainability, namely in terms of impacts on the environment and on human health. From 2004 to 2007, in the Vakinankaratra, we tried to quantify the risks related to the use of imidaclopride (Gaucho®), the reference product for the treatment of rain-fed rice seeds, and to identify alternatives, also as synthetic molecules, to prevent the emergence of resistance from the pests, while ensuring a high level of efficiency, as well as in the form of organic products, with a lesser long-term environmental impact, even though they might be less efficient in the short term.

Method

In 2005, we collected in Andranomanelatra (Vakinankaratra highlands, 1500m altitude) samples of soils and rice grains in plowed plots and in DMC plots, in the framework of a system that has been already been described [2] whose seeds (re.: FOFIFA 161) had been treated with Gaucho® T45WS (35% imidaclopride - 10% thirame) at 5 g/kg. Besides, aliquotes from the runoff waters were sampled during the first phase of the 2006-07 rainy season, on the 3 plots (repetitions) fitted with runoff and erosion control batches of 12m x 1.8m of the system installed below the matrix of the URP SCRid in Andranomanelatra [7], for each of the 2 soil management methods (3 years of plowing and 3 years of DMC). These plots were cultivated in corn-bean association (following the rain-fed rice in 2005-06) with corn seeds treated with Gaucho® T45WS at 5 g/kg. Composite samples were put together from aliquots corresponding to each rain. Residues of imidaclopride were analyzed on these samples of soil, grains and waters by Lara Europe Analyses, Toulouse.

In 2004-05, a test was conducted in Ivory (Middle West of the Vakinankaratra, 900m of altitude) with a 3-level split-plot using 2 soil management methods (plowing and direct sowing), 2 rice varieties (FOFIFA 154 & FOFIFA 161) and 4 "biological" treatments, on top of the Gaucho® T45WS at 5 g/kg and the untreated control plot. 3 of these treatments used products supplied by Elvisem-Europe, Chiavari, Italy: elicitors (seed treatment with SS3 at 5 g/kg, then weekly treatments with an Eco+® at 1%), liquid humus® (concentration 2%; dose 3 l/ha 5 times in the course of the cycle); Umisan TY20® neem extract (insect killer, commercial fungistatic at 0.3% 3 times in the course of the cycle).

The last treatment implied crushed seeds of *Melia azedarach* at 189/ha in the pocket at sowing, then the same quantity at tillering and at flowering, by spraying a filtrate obtained through overnight maceration of 200g/l of water.

In 2005-06, an assessment was made in Ibity (Vakinankaratra highlands, 1500 m altitude), on FOFIFA 161 in direct sowing on fallow enriched with Brachiara and Cassia and killed with herbicide, and at Ivory, in plowing and direct sowing on residues of corn and Mucuna, of two neonicotinoids used as potential alternatives to Gaucho® T45WS at the same time as this product: Poncho® 600FS (600 g/l de clothianidine), and Cruiser® 350FS (350 g/l of thiametoxam). Calthir® (800 g/kg of thirame) was tested both alone as control fungicide and in association with clothianide. A cocktail of organic Elvisem products was also tested which combined all the treatments (with SS3®, Eco+®, liquid Humus® & TY 20®) applied separately in 2004-2005. On the 96 central pockets (useful plots), an attack on the rice by white worms/black beetles was noted at tillering, on a scale of 1 to 5 [4], and, at harvest, the yield of the paddy rice was measured.

Results and discussion

The results of analyses of the Adranomanelatra grains showed no residue of imidaclopride detectable at the 0.05 mg/kg threshold on any of the samples. The soil imidaclopride content was 0.12 mg/kg on average in direct sowing, compared to 0.03 mg/kg in plowed soils, however, the difference was not significant. The quantities of runoff imidaclopride on the plots in direct sowing were very low (0.17µg/m²), compared to those from the plowed plots (4.61 µg/m²): an insignificant difference, but with a P=0.055 trend (Student *t* test). In 2004-05, in Ivory, the attacks were reduced by the treatments with Gaucho® and TY20® (score <1.7) compared to all the other treatments and to the untreated control plot (score>2.0), however, the differences were not significant (Friedman non parametric test). The same trends could be found in yields, with a significant difference (F test and Newman-Keuls method) between the TY20® (1.3t/ha) treatment and the control, and the liquid humus treatment and *M. azedarach* (0.9 à 1.0t/ha) treatment. In 2005-06 in Ivory, the attack was very low and the differences were not significant for any of the parameters, even though the attack was weaker on the 3 neonicotinoid treatments (score <1.1) compared to the non-treated control and the Calthir® control and to the organic treatment (score >1.3). In 2005-06 in Ibity, the Friedman test was significant in terms of the attack scores (score ≤1.3 for the 3 neonicotinoid treatments and score ≥1.6 for the 3 other treatments. Differences were not significant in terms of yields.

These results, like the ones obtained at Lake Alaotra [4], highlight a promising effect of some organic products (namely neem extract), even though it is not as consistent as neonicotinoids nor with the same level of efficiency. Other results obtained elsewhere suggest that some DMC systems make it possible to do without seed treatment after a few cycles, particularly systems whose rotation/catch crops with rice do not host *Heteronychus* spp., the presence of a grass seeming to attract attacks [7]. Several processes can explain the reduction of attacks by soil-borne insects or their impact on rain-fed rice in DMC [2 ; 8]. Based on our results on imidaclopride content, this could very well result from an after-effect (remanence) of DMC treatments as well as from increased action of the pest antagonists in this soil management method. This is suggested by other results which do not highlight a negative impact of seed treatment on the biodiversity of macro fauna [2]. Thus, the environment modification induced by DMC, without necessarily entailing a soil detoxification, would limit the flight of toxic molecules into the environment compared to plow-based systems.

However, there remain on the one hand the problem of imidaclopride resistance of pests, considering the fact that the alternatives identified so far are close in chemical terms, and on the other hand, the problem of the suspected effect on bees, even in the absence of risks for man through the consumption of grains from treated seeds or the risk of water contamination. Moreover, even if the technique of soil inoculation by the entomopathogenic fungus *Metarhizium anisopliae* gave disappointing results on *Heteronychus* spp in DMC with exogenous straw [6], it could be applied to the most promising DMCs [7], and associated to an organic treatment of seeds with neem based products. The addition of partial effects expected from such combinations could help envision a sustainable production of rain-fed rice with an organic farming approach.

Bibliographic references

[1] Randriamanantsoa, R., et al. 2010. Les larves des Scarabaeoidea (Insecta, Coleoptera) en riziculture pluviale des régions de haute et moyenne altitudes du Centre de Madagascar. Zoosystema 32: 19-72.

[2] Ratnadass, A. et al. 2012a. Influence du système de culture avec couverture végétale et de la matière organique du sol sur le statut et les dégâts des vers blancs (Coleoptera : Scarabeoidea) associés au riz pluvial sur les Hautes-Terres de Madagascar. Cahiers Agricultures (submitted).

[3] Ratnadass, A. et al. 2006. Effects of soil and plant management on crop pests and diseases. in : Uphoff N, Ball A, Fernandes E, Herren H, Husson O, Laing M, Palm C, Pretty J, Sanchez P, Sanginga N, Thies J, eds. Biological Approaches for Sustainable Soil Systems. Boca Raton (USA): CRC Press, p. 589-602.

[4] Ratnadass, A. et al. 2012b. Protection of upland rice at Lake Alaotra (Madagascar) from black beetle damage (*Heteronychus plebejus*) (Coleoptera: Dynastidae) by seed-dressing. African Entomology 20: 177-180.

[5] Randriamanantsoa, R., Ratnadass, A. 2005. Protection insecticide du riz pluvial par traitement des semences à Madagascar. In AFPP: Proceedings of the 7th International Conference on Agricultural Pests (Cd-rom), 2005/10/26-27, Montpellier, France. 6 p.

[6] Razafindrakoto Raeliarisoa, C. et al. Lutte biologique intégrée contre des insectes terricoles, *Heteronychus* spp à Madagascar, par un champignon entomopathogène sur riz pluvial en semis direct sous couverture végétale. Etude et Gestion des Sols 17:159-168.

[7] Ratnadass, A. et al. 2008. Dispositifs pour l'évaluation des impacts des systèmes de culture sur les dégâts des insectes terricoles sur le riz pluvial à Madagascar. Terre malgache 26: 153–155.

[8] Ratnadass, A. et al. 2012a. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review. Agronomy for Sustainable Development 32: 273-303.

Nonchemical methods for rice crop insect pest management in Africa

Silvie, Pierre [1], Adda, Cyrille [2], Togola, Abou [2], Nwilene, Francis [3], Menozzi, Philippe [4]

[1]CIRAD UPR Systèmes de culture annuels, F-34398 Montpellier Cedex 5, France, pierre.silvie@cirad.fr
[2]Africa Rice Center (AfricaRice), 01 B.P. 2031, Cotonou, Benin, West Africa
[3] Africa Rice Center (AfricaRice), Oyo Road, PMB 5320, Ibadan, Nigeria
[4] CIRAD, UPR SCA, F-34398 Montpellier Cedex 05, France ; Africa Rice Center, 01 BP 2031, Cotonou, Benin

Keywords
Pest management, organic rice, Africa

Introduction
Various rice growing methods are implemented in sub-Saharan Africa. The type of method depends mainly on the irrigation possibilities: rainfed upland and lowland rice, irrigated rice. In the field, amongst the different factors that hamper crop growth and production, insects are often ranked after other constraints associated with water management, low soil fertility, weed infestation (at emergence), nematodes, diseases and birds (at harvest) (AfricaRice, 2011). During storage, Curculionidae species such as *Sitophilus oryzae* are known to be problematic, but an increase in seed production could also give rise to serious problems associated with lepidopterans such as *Sitotroga cerealella* (Togola et al., 2010). In Africa, the identity and diversity of rice pests and their natural enemies in Africa are well known at the field level (Brenière, 1982).
We conducted a survey to determine what nonchemical methods are currently available for managing rice insect pests in sub-Saharan African rice-producing countries (excluding Madagascar).

What has been published about organic rice in Africa?
A search in databases, including the Web of Science (online since 1975) and SCOPUS (since 1960), and the OvidSP platform (queries of AGRICOLA/1970, AGRIS/1991, CAB/1973, ECONLIT/1960 and PASCAL/1984), was carried out to highlight bibliographical references concerning organic rice. This search, using the expression 'ORGANIC RICE', was done on 27 March 2012. A boolean query with the added words 'AFRICA' or 'MADAGASCAR' was also conducted. Two hundred and three references were found when duplicate references were eliminated. Thirty of these concerned insects, mainly in Asia. No literature references on organic rice in Africa were found. The information gathered and presented in this short summary is thus derived from articles published by research experts on IPM in rice cropping conditions in Africa. Only insects causing crop damage in the field were taken into consideration, not those that infest stored rice.

Results on nonchemical pest management methods

Nonchemical management methods that were studied:

- The use of partially resistant varieties. There are indeed between-variety differences in the susceptibility to some pests such as termites (Agunbiade et al., 2009), the Cecidomyidae fly *Orseolia oryzivora*, which is often considered to be a serious pest (Williams et al., 2002; Nwilene et al., 2002) and stemborers (Nwilene et al., 2011). Tolerant varieties do not hamper insect development. Little is known about tolerance and resistance mechanisms except the work by Nwilene et al. (2009). The overcompensation capacities of some varieties, i.e. greater tillering, are involved.
- Strip-cropping rice with maize. Planting rows of rice between four rows of maize (all rows of equal width) leads to a reduction in attacks of stemborers such as *Maliarpha separatella* and *Sesamia calamistis* on the rice crops (Nwilene et al., 2011). Diversion of *Sesamia* stemborers towards the maize crop is the suggested mechanism.
- The application of plant extracts such as neem (*Azadirachta indica*) oil has been studied and recommended for controlling termites (Nwilene et al., 2008a).
- Regular weeding and the use of the entomopathogenic fungus *Metarhizium anisopliae* result in lower termite population and damage in rice field (Togola et al., 2012).

- The management of habitats in the immediate vicinity of plots could be carried out by two different approaches: (i) preserving the diversity of natural enemies, predators or parasitoids: planting *Paspalum scrobiculatum* (Poaceae) along the edges of rice crop fields enables the development of *Orseolia bonzii* (Cecidomyidae), which does not harm rice crops. This species is a substitute host of *O. orseolia* parasitoids such as *Platygaster diplosisae* and *Aprostocetus procerae* (Nwilene et al., 2008b); and (ii) eliminating host plants or rice ratoons that facilitate the development or survival of some pests like Diopsides flies (Togola et al., 2011) or gall midges (Williams et al., 2002).

Habitat management on a broader landscape scale has not been studied in Africa. This is of considerable research interest, in line with the studies carried out in Japan by Takada et al. (2012) on the bug *Stenotus rubrovitattus* (Miridae), pests of seeds.

Hence, if certain rules are actually fulfilled, e.g. with respect to organic fertilization or crop rotations, several techniques are potentially available for organic rice production in Africa.

References

[1] Africa Rice Center (AfricaRice), 2011. Boosting Africa's rice sector: A research for development strategy 2011-2020. Cotonou, Benin.

[2] Agunbiade, TA, et al., 2009. Resistance status of Upland NERICA rice varieties to termite damage in Northcentral Nigeria. *Journal of Applied Science* 9, 3864-3869.

[3] Brenière, J, 1982. Estimation des pertes dues aux ravageurs du riz en Afrique de l'Ouest. *Entomophaga* 27 (H.S.), 71-80.

[4] Nwilene, F, et al., 2002. Reactions of differential rice genotypes to African rice gall midge in West Africa. *International Journal of Pest Management* 48, 195-201.

[5] Nwilene, F, et al., 2008a. Efficacy of traditional practices and botanicals for the control of termites on rice at Ikenne, southwestern Nigeria. *International Journal of Tropical Insect Science* 28, 37-44.

[6] Nwilene, F, et al., 2008b. Parasitoid biodiversity conservation for sustainable management of the African rice gall midge, *Orseolia oryzivora* (Diptera: Cecidomyidae) in lowland rice. *Biocontrol Science and technology* 18, 1075-1081.

[7] Nwilene, F, et al., 2009. Antixenosis component of rice resistance to African rice gall midge, *Orseolia oryzivora*. *International Rice Research Notes* 34, 1-5.

[8] Nwilene, F, et al., 2011. Effect of intercropping maize and cassava with Upland NERICA rice varieties on stemborer attacks in Southwestern Nigeria. *Journal of entomology* 8, 417-48.

[9] Takada, MB, et al., 2012. Multiple spatial scale factors affecting mired bug abundance and damage level in organic rice paddies. *Biological Control* 60, 169-174.

[10] Togola, A, et al., 2010. Présence, populations et dégâts de l'alucite des céréales *Sitotroga cerealella* (Olivier) (Lepidoptera, Gelechiidae) sur les stocks de riz au Bénin. Cahiers Agricultures 19: 205-209. doi: 10.1684/agr.2010.0398.

[11] Togola, A, et al., 2011. Sédentarisation des populations des mouches Diopsides dans les agro-systèmes rizicoles au Bénin. *Tropicultura* 29, 101-106.

[12] Togola, A, et al., 2012. Effect of upland rice varieties and cultural practices on termite populations and damage in the field. *Journal of Applied Sciences* (in press). doi: 10.3923/jas.2012.

[13] Williams CT, et al., 2002. African rice gall midge research guide. Bouaké, Côte d'Ivoire: West Africa Rice development Association, and Wallingford, UK: CAB International, 28 p.

Appendix Table 1 The main rice pests and nonchemical management methods

Physiological stages (from Brenière, 1982)	Families and species	Nonchemical pest control methods and efficacy[(a)]	References
Herbaceous state (nursery or 1st month)	Coccinellidae (*Chnootriba similis assimilis, Epilachna reticulata*) Pyralidae (*Nymphula depunctalis*)		

Root pests	Termites	Varietal tolerance (+)	[2]
		Neem seed oil (++)	[5]
		Regular weeding (++)	[12]
		Metarhizium anisopliae (++)	[12]
	Scarabaeidae (*Heteronychus* spp.)		
	Nematodes		
<u>Tillering</u>			
Foliage	Arctiidae (*Diacrisia scortilla*)		
	Hesperiidae (*Parnara* sp., *Borbo* sp.)		
	Noctuidae (*Spodoptera* spp.)		
	Pyralidae *Marasmia trapezalis*		
	Hispidae (*Hispa unsambarica*, *Lema* spp., *Trichispa sericea*)	Varietal tolerance (+)	
Sheaths and stems	Cecidomyidae (*Orseolia oryzivora*)	Varietal tolerance (++)	[4,7]
		Parasitoid conservation (++)	[6]
	Diopsidae (*Diopsis apicalis*, *D. thoracica*)	Ratoon elimination (++)	[11]
	Crambidae (*Chilo zacconius*)	Strip-cropping (maize) (++)	[8]
	Pyralidae (*Eldana saccharina*, *Maliarpha separatella)*		
<u>Heading</u>	Crambidae (*Chilo zacconius*)	Varietal tolerance (+)	[4]
Stemborers	Noctuidae (*Sesamia calamistis*, *S. nonagrioides botanephaga*, *S. nonagrioides penniseti*, *S. poephaga*, Pyralidae (*M. separatella*, *Scirpophaga* spp.)	Strip-cropping (maize)(++)	[8]
<u>Ripening</u>			
Stemborers	Noctuidae (*Sesamia* spp.)		
	Pyralidae (*Maliarpha separatella*, *Scirpophaga* spp.)	Varietal tolerance (+)	[4]
	Pentatomidae, Lygaeidae		
Sucking insects	Delphacidae, Jassidae	Varietal tolerance (+++)	

[a] +, ++, +++: low to high efficacy

Sprinkler-irrigated organic rice

SPANU Antonino[1], BARRACU Francesco[1]

[1] Dip. AGRARIA – Sez. Agronomia, Coltivazioni erbacee e Genetica - Università degli Studi di Sassari

e-mail: tspanu@uniss.it

Keywords: organic rice; sprinkler irrigation; preceding crop

Introduction

In the last ten years organic rice has occupied in Italy a very variable proportion of agricultural land. Organic rice is sold at the same prices of conventional one on Italian markets, but the average yield of 4.5 t ha^{-1} is lower compared to conventional rice yields, mainly as a consequence of the interdiction imposed by the Council Regulation 2092/91 on chemical fertilization and herbicide use on weed control. The insufficient availability of organic seeds also limits organic rice production.

A long-term experimentation carried out in Sardinia lead to develop a sprinkler-irrigated technology (Spanu et al., 1992, 1996a, 1996b, 2004) instead of traditional continuous flooded irrigation systems. Sprinkler irrigated rice has demonstrated the possibility of producing grain yields as high as those of flooded rice, and showed many advantages:

- energy saves, as precision land grading is not necessary;
- use of tyre-weel machinery, with no specific modifications;
- simpler control of weeds, with pre-emergence treatments;
- inclusion in more favorable rotations with legumes, instead of traditional monocolture, to increase natural N and organic matter availability;
- weeds can be mechanically controlled;
- rice yields comparable with flooded rice;
- save 40-50 % of water.

This paper reports the results of three years research with the aim of increasing the production of rice seed for organic farming and for human use.

Methodology

Tree trials were carried out in the experimental fields of the University of Sassari (39°59' N, 8°40' E, 15 m asl). The soil has alluvial origin, was a medium clayey textured, Typic Eutric Haplic Fluvisol. Soil chemical properties are characterized by neutral pH (pH 7.3), absence of carbonates (3.2%), low total nitrogen (0.08 %) and organic carbon and by high phosphorus (43.0 ppm) and potassium (202.0 ppm) content. Water contents at field capacity and at permanent wilting point were those typical for this type of soil.

A) In the first year *Trifolium alessandrinum* and *T. subterraneum* were compared as preceding crops for their effects on weeds and on soil nitrogen. As experimental design, a randomized block, with 3 replications were used for preceding legumes; each parcel area was 50 m2, sowing density of 400 germinable seeds m-2, and row distance of 14 cm. *T. alessandrinum* was ploughed into the soil whereas *T. subterraneum* was cut, one month and one day before rice sowing, respectively, and then N soil content was determined. Competitive ability of *Trifolium* against weeds was compared by several sampling in which fresh and dry weight of *Trifolium* and of each species of weeds were measured.

The experiment was set up as a split-split plot with four replications. Two rice cultivars ('Balilla' and 'Eurosis') were assigned to the main plot and three sowing rates (300, 450 and 600 viable seeds m^{-2} with an inter-row distance of 0.14 m) to the sub-plots. The sub-sub plots received two nitrogen rates: 0 (green manure only) and 80 kg ha^{-1} of organic N (green manure plus 30 kg ha^{-1} at sowing and 50 kg ha^{-1} at stem elongation). Weeds were mechanically controlled using a spiked chain harrow.

In the subsequent years a new set of trials was set up with green manure preceding rice sowing: B) four cultivars with T. Alessandrinum as preceding crop were compared ('Balilla', 'Eurosis', 'Creso' and ‘Selenio’); C) an additional trial was carried out with the cultivar ‘Eurosis’ to compare spontaneous fallow and green manure of *T. alessandrinum*. In this case soil and plants were sampled monthly to determine their nitrogen content.

Nitrogen supply in trials B and C was provided by plowing preceding crops about one month before rice sowing, plus three N rates: D_0 (green manure only), D_{80} and D_{160} of organic N after sowing (80 and 160 kg ha^{-1} respectively). An inter-row distance of 0.2 m was used with a sowing rate of 500 viable seeds m^{-2} to allow mechanical control of weeds, performed by a precision weeder.

Plots were sown with a cone-seeder placing the seeds at a depth of about 3 cm. Water was applied according to Spanu et al. (2008).

Irrigation was performed by sprinklers, depending of both evotraspiration (measured by Class A vessel “PAN”) and physiological stage. From sowing to complete emergence of rice were supplied 100 m^3ha^{-1}; during growth stages, irrigation water volumes were established replacing evotraspiration losses and providing a surplus according to coefficients: 0.4 (from emergence to tillering), 0.8 (tillering-stem elongation), 1.0 (stem elongation-earing), 1.2 (earing-cereous maturation), 0.9 (cereous maturation-physiological maturation). Water was applied when PAN evotraspiration exceeded 25 mm.

Presence and developmental stage of weeds was periodically monitored for a correct timing of weeding. Measurements were made to determine main phonological stages, number of plants m^{-2} at emergence and harvest, number of fertile and sterile panicles per m^{-2}, plant height and panicle length, kernel weight, percent of whole kernels and viable seeds.

Results and discussion

Meteorological parameters, characterized by no rain and high temperatures during rice crop cycle, showed no significant variations compared with means of last 50 years.

Using spiked chain harrow in mechanical weed control was effective after *T.alessandrinum*, insufficient after *T. subterraneum*. Grain yield following *T.alessandrinum* was significantly higher than that following *T.subterraneum* for both cultivars, likely as a consequence of the greater N

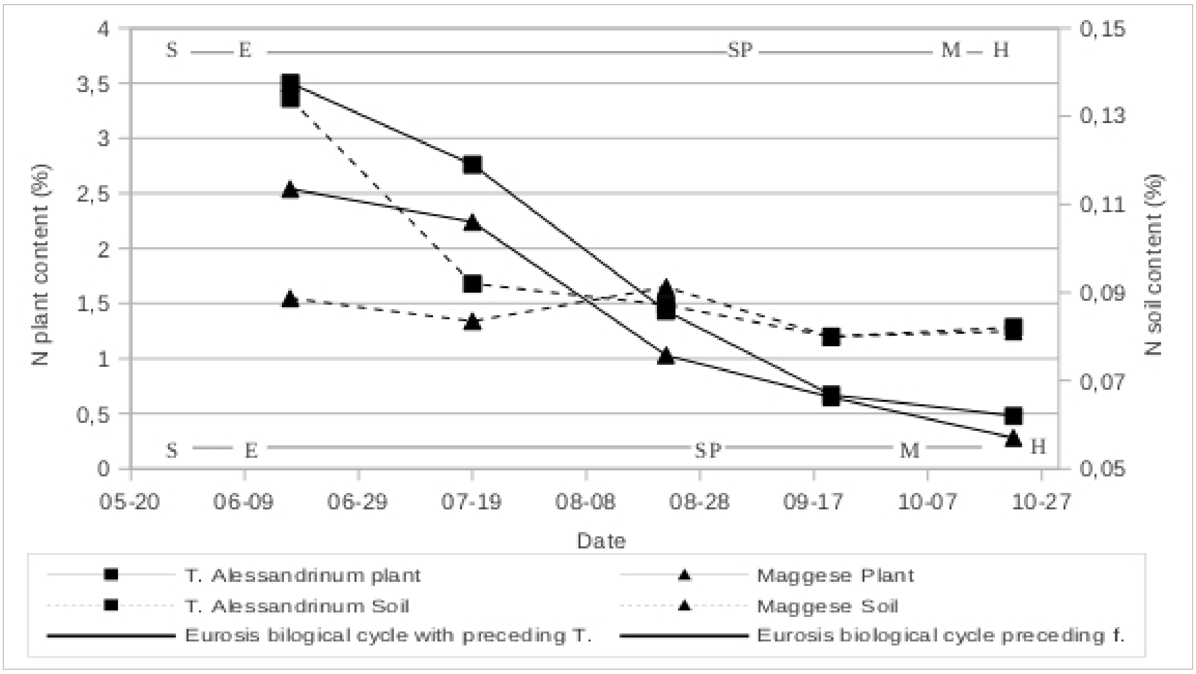


Fig. 1: Variation of rice plant and soil nitrogen content at different growth stages (S = sowing, E = seedling, SP = heading, M = maturation stage, R = Harvest) in Trifolium Alexandrinum and Fallow treatments.

availability. Grain yield after *T.alessandrinum* was higher at the N rate of 80 kg ha^{-1} in both ‘Balilla’ (8.1 vs 6.8 t ha^{-1} N_{80} and N_0, respectively) and ‘Eurosis’ (9.1 vs 8.2 t ha^{-1} N_{80} and N_0, respectively), whereas no difference was detected between sowing rates or cultivars.

Seed viability was always greater than 90%, with maximum values of 97%, positively affected by *T.*

alessandrinum as preceding crop, and higher in cultivar ‘Euro’ than in’ Balilla’ (Spanu et al., 2007).
In trials B and C, widening the inter-row distance to 0.2 m allowed an almost complete control of weeds by the ‘precision weeder’.

Both cultivar and N rate affected grain yield: 6.6 t ha^{-1} were produced by ‘Balilla’ and ‘Selenio’ and 8.4 t ha^{-1} by ‘Eurosis’ at N_0. At N_{160} all cultivars yielded more than 8 t ha^{-1}, with a maximum of 9.7 t ha^{-1} for cultivar ‘Creso’

The only treatment affecting percent of whole kernels at the analysis of variance was the cultivar, with values of 65% for cultivar ‘Eurosis’, 68% for ‘Creso’ and greater than 70% for ‘Selenio’ and ‘Balilla’.
Trial C showed *T. alessandrinum* as a preceding crop resulted in greater yields (8.4 t ha^{-1} at N_0 and 9.5 t ha^{-1} at N_{160}) compared to fallow (7.4 t ha^{-1} at N_0 and 8.1 t ha^{-1} at N_{160}) when cultivar Euro was utilized (Spanu *et al.*, 2008). Mean percent of whole kernels was 65%, and seed viability was around 90% (Spanu *et al.*, 2008).
Fig. 1 shows total N content in soil and in rice plants measured during biological cycle in both fallow and Trifolium preceding crops.
Soil N content derive advantage mosly by green manuring with *T. alessandrinum* (Fig. 1), although an addition of organic N fertilizer was needed to reach the highest yields. Probably, using multiannual legouminous plants like *Medicago Sativa* (L) it could be possible to allow a satisfactory N soil content as well as a more effective weed control, because of several mowing.
Organic rice can take great advantage from sprinkler irrigation as it allows the use of a preceding crop like *T. alessandrinum* which can have positive effects on both weed control and N availability. Furthermore, sprinkler irrigation reduces environmental impact by reducing both water use - to about 8000 m^3 ha^{-1}- and energy use, due to the possibility of using tyre-wheel machinery and no need for precision land grading. Another advantage of sprinkler irrigation is the negligible arsenic and cadmium content of kernels compared to flooded rice, evidenced in a trial comparing 37 rice cultivars (Spanu et al., in press). A higher incidence of cancers and others diseases due to arsenic in rice is common in countries, like Bangladesh, where this cereal represents the basis of the diet (Spanu *et al.*, 2012a; 2012b).

References

Spanu A., Pruneddu G., Cabras P., Melis M., Spanedda L. - 1992 - Persistence and mobility in clay soil of different herbicides in sprinkler-irrigated rice (Oryza sativa L.). Agricoltura Mediterranea , Vol.122, 287-292.

Spanu A., Pruneddu G., D'Andria R., Lavini L., Quagliettà Chiarandà F. – 1996a - Yield response of rice (Oryza sativa L.) to increasing sprinkler-irrigation volumes. ICID Journal, Vol. 45, N° 2, 55-66.

Spanu A., Pruneddu G. - 1996b - The influence of irrigation volumes on sprinkler-irrigated rice (Oryza sativa L.) production. Agricoltura Mediterranea, Vol 126, n°4, 377-382.

Spanu A., Pruneddu G. - 1997 - Effect of increasing nitrogen rates on the yield of sprinkler-irrigated rice (*Oryza sativa L.*). Agricoltura Mediterranea; Vol.127, n°4, 379-387.

Spanu A., Murtas A., Ledda L., Ballone F. - 2004 – Innovative agronomic techniques for rice cultivation. Proceeding of the Conference “Challenger and Opportunities for Sustainable Rice-Based Production Systems” - Torino – Italy – 13-15 September.

Spanu A., Murtas A. - 2007 - Produzione di semente certificata di riso destinata all’agricoltura biologica – Dal Seme, n.4.

Spanu A., Murtas A. - 2008 -Tecniche agronomiche innovative per la produzione di semente certificata di riso (Oryza sativa L.) in regime biologico. In: Azioni di innovazione e ricerca a supporto del piano sementiero. Pag. 245 – 258.

Spanu A., Murtas A., Ballone F. - 2009- Water Use and Crop Coefficients in Sprinkler Irrigated Rice.- Italian Journal of Agronomy, 2:47-58

Spanu A., Daga L., Orlandoni A.M., Sanna G. - 2012a – The role of irrigation techniques in Arsenic bioaccumulation in rice (*Oryza sativa* L.) - In corso di stampa.

Spanu A., Sanna G. - 2012b – The role of irrigation techniques in Cadmium bioaccumulation in rice (*Oryza sativa* L.). - Atti di “International Cadmium Simposium” P.5 - Sassari – 8-9 giugno.

Approaches and methods to produce technical references and to support organic rice producers in Camargue

Mouret, Jean-Claude, Hammond, Roy , Lopez Ridaura, S, Delmotte, Sylvestre

Inra Umr Innovation -Montpellier France
Email : mouret@supagro.inra.fr

Introduction

For several years now, rice growing is Camargue has been affected by relative instability due to a stagnation of yields, price fluctuation, an increase of production costs and to regulations limiting the use of cropping practices which impact the environment. In this context, organic rice production has progressively emerged as a possible alternative for a certain number of rice producers. Three major stages can be seen in the evolution dynamics of the development of this type of production. The first stage took place at the end of the 1970s. It happened at the same time as the launch of the recovery plan for French rice production, advocated by the representatives of rice production with the support of the Parc Naturel Régional de Camargue (Camargue regional natural park). The handful of rice growers who developed organic rice back then were the pionneers of this production method. Marginalized for about two decades, they are now recognized and stand as models of reference for part of the Camargue farming sector. In the mid-nineties, the economic downturn and the drop in the prices of conventional rice resulting from the 1994 GATT agreements account for the significant development of surfaces converted to organic farming (OF). This second stage translated into a significant increase in the number of rice producers who partially or fully converted their farm operations. Based on our observations, the third stage is currently in the making and translates into a new development of organic rice farming at the level of the Camargue territory. It relies on the one hand on the incentives and/or regulatory measures proposed by the Grenelle meetings on environment and on the other hand on directives being drafted on the new European agricultural policy. It was during the second stage that the INRA, in collaboration with the Centre Français du Riz (French Center for Rice) and the support of FranceAgriMer, initiated research actions focused on the operation of organic rice production systems. These research actions aim at giving concrete answers to questions raised by the farmers to help them achieve their targets while meeting production specifications and responding to the community’s requirements.

Approaches, methods and research programs

The INRA does not have an experimental station dedicated to rice growing. Questions regarding the functioning of organic rice production systems were considered in the framework of a partnership-based research action approach. The research projects are conducted in situ on farms managed by farmers who are de facto partners of actions performed by the research team. This team also relies on professional organizations such as the French Center for Rice and it sets up ad hoc associations with other public (Inra, Cirad, Cemagref) and/or private (Station Biologique de la Tour du Valat / Tour du Valat organic station) research units. Training is also incorporated in each of the phases of the research action whose results subsequently feed the modules of the teaching curriculum. In retrospect, it is possible to define six phases making up the overall research approach implemented over the 2002/2012 decade:

- Phase1- Even if the research team was already deeply involved in the analysis of the functioning of conventional rice production systems, some learning proved necessary to efficiently identify issues implied by the operation of organic rice production systems. This training was made possible by an agronomic pre-survey based on monitoring of the plots managed by those rice producers who had pioneered the conversion to OF.

- Phase 2- Surveys in organic rice farms, supported by a regional agronomic diagnosis and an analysis of the diversity of agricultural practices made it possible to draw a typology of farms and formalize questions raised by organic rice farmers as well as identify the obstacles, constraints and assets of this production method. This work was carried out in the framework of an interdisciplinary research action formalized in the “Cebioca” project (organic grain farming in Camargue. 2002-2005) [1]
- Phase 3 - Questions on weed control and the management of organic fertilization were researched based on factor-based experiments conducted with the rice producers on their plots.
- Phase 4 - From 2006 to 2008, the "ORPESA" project (Organic Rice Production in Environmentally Sensitive Areas) [2] aimed at setting up pilot groups in each of the rice growing areas of the European countries involved as partners of the project
- Each pilot group was then mobilized in the participative drafting of the specialized modules, learning and vocational training materials.
- Phase 5 - The question of economic opportunity and conservation of soil fertility permitted by a second subsequent cycle of rice cultivation was studied based on the prototyping of the technical method. [3]
- Phase 6 - Last, in relation to the context evolution as described in the 3rd phase of development of Camargue organic rice production (see introduction §), work was carried out on the co-construction and assessment of scenarii related to the development of organic rice production systems, based on models elaborated in partnership with the stakeholders of the territory for the execution of interactive simulations.[4]

In the course of this decade, the various phases of the approach relied on a program made up of a network of plots located in partly or totally organic rice farms. The program fits in the conceptualization of a network-based agro-ecology program proposed by K. Warner in 2007: "A program of voluntary work in a network over several years, between, at least, producers, a producers’ organization and one or several farming consultants and researchers to develop agro-ecological knowledge and to protect natural resources using “on-farm” demonstrations at the level of the plot.” [5]

Results and discussion

The learning phase was a determining stage for the research team. It led to the discovery of new technical systems and innovative cropping practices used by farmers who had until then not been referenced at all or very little by development and research organizations. Involvement of the team in the field during that phase fostered the climate of trust necessary to enhance loyalty to the partnership and objectify the data collected in the course of successive surveys. The program’s network structure, the base of all the research and training actions conducted during the decade, was achieved thanks to this loyalty and the climate of trust. Factorial experiments carried out on the cover crop management and organic fertilization produced references on the effects of crop rotation and of the fractioning of fertilization [6][7]. The prototyping of the technical method made it possible to test an original weed management technique through the introduction of ducks in the fields. This innovation raises many questions of research and development likely to foster new research actions. Lastly, the Cebioca and Orpesa projects as well as the 1st international conference organized in Montpellier in 2012 were great opportunities for multidisciplinary interactions and encounters between scientists and stakeholders of the sector.

In the evolution path of organic rice production in Camargue, one can now observe a stage of development of these production methods at territorial level. Some farmers have changed their minds regarding organic rice production and are partly or totally converting their farms to OF. Moreover, outlets and markets are growing and consolidating for products from OF. Co-assessment with local stakeholders of the various scenarii on the development of OF in Camargue must involve helping them in their reflection on the implementation of action plans to make these changes sustainable. The contribution of these research actions to the development of organic rice production in Camargue proves that it is possible to continue approaches for partnership-based research /action and to support farmers and other stakeholders in the transformation of their farming systems toward a more sustainable agriculture.

References.

[1]- Mouret J.-C., Dreyfus F., Desclaux D., Marnotte P., Mesleard F., Barbier J.-M. 2003. La construction d'unedémarche interdisciplinaire à partir de l'émergence de la céréaliculture biologique en Camargue; le projetCEBIOCA, *Séminaire sur les recherches en Agriculture Biologique INRA-ACTA*, Draveil, 20-21/11/2003, Sylvander B.: 31-41.

[2]- Bayot M., Mouret J.-C., Hammond R**.** 2007. The O.R.P.E.S.A. project: a professional training scheme fororganic rice growing combined to a research-action follow-up - *4th international temperate rice conference*, Novara, Italy, 25-28/06/2007, Bocchi S., Ferrero A., Porro A. (ed.): 192-193

[3]- Vereijken P., 1997. A methodology way of prototyping integrated and ecological arable farming: systems (I/EAFS) in interaction with pilot farm. Eur.JAgron, 7: 235-250

[4]- Delmotte, S., 2011. Evaluation participative de scénarios : quelles perspectives pour les systèmes agricoles camarguais ? PhD dissertation, SupAgro Montpellier, 380p

[5]- K.D; Warner; 2007 Agroecology in Action.Extending Alternative Agriculture through social networks. Massasuchetts Institute of technology

[6]- Mouret J.-C., Marnotte P., Hammond R., Lannes G., Roux S. 2001. Effets du sarclage mécanique sur lepeuplement végétal en riziculture biologique camarguaise (France) AFPP 18ème, In *Conférence duColuma. Journées Internationales sur la lutte contre les mauvaises herbes. Toulouse 5/7 Déc 2001*, Vol. 1:323-332.

[7]- Mouret J.-C., Bayot M., Hammond R**.** 2007. A contribution to ameliorate organic fertilisation practices inorganic rice growing, *4th international temperate rice conference*, Novara, Italy, 25-28/06/2007, Bocchi S.,Ferrero A., Porro A. (ed.): 110-111.

SESSION 2

RICE PRODUCTION AT THE FARM SCALE

Evaluating the benefits of integrated rice-duck farming as organic system in Bangladesh

Hossain S T[1*], Konagaya H[2], Furuno T[2] and Sugimoto H[3]

[1] Friends In Village Development Bangladesh , Bangladesh ; E-mail : tanveer107@yahoo.com
[2] Japan Rice-Duck Farming Society, Japan
[3] Faculty of Agriculture, Ehime University, Matsuyama, Faculty of Agriculture, Ehime University, Japan

Abstract

The conventional system of rice production requires agro-chemicals like fertilizers and pesticides, often in heavy doses. These chemicals are harmful to the environment, water bodies, animals, and human beings. Bangladesh is now in forth position in rice production in the globe and uses of chemical compounds increasing rapidly. The integrated rice-duck farming is observed economically profitable, environmentally friendly, and technically feasible for the rural farmers in Bangladesh. The technology raised income significantly and this income did not derive just from higher yields but also from reduced expenditure on various inputs. The system has become very popular among the poor farmers of Bangladesh as a suitable system for the organic rice production along with economic benefit.

Keywords

Bangladesh, Integration, Rice-Duck Farming, Organic.

Introduction

The present rice production system in Bangladesh totally depends on higher use of chemical fertilizers, agro-chemicals and other inputs. The increasing use of these inputs has raised the concern of consumers and growers about environment pollution. The integrated rice-duck system is practiced in some East Asian countries, particularly Japan, Korea, Vietnam, China, and Philippines. The farmers of these countries have adopted rice-duck culture as one of the means of organic farming where weeds and insects can be controlled effectively by the ducks (Pham, 1994).This technology was introduced in Bangladesh with the technical cooperation of Japan Rice-Duck Farming Society. The simultaneous raising of ducks with rice cultivation aids in the control of weeds and insects, thus helping to eliminate the application of pesticides (Manda, 1992). The integration of rice cultivation with crossbred duck farming -also known as mixed farming- enables resource-poor farmers to obtain not only rice, as the main crop, but also subsidiary products (duck meat and eggs), from the same piece of land at the same season.

Methodology

Demonstration plots were established in Bheramara upazila of Kushtia district and Iswardi Upazila under Pabna district in *Boro* (January-June) 2009-10, *Boro* 2010-11 and *T.Aman* (July-December) 2010 season.
The selected land of each farmer (n=38) was divided into two equal plots; one is for rice-duck and other for farmers' own practice. Moreover, an area of 5m x 2 m was laid out in the farmer's plot where no insect and weed control measures were done. The locally popular modern rice varieties (BRRIdhan 29 variety in Boro season and BRRIdhan 34 variety in T.Aman season) were used in the experiments. In the rice-duck plots, 30 days old rice seedlings were transplanted at 25 cm x 20 cm spacing. After 10 days of rice transplantation, 20-30 days old ducklings (cross bred of local with Khaki Campbell) were released in the rice-duck plots. The ducks were purchased from local hatchery at the cost of 35 Taka per one day old duckling (1 US$ = 82 Bangladeshi Taka). Ducklings were released at the rate of 350-400 head per hectare. During the first 3-5 days, ducks were kept in the field for 2 to 4 hours a day. Later on they were kept in rice fields all day-round. A synthetic thread net was used to encircle the rice-duck plot to ensure the presence of ducks in the plot and to keep them safe from wild animals. In the farmer's field chemical fertilizer was applied two times and insecticide once and weeded two times as usual practice. In the rice-duck plots none of agro-chemicals or chemical fertilizers was used. In rice-duck plots only cow dung (5

ton/ha) was used at the time of land preparation. Ducks were removed from the rice field at the heading time. After four months of age the ducks were either sold or kept for egg and meat purposes.

Results and discussions

It was evaluated and observed that ducks completely weeded the rice plots by eating young weeds (Table 1) and also harmful insects. The total number of insect caught by sweep net was observed 0.35-3.20 (no./5 sweeps/week) higher in sole rice over rice-duck farming.So, farmers can save substantial amount of money for other purposes. The net profit was 52-59% higher in rice-duck farming comparing with conventional rice production and the grain yields of rice in the rice-duck plots were 13-21% higher than those of sole rice plot (Table 1)supported by Hossain et.al., 2005. The rice–duck system is not only cost-effective, it is sustainable and friendly to the environment. The technology has an inherent ability to improve the nutritional status of the resource poor farmers through the supply of high protein food.

Table: 1.Comparative effects of integrated rice-duck farming and traditional sole-rice farming on the weed population and yield of rice.

Location	Cropping Season	Weed population(no/m^2) at 40 Days After Transplanting (DAT)			Yield (ton/ha)		Gross margin (Tk/ha)	
		Rice-Duck farming	Sole Rice farming	Control	Rice-Duck farming	Sole Rice farming	Rice-Duck farming	Sole Rice farming
Bheramara, Kushtia	Boro 2009-10	4	39	81	6.25	5.10	104197	54753
	T. Aman 2010	-	27	58	5.03	4.28	79178	43975
Iswardi, Pabna	T. Aman 2010	2	36	64	4.75	4.10	81737	48819
	Boro 2010-11	4	46	75	5.66	4.42	107399	61556

1 US$ = 82 Bangladeshi Taka (Tk.)

Conclusions

Organic farming is potentially a profitable enterprise, with a growing global market, already being adopted by 90 developing countries, but not including Bangladesh (Sarker and Itohara, 2008). An organic certification authority needs to be established on the basis of international standards. The rapid expansion of organic diversified systems such as integrated rice-duck farming in Bangladesh could significantly reduce poverty of the poor farmers and protect the environment. It is important to ensure the community participation, availability of ducklings, farmer's initial capital, and better market price for extension in this technology. The farmers of Bangladesh do not get premium prices for organic rice due to the consumers' lack of awareness and trust in organic products. The technology will have much impact and lead to sustainability if this model can be developed. Recently, we are trying to introduce a model based on the experience of the Japanese Teikei system (producer-consumer direct distribution system). In addition, three organic farmers groups have been formed in Sylhet region in 2011. They plan to involve the local government in this production system taking experience from the Philippines. It may suggest including the rice-duck farming technology in the government national agricultural extension policy.

Finally, from the above study it can be concluded that "Integrated Rice-Duck Farming" had becoming popular technology especially as a means of organic rice cultivation in Bangladesh.

References

Hossain, S. T.**,** Sugimoto, H., Ahmed, G. J. U. and Islam, M. R. 2005. Effect of integrated rice-duck farming on rice yield, farm productivity, and rice-provisioning ability of farmers. Asian Journal of Agriculture and Development, 2 (1 & 2) : 79-86.

Manda, M. 1992. Paddy rice cultivation using crossbred ducks. Farming Japan, 26(4): 35-42.

Pham, C.P. 1994. Integrated rice-duck cultivation in Vietnam. ILEIA Newspaper, 13(4): 17.

Sarker, M. A. and Itohara, Y. 2008. Organic farming and poverty elimination: a suggested model for Bangladesh. Journal of Organic Systems, 3 (1) : 68-79.

Agroecological indicators for Organic Rice Farming Systems in Lombardy, IT

Porro, Andrea [1]., Spigarolo, Roberto [1]., Bocchi, Stefano[1].

[1] University of Milan, Department of Agricultural and Environmental Sciences (DISAA)
andrea.porro@unimi.it

Keywords
AEI, Organic Rice, nutrient cycle management.

Introduction

Italy is among Europe's leaders and ranks fifth worldwide in terms of area farmed using organic methods. It is a rapidly-growing sector now targeting foreign markets. An approximate area of 20,000 hectares are involved in organic farming, 25% of UAA (utilised agricultural area) in Region Lombardy. There are currently 1,200 organic enterprises in Lombardy region, 700 of which are farms, and about 500 are involved in converting and marketing agri-food products. Most of these farms cultivate annual herbaceous crop using almost 80% of that 20,000 hectares, and the percentage of UAA dedicated to cereals is about 60%. Rice is the most important organic cereals and tends to occupy more than half of the surface dedicated to cereals. In collaboration with Lombardy Region's Agriculture Authority, organic farming associations and University of Milan a research was carried out on 81 organic farms with the aim to develop a pool of indicator for characterization, monitoring and evaluation of management options and their relationship with environmental, economic and social sustainability. (Bockstaller, 2000). The first objective is to create an internal benchmark of organic farming system, the comparison with conventional and/or integrate agriculture is a second phase of the present research. The EU has recently defined a set of agro-ecological indicators (AEI) as described in an European Commission report of 2011. The European Environmental Agency (EEA) proposes to classify AEIs according to the scheme DPSIR (Driving forces, Pressure, State, Impact, Response). Agro-ecological indicators are suitable to integrate data about cropping and farming systems and to discuss about their sustainability (Dawe et al., 2003).
The purpose of this activity is to evaluate the use of some indicators of crop production in order to be able to characterize different organic farming system regarding different aspect (efficiency, sustainability etc) and to provide to decision makers with a simple DSS (Decision Support System).

Methodology

The organic rice farms (23 out of 48 farms with herbaceous crop) selected for the research were deeply investigated, through a questionnaire to describe all their activities. To describe them, 6 farm level indicators were calculated (all indicators of State) are: hedges and rows (agroforestry) in meter per hectare , energy input (Giga Joule per hectare - GJ/ha), energy output (GJ/ha), energy output/input ratio, N balance (Meynard, 2002) in kg/ha, P_2O_5 balance in kg/ha, labour unit in hour per hectare per year and number/type of crops (Bocchi et al, 2004). Moreover some additional information were collected such as crop rotation (maize 20 out of 23 farms, forage peas 13 out of 23 and also barley, alfalfa and soybean are reported) presence and number of livestock (beef cattle: 4 farms, pig: 1 farm) and irrigation management (all flooded rice). For energy input/output indicator, the specific energy contribution (INPUT) of each means of production (machinery, organic pesticide etc) was calculated, the same were done with the energy output (plant biomass, waste, by-products), according to literature value for the energy stored or embedded in a factor per unit of volume or per unit of mass (in MJ * UM-1 where UM is Unit of Measure). A central aspect of sustainability is the nutrient cycle management, so a nutrient budgets is also proposed as an indicator. Nutrient balances (Oenema et al., 2003; Öborn et al., 2003) are the simplest and most commonly applied nutrient indicators: they can be calculated with data available on different scales (from field to national) and can be used to analyse various chemical elements.

Results and discussions

As reported in table 1, the main results are related to the comparison between the general average for rice organic farming with the value of indicators related to all the other farms which cultivate annual herbaceous crop (rice included). The main differences are related to Nitrogen balance and hour of work per year per hectares, probably due to higher dimension of rice farms compared to the others. Organic rice farming system seems to be slowly in debt of nitrogen with an input output ratio negative thanks to the flooding rice management which force farmers to use carefully nitrogen to avoid problem of pH, while for other herbaceous farming system is positive and consume an amount of working hours fairly below the average (50 compared to more than 270). For the other indicators the value are in range with the rest of the sample and these difference can be easily explained by the intrinsic variability of the environment in which the farms are operating. The final scope was to individuate a benchmark for organic farming systems, based on our sample of 81 farms that can provide a DSS to “guide” farm managers or policy makers’ decisions. The real effort will be to try to make this values comparable to other kind of agriculture such as conventional and conservative, in particular to find a pool of indicators that can easily discriminate different options. Finally the research has reported the utility and resolution of the agroecological indicators proposed at farm level, while usually these indicators are proposed at crop level. A comparison with conventional farming system at crop level was carried out for the energy indicator input (Conventional 22,7 compared to Organic 17.1 GJ/ha), output (138.2 vs 169.9 GJ/ha) and ratio (6.2 vs 10) was carried out, showing a certain homogeneity.

Table 1: value for each farms, mean and mean of all organic herbaceous farms

Organic Rice Farms	UAA	hedgerows	energy O/I	Labour	N INPUT	N OUTPUT	N balance	P INPUT	P OUTPUT	P balance
	ha	m/ha		h year/ha	kg/ha	kg/ha		kg/ha	kg/ha	
1	97,38	97,38	10,31	43,43	35,64	104,61	-68,97	26,80	48,18	-21,37
2	36,12		10,55	46,26	45,95	115,12	-69,16	10,88	48,46	-37,58
3	51,24		14,31	46,75	68,68	177,75	-109,07	-	74,08	-74,08
4	21,26		6,39	51,79	120,00	91,49	28,51	45,00	40,11	4,89
5	100,60		12,11	52,89	142,56	144,23	-1,67	38,75	60,35	-21,60
6	49,38		13,37	52,48	128,50	156,92	-28,41	36,68	64,33	-27,65
7	91,84		12,65	62,99	29,48	132,75	-103,27	-	60,17	-60,17
8	23,61	23,61	6,00	48,50	277,18	66,50	210,68	-	36,71	-36,71
9	305,24		3,82	21,16	25,22	21,69	3,53	1,58	10,48	-8,91
10	5,81	5,81	6,74	79,72	109,34	37,98	71,36	138,19	41,50	96,70
11	147,48	126,48	11,26	45,20	43,51	125,39	-81,87	17,77	54,33	-36,56
12	33,70	34,50	10,40	57,41	41,98	138,21	-96,24	27,64	66,83	-39,19
13	482,74		14,72	52,16	57,53	85,96	-28,43	-	71,19	-71,19
14	169,07		9,50	43,39	37,77	124,95	-87,18	20,20	54,47	-34,27
15	12,44	12,44	10,40	16,55	74,69	77,76	-3,07	39,79	33,28	6,51
16	119,50		8,68	59,48	48,47	86,24	-37,77	4,19	48,48	-44,29
17	32,34		7,79	58,12	49,40	118,39	-68,99	104,28	46,20	58,08
18	76,59		10,81	71,76	64,76	73,92	-9,16	-	55,69	-55,69
19	121,00		10,73	59,77	52,21	92,14	-39,94	-	53,17	-53,17
20	110,72		9,86	39,09	25,23	105,00	-79,77	4,15	47,76	-43,60
21	10,50	10,50	12,88	43,16	43,81	184,84	-141,03	126,67	72,75	53,92
22	78,18		7,78	47,23	47,31	63,94	-16,63	14,77	37,95	-23,18
23	231,80		9,28	58,15	78,14	116,62	-38,48	158,54	58,07	100,47
Mean of Rice Farms	104,72	44,39	10,02	50,32	71,62	106,19	-34,57	35,47	51,50	-16,03
Mean of Herbaceous Crop (48 Organic Farms)	60,21	75,86	14,93	276,97			134,93			-2,17

Conclusion

This work is part of a framework in which region Lombardy wants to create a benchmark for organic farming system, in order to propose a unambiguous method to evaluate the matching of organic farming to the request of GPP (green public procurements) of school canteen call for proposal

References

Bocchi S., Pileri P., Gomarasca S., Sedazzari M., 2004. L’indicatore siepe-filare per il monitoraggio e la pianificazione. In: Proceedings of the congress “The rural system, a challenge for planning between protection, sustainability and changing management”, 113-123.

Bockstaller, C., Girardin, P., 2000. Mode de calcul des indicateurs agro-ecologiques, INRA, Internal Report, pp. 89.

Dawe, D, et al, 2003. Do organic amendments improve yield trends and profitability in intensive rice systems?. Field Crops Research. Volume 83-2, Pages 191-213.

Meynard, J.M., Cerf, M., Guichard, L., Jeuffroy, M.H., Makowski, D., 2002. Which decision support tools for the environmental management of nitrogen? Agronomie, 22, 817–829.

European Commission. 2011. Data requirements, availability and gaps in agri-environment indicators (AEIs) in Europe. Luxembourg: Publications Office of the European Union.

Öborn, I., Edwards, A. C., Witter, E., Oenema, O., Ivarsson, I., Withers, P. J. A., Nilsson, S. I., Richert Stinzing, A., 2003. Element balances as a tool for sustainable nutrient management: a critical appraisal of their merits and limitations within an agronomic and environmental context. European Journal of Agronomy, 20, 211–225.

Oenema, O., Kros, H., de Vries, W., 2003. Approaches and uncertainties in nutrient budgets: implications for nutrient management and environmental policies. European Journal of Agronomy, 20, 3–16.

Rice Farm in Lombardy

Caimo Duc Rosalia[1].

Environmental and economic performance of paddy rice and upland crop rotation in Japan: A comparison between organic and conventional systems

Hokazono Shingo[1], Hayashi Kiyotada. [1],

[1] National Agriculture and Food Research Organization, hokazo@affrc.go.jp

Keywords
Agricultural income, Crop rotation, Life cycle assessment, Soya bean, Yield

Introduction

Crop rotation between rice and upland crops is widely practiced in Japan, although rice could be planted continuously due to flood irrigation in cropping season. Some agronomical studies have been conducted on the environmental and economic effect of the transition to environmentally friendly rice production practices (Hayashi 2012) and the introduction of crop rotation in upland fields (Nemecek et al. 2008). However, the environmental and economic performance of paddy rice and upland crop rotation under organic farming is still unclear.

Therefore, it is necessary to evaluate the environmental and economic effects of introducing crop rotation in organic paddy fields and to determine whether tradeoffs exist between them. In this study, we compared continuous rice cropping with crop rotation and organic with conventional farming in paddy fields in terms of environmental impact and profitability.

Methodology

Data on organic and conventional paddy rotation were collected from Tochigi Prefecture, one of the regions where arable crops other than rice are most frequently planted in paddy fields. Seven rotation systems including rice (*Oriza sativa*), barley (*Hordeum vulgare*) and soya beans (*Glycine max*) within three years as well as continuous rice, barley or soya bean cropping system were assessed. Each cropping system was based on the prefectural guidelines, recommendations from extension services and additional documents. In particular, product yields, unit price, and application rates of fertilisers differed on the basis of the preceding crops as well as between organic and conventional farming.

Inventories of individual crops for environmental assessment were built in SimaPro version 7.3 with the JALCA (Japanese Agricultural Life Cycle Assessment) database in the same manner as Hokazono and Hayashi (2012). System boundaries encompassed entire farm-level processes as well as upstream processes such as manufacture of fertilisers, pesticides, machinery, and materials for nursery production. Direct field emissions of methane (only in rice cultivation), nitrous oxide and ammonia to air, and nitrogen and phosphorus to water were included for inventories of each crop. Four impact categories were used for the assessment: global warming, acidification, eutrophication and non-renewable energy. Agricultural incomes for each crop were calculated by subtracting total cost, including material costs and depreciation of machinery and implements, from total value of sales.

The environmental impacts of crop rotations were assessed by combining inventories of each crop; the profitability of crop rotations was calculated by adding incomes for each crop together with governmental subsidies through the Income Support Direct Payment Program in 2011.

Results and discussions

Although the yield of organic rice was lower than that of conventional rice, the income of organic rice production was higher because of the higher market price of organic products. In addition, most organic crop rotations afforded higher annual incomes than rice monoculture.

The environmental impacts (other than eutrophication) of consecutive organic rice production were lower than those of conventional farming. Introducing crop rotation in organic paddy fields, except the rice and winter barley rotation, was accompanied by greater superiority of organic farming in all impact categories including eutrophication; this is attributed to the relatively low impacts of organic soya bean cultivation, and the nitrogen fertiliser reduction and the yield increase in organic rice and barley cultivation following soya beans (Nemecek et al. 2008).

The relationship between environmental impacts and incomes and between environmental impacts and yields of each cropping system was depicted on the two-dimensional space (Fig. 1). The frontiers of organic farming systems in the plots of the impact–income relation were located closer to the lower right corner than those of conventional farming systems, although tradeoffs existed in the impact–yield relation for organic farming systems. This means that organic farming is more successful at enhancing both environmental and economic performance than conventional farming despite the lower productivity. Furthermore, crop rotation outperformed continuous rice production, which fell far inside the frontiers in the plots. Specifically, organic crop rotations including both barley and soya beans in paddy fields were able to achieve higher profitability while reducing environmental burdens.

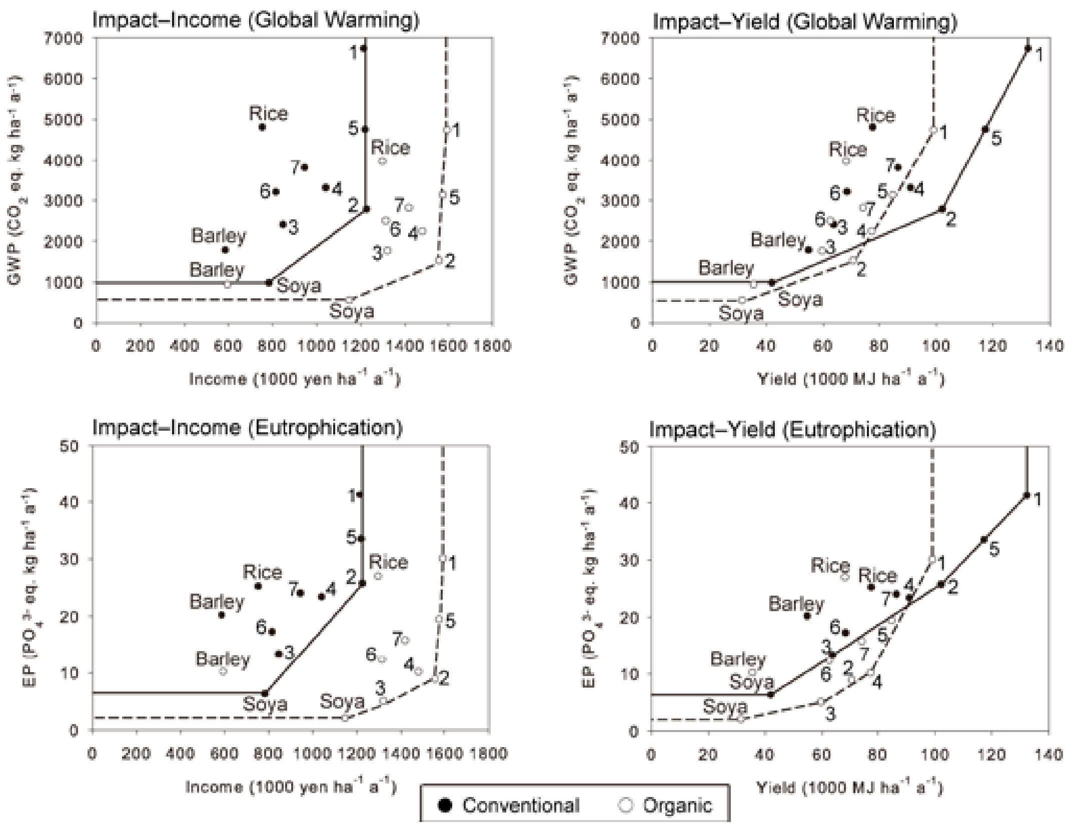


Fig. 1 Relationship between impacts and incomes and between impacts and yields for crop rotations in organic and conventional paddy fields. The numbers represent the following crop rotations: 1 (R-wB), 2 (S-wB), 3 (R-S), 4 (R-wB-S), 5 (R-wB-S-wB), 6 (R-R-S), 7 (R-R-wB-S) (R = rice, wB = winter barley, S = soya bean).

References

Hayashi, K., 2012. Ecological–economic assessment of farms using multi-input multi-output models: life cycle assessment with multiple paired comparisons. International Journal of Sustainable Development. (in press).

Nemecek, T., et al., 2008. Environmental impacts of introducing grain legumes into European crop rotations. European Journal of Agronomy. 28(3), 380–393.

Hokazono, S., Hayashi, K., 2012. Variability in environmental impacts during conversion from conventional to organic farming: a comparison among three rice production systems in Japan. Journal of Cleaner Production. 28, 101–112.

Integrated vs. organic rice production in Southern Spain.

Aguilar Portero, M., Aguilar Blanes, M, Rivas Vañó, E ., Fernández Ramírez, J.L.

Instituto de Investigación y Formación Agraria, Pesquera y de Producción Ecológica (IFAPA), Centro Las Torres-Tomejil, manuel.aguilar.portero@juntadeandalucia.es

Keywords
Rice, Integrated production, Organic production, cropping costs

1. Introduction.

Organic rice eliminates the use of chemical (synthetic) both pesticides and fertilizers, enhances the role of farmers as environmental agents and leads to a better nutritional quality of the products, more valued by the market. Integrated Production/Farming is a farming system that produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming. In 1990 the European Council established the basic strategies and technical guidelines of Integrated Production. Andalusia (southern Spain) has been pioneer in Europe by preparing the Specific Regulations of Rice Integrated Production. These Regulations structured the Andalusian rice area in Rice Integrated Production Groups, each advised by a technician who supervises the agronomical practices, which include the use of synthesis agrochemicals with limits and thresholds. The economical aids provided by the UE to the farmers is conditional upon the compliance of these Specific Regulation.

Weed control is essential. Weeds not only reduce the amount and quality of harvested grain but also increase production costs.

The main objective of this study is to get economical information about rice organic production in comparison with integrated production. Almost the whole rice surface in Andalusia (38.000 ha.) is dedicated to integrated production and only 300 ha. are cultivated under organic production.

- 2. Methodology

The study was carry-out in Aznalcazar (Seville) during 2009 and 2010. For organic production we used the cultivar “Bomba” (medium grain, low grain yield potential but high grain quality) . For integrated production the chosen variety was “Marisma” (medium grain, high yield potential). The plot size was twelve hectares per variety and year. Recorded parameters include comparative production costs for both integrated and organic rice.

- 3. Results and discussions

We have determined the incomes provided by both cultivation systems, including subsidies and those obtained from the sale of the product (derived from grain yield and price). “Bomba” reached a high grain yield (4.256 kg/ha) as well as “Marisma” 7.376 kg/ha.

Cropping costs in organic production were higher in comparison with integrated production. However benefits (two year average) were a little bit higher under organic system in our study conditions (see tables).

This study is based in cost information provided by farmers and the agronomic results of a single campaign with regard to grain yield and grain prize, for both production systems. Thus, the comparative benefits described in Table 2 must be taking as orientative.

- **4. Tables.**

Table 1. Cropping costs under organic and integrated production (€/Ha).

Item/service	Organic Production	Integrated Production
Fertilization	512,17	246,91
Working days (replanting, hand weeding, etc.)	392,00	196,00
Staff responsible of the rice field	68,89	69,09
Seed	226,89	174,98
Seed desinfeccion	-	4,28
Cropping operations	321,00	185,00
Seeding	21,40	21,40
Phytosanitary treatments (weeds and *Pyricularia oryzae*)	-	29,00
Organic pest control	67,29	-
Airplane application	-	40,00
Cost of conservation of utillities	51,46	51,46
Irrigation cost	314,78	314,78
Integrated Production Association	-	30,00
Company of certification	19,18	-
Hail insurance	16,69	15,16
IBI (Yearly Property Tax)	44,75	36,11
Harvest	156,00	156,00
Harvest transportation	21,27	49,86
Straw incorporation	72,00	36,00
Retro	6,36	6,36
Other	18,05	11,91
Grain drying	74,47	174,41
TOTAL	2411,11	1855,03

Table 2. Crop balance under Organic and Integrated Production.

Item		Organic Production	Integrated Production
Income	PAC (aid)	1200	1200
	Organic Production Aid	600	-
	Integrated Production Aid	-	248
	TOTAL A	1800	1448
	Grain Yield (Kg./ha)	4256	7356
	Price (€/Kg.)	0,675	0,27
	TOTAL B	2873	1986
A + B		4673	3434
Cropping cost		2411,11	1855,03
Benefits		2261,89	1578,97

SESSION 3

PRODUCTION, COMMERCIALISATION CHAIN, TERRITORY AND SUSTAINABLE DEVELOPMENT

Influence of organic nutrient management in aromatic rice based system on soil carbon dynamics, physical parameters and global warming potential

Singh, Y.V. *, Lata, Prasanna, R., Pradhan, S., Gaind, S and Saxena, A.K

Indian Agricultural Research Institute, New Delhi -110012, India
(Corresponding author: *E-mail:* yvsingh63@yahoo.co.in)

Introduction

Indiscriminate use of chemical fertilizers and pesticides for crop nutrition and to control various insect pests and diseases over the years has destroyed many naturally occurring effective biological control agents and created health hazards. The occurrence of multi-nutrient deficiencies and overall decline in factor production of the soil has been widely reported. Such concerns and problems posed by modern-day agriculture have emphasized for organic farming and area under organic production system is increasing worldwide. Growth of organic production is estimated at 15-20% annually in India and it is expected to continue because of strong domestic and overseas demand and aromatic (*Basmati*) organic rice has a special place in this aspect. Soil biological health is a central principle of organic agriculture and is vital to sustainable agriculture. Soils under organic production systems are generally reported to be rich in organic matter and biological activity (Marinari *et al*. 2006). Large quantities of organic matter are used in organic production systems as a source of nutrients and also to enhance the physical, chemical and biological fertility of soils. In contrast, integrated nutrient management and chemical fertilized production system receives low and imbalanced inputs and soil fertility levels decline gradually so that the sustainability of such farming systems are questioned. Methane is emitted in substantial quantities from rice fields, domestic animals and biomass burning (Pathak *et al.* 2003). Rice grown in flooded fields emit considerable amount of methane (CH_4) and this flux may increase if more organic matter is added to soil. However, if we take the green house gas emission in production of chemical fertilizers, than the negative effect of higher CH_4 flux in organic rice may be nullified. With this background, an investigation was conducted to study the effects of organic rice-vegetable cropping system *via-a-vis* integrated nutrient management and chemical fertilized production system on the carbon dynamics, soil physical properties and global warming potential.

Keywords: Basmati rice, global warming potential, organic farming, soil carbon dynamics, soil physical properties

Methodology

A field experiment was conducted at Indian Agricultural Research Institute, New Delhi, India during 2009-2011 to study the effect of organic rice-vegetable cropping system *via-a-vis* integrated nutrient management and chemical fertilized production system on soil carbon dynamics, soil physical properties and global warming potential. The soil of the experimental plot was sandy clay loam with pH 7.8, organic carbon 0.76%, available nitrogen 398.5 kg ha^{-1}, available phosphorus 28 kg P ha^{-1} and available potassium 286.4 kg K ha^{-1}. The experiment was conducted as per the guidelines of International Federation for Organic Agriculture Movement (IFOAM). This experimental field was under organic cultivation since 2003 and during 2003-08 rice- wheat cropping system was followed. In this experiment irrigated transplanted rice-vegetable/wheat system was followed. Wheat and vegetables were sown/ planted using zero-tillage practice. The field experiment was laid out in split plot design where aromatic rice was grown in main plots and vegetables like cauliflower, broccoli, cabbage, garden pea, carrot and cereal crop wheat in sub-plots. Three crop nutrient practices viz. organic, integrated nutrient management (INM) and chemical fertilization were taken in all the crops. In organic crop nutrition four organic inputs viz. Blue Green Algae(BGA), *Azolla*, Vermicompost and Farm Yard Manure(FYM) were applied in rice crop in combination. This treatment was taken on the basis of results of six year field experimentation by Singh *et al.* (2011). In organic treatment, entire dose of FYM was applied as basal and vermicompost was applied in 2 equal doses as basal and at panicle initiation stage. BGA and *Azolla* were applied 3 days after transplanting. In INM, FYM (5 t/ ha) was supplemented with 90 kg N ha^{-1} applied through urea. In chemical fertilization 120 N ha^{-1} was applied through urea and applied in three splits. The same treatments were used in rice, wheat and vegetable crops except the *Azotobacter* biofertilizer which replaced *Azolla* in wheat and vegetable crops. Observations on soil organic carbon content and microbial properties viz. Fluoresein diacetate (FDA), dehydrogenase activity, microbial biomass carbon (MBC) and soil chlorophyll were taken by standard procedures. Collection of gas samples for methane (CH_4) and nitrous oxide (NO_2) emissions was carried out by the closed-chamber technique using the chambers of 50 cm x 30 cm x 100 cm (length x width x height) (Pathak *et al.,* 2002). Estimation of total emissions during the crop season was done by successive linear interpolation of average emission on the sampling days assuming that emission followed a linear trend during the periods when no sample was taken (Pathak *et al.* 2003).

Results and discussions

Results showed that the soil (0-15 cm) organic carbon content under organic management has continuously built up over the years under organic management and it has almost doubled (0.54 to 1.04%) during 2003-2011(Fig 1). The labile and most stable fraction carbon content of soil was also highest in organic treatment. Soils under organic production systems are generally rich in organic matter and biological activity (Marinari *et al*. 2006). Dehydrogenase, alkaline phosphatase and FDA activities and MBC were highest under organic treatment followed by INM (Fig.1). Changes in composition of microbial communities due to fertilizer treatment (Jha *et al*. 2004) and application of organic matter (Singh *et al,* 2011; Singh and Dhar, 2011) has been reported. Fließbach *et al. (*2007) also reported enhances microbial biomass and enzymatic activities under organic farming systems. The values of soil physical parameters like available water content (AWC) and water retention capacity(WRC) were higher under organic management compared to INM and chemical fertilization (Fig 1). The increase in AWC was related to the increase in micro-and macro-porosity. Lower bulk density (BD) was observed in organic treatment as compared to INM and fertilizer treatments. The mean weight diameter (MWD) value of soil also showed similar trend. Higher CH_4 emission was recorded in organic plots and it was lowest in chemical fertilization (Fig 2). NO_2 emission was highest under chemical fertilization and lowest in organic farming. CH_4 and NO_2 emission peaks were observed two hours after chemical fertilizer application while in organic management no such peak was observed. GWP was slightly higher in organic plots compared to fertilizer applied plots. Singh *et al*. (1998) reported higher CH_4 flux from the FYM treated plots than urea applied plots due to the presence of additional amount of organic matter which served as an additional source of electrons.

It was concluded that soil carbon content was considerably built up under organic farming. Soil physical and microbial quality also improved due to organic farming. However, GWP was slightly higher in organic plots compared to chemical fertilizer applied plots.

References

Fließbach, A., Oberholzer, H.R., Gunst, L. and Mader, P. 2007. Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. *Agriculture, Ecosystems and Environment* 118: 273–284

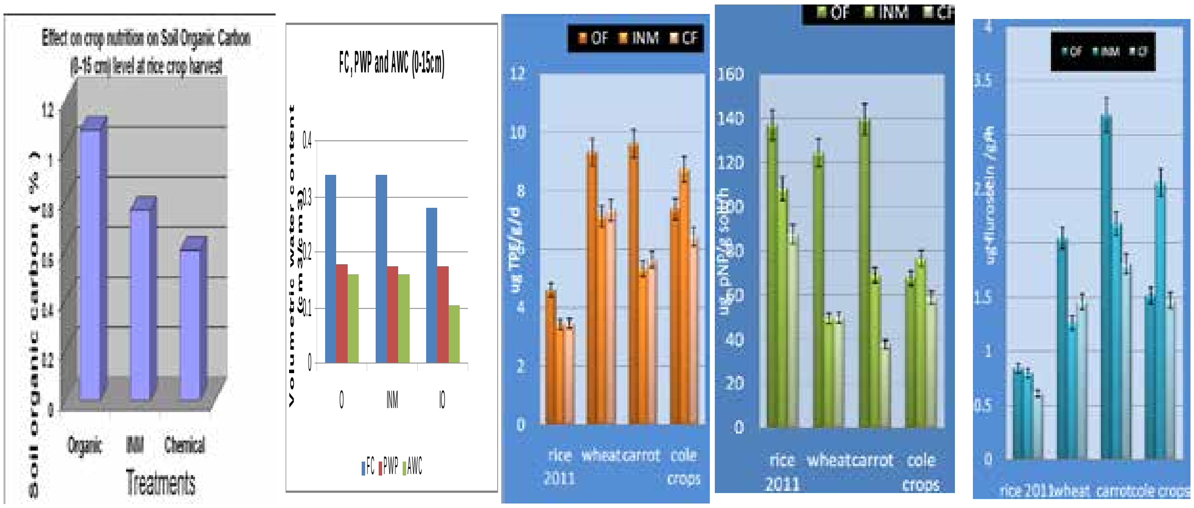
Jha, M.N., Prasad, A.N and Misra, S.K. 2004. Influence of source of organics and soil organic matter content on cyanobacterial nitrogen fixation and distributional pattern under different water regimes. *World Journal of Microbiology and Biotechnology* 20:673–677

Marinari S, Mancinelli R, Campiglia E, Grego S (2006) Chemical and biological indicators of soil quality in organic and conventional farming systems in Central Italy. *Ecological Indicators* **6**, 701-711.

Pathak, H, Prasad,S, Bhatia, A, Singh,S, Kumar,S, Singh,J and Jain, M.C. 2003.Methane emission from rice–wheat cropping system in the Indo-Gangetic plain in relation to irrigation, farmyard manure and dicyandiamide application. *Agriculture, Ecosystems and Environment* 97: 309–316

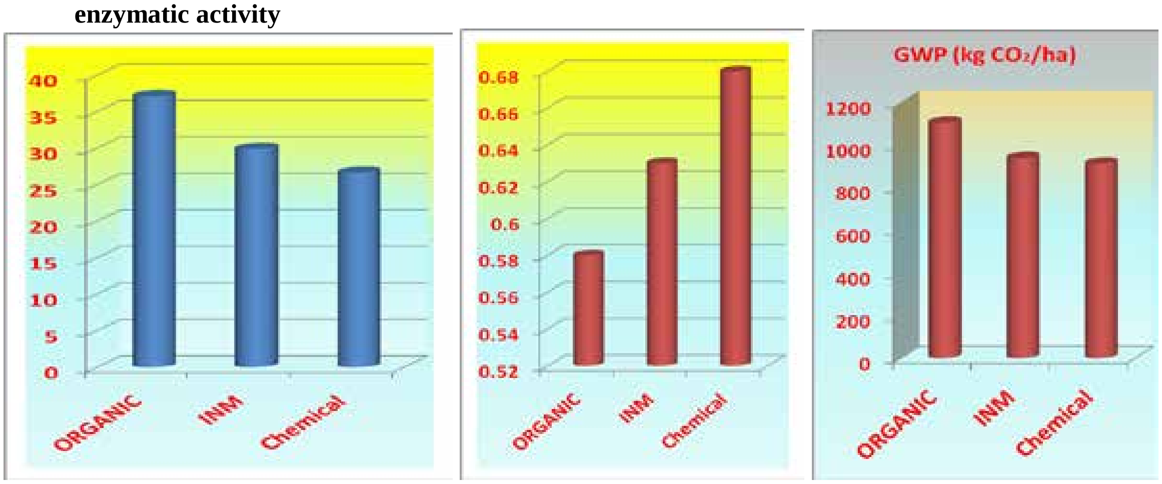
Singh, J.S, Singh, S, Raghubanshi, A.S, Singh, S, Kashyap, A.K, 1996. Methane flux from rice/ wheat agro-ecosystem as affected by crop phenology, fertilization and water level. *Plant Soil* 183, 323–327.

Singh, YV; Dhar DW and Agarwal B. 2011.Influence of organic nutrient management on Basmati rice *(Oryza sativa)*-wheat *(Triticum aestivum)*-greengram *(Vigna radiata)* cropping system. *Indian J Agronomy*. 56(3):169-175
Singh, Y.V and Dhar, D W. 2011. Changes in soil organic carbon and microbial population under organically managed rice (*Oryza sativa*)-wheat (*Triticum aestivum* L. emend. Fiori & Paol.)-green gram cropping system. *Indian J Agricultural Sciences.* 81 (4): 55–58



Soil organic carbon content(%) Soil physical parameters Dehydrogenase activity Alkaline phosphatase activity FDAse activity

Fig 1. Effect of organic farming on soil organic carbon content, soil physical parameters and enzymatic activity



Total methane emission (kg/ha) Total nitrous oxide emission (kg/ha) Global warming potential (kg CO_2/ha)

Fig 2. Effect of organic farming on total methane and nitrous oxide emission and global warming potential in rice field

Guinean mangrove rice cropping, organic by nature

Barry Mamadou Billo[1],

[1]Scientific Director of the Guinea Agronomic Research Institute(IRAG)
E-mail. billobarry@hotmail.com

Keywords: mangrove rice cropping**,** fertile soils, salinity, acidity, Guinea

Introduction

Guinea is a West African country where rice cropping is the first agricultural activity. It covers about 40% of total surfaces cultivated per year. Mangrove rice-cropping is part of the country's rice cultivation systems and ranks second after rain-fed rice as such, i.e. more than 40000 ha. This kind of mangrove rice cropping is by nature organic and sustainable. Indeed, mangrove soils are formed by marine sediments rich in organic matter on which a forest of mangrove trees grows. Rice fields are established on these fertile soils after clearing. The soil's natural fertility is maintained over time by sea water entering the rice casings in the dry season. This sea water carries marine mud rich in organic matter and mineral salts. This sea water also prevents the proliferation of hydrophilic adventitious flora because of its toxicity. Which makes rice cultivation possible in this amphibious environment, in a continuous way over several decades, without fallow nor mineral fertilizers and weed killers, with average yields of around 2 t/ha sometimes reaching or even exceeding 6 t/ha. Rice harvested in this environment is also considered by consumers as very high quality rice, thus benefiting from a purchase premium. This rice, known as "Bora Malé" is actually part of a dozen products recently submitted to the OAPI by Guinea to be listed for protection under the *"Product of the Terroir"* label.

This presentation is organized in three parts: 1- the mangrove; 2- the types of mangrove rice cropping; 3- the technical method.

1. The mangrove: a specific ecosystem with multiple uses

The mangrove is defined by Leruse (2000) as a "set of plant formations subjected twice a day to the action of tides, colonizing estuaries, deltas and bays in tropical areas (so-called mangrove forests), exposed areas tightly interwoven with them and all the peripheral areas where typical mangrove tree species are mixed with other species".



Photo 01. Carpet of *Paspalum Vaginatum* **Photo 02**. Avicenia and its exposed roots. **Photo 03**. Carpet of *Sesivium*

In Guinea, this mangrove is located along the coastline, from the North-East to the South-West, along the Atlantic Coast. This 30 to 40 km wide area covers some 300 kms. It consists of two parallel strips, on the sea side, the mangrove area, covering about 385000 ha (9% of maritime Guinea's surface) and inland, the coastal plateau supporting the urban and road infrastructures. The mangrove area arising from fluvial and marine sediments, is colonized by a Rhizophora and Avicenia mangrove (Photos 1 & 2), and crossed by numerous wide mouth waterways subjected to tides. Average annual rainfall exceeds 2000 mm.

The Nalou, Landouma, Mikiforè, Bagas and Soussous populations who make up the main population of the coastline mainly derive their sustenance from this amphibious environment through rice production, the cutting of fire wood and work wood, fishing and the extraction of sea salt.

2. The forms of mangrove rice cropping

The setting up of mangrove plains of maritime Guinea dates back to more than 6000 years ago. Mangrove rice fields are established on these soils, essentially composed of marine and fluvial sediments, rich in organic matter and mineral salts. The mangrove was conquered for rice cultivation by means of clearing, followed by a development work in case the influence of the sea remains strong. Depending on the influence of the sea, there can be two different types of rice cultivation: enclosed or dyked mangrove rice farming, and open mangrove rice fields.

Enclosed mangrove rice growing

Enclosed mangrove rice farming, largely prevailing, is located on the sea front. After the clearing of mangrove trees, an impressive dyke belt is built by the villager's community to protect rice fields against salt water tides. The area is divided into small cases (about 1000 to 5000 m^2) enclosed by the small dykes (Photo 4) built by each owner.

Photo4. Enclosed mangrove rice field

These small dykes, fitted with hollowed out palm tree trunks or PVC pipes, make it possible to control water input at plot level. This control is necessary so that during the crop season, salt water would not get in the casings and that a minimal waterbed be kept at all times to avoid salinization through capillary action. And that in the dry season, the sea water may enter the casings to avoid the start of a soil acidification and weed growth process. Salinity is the major constraint of enclosed mangrove rice fields, as in most mangrove rice fields (Marius, 1985). These rice fields thus require varieties that tolerate the salinity of a cycle, but not too long to be harvested before the end of the rainy season. In case of salt water intrusion, namely during the flowering phase, damage to the harvest can be disastrous.

Open mangrove rice fields

Open mangrove is located along the upper estuaries. The duration of the saltless period is generally long, from June to January or February, so that rice cropping is not affected by salinity issues. So organization is not required (Photo 5). The length of the saltless period makes it possible to cultivate long-cycle varieties, even if they are sensitive to salinity.

Photo 5. Rice field on open mangrove with plant transplant

3. The technical method

Mangrove rice is grown only in the rainy season between June and November. Crop operations in these two main forms of rice cropping are almost identical. The soil is prepared with manual plowing using daba or through ridging by means of a special tool known as "Kofoui". Rice is transplanted flat (Photo 5) or on ridges (Photo 6) with plants one month old, more or less. Maintenance work is limited to stopping the dykes and small dykes to control clear and salt waters, to keeping crabs away and replacing missing plants. Rice fields are protected by the children against seed eating birds, from flowering to maturity. Rice is hand-harvested, with a knife or a sickle, left in the field one or two weeks or even longer, to dry in the sun, before being bundled and beaten with a scythe. The harvest is put in bags, carried on the head or transported by bicycle or motorcycle, in a car or truck to the village where it is stored in traditional granaries.

Photo 6. Healthy rice field on ridges

Lastly, mangrove rice growing has a very interesting potential for organic rice production. It deserves to be better known and supported to improve its productivity and sustainability, and also to enhance its product. This is the context in which the Guinean government has been conducting a development program for mangrove rice production for some twenty years with the help of the French Development Agency (AFD). This help applies to the whole mangrove rice sector, with a highlight on the control of clear and salt waters.

References

BARRY, M. B. 1996. Organisation du travail agricole et diagnostic agronomique en riziculture de mangrove, plaine de Menkinè, Guinée maritime. DIAT Dissertation CNEARC. p. 87.

Marius, C. 1985, Mangroves du Sénégal et de la Gambie : Ecologie, pédologie, agrochimie, mise en valeur et aménagement, Pris, ORSTOM, coll. Travaux et Documents, 193, 3p 5-7.

Leruse, 2000 quoted by IIka C. Feller and Marsha Sitmik, 1996. Mangrove Ecology Workshop Manual.

Organic farming and sustainability: the point of view of Camargue rice producers

Hammond, Roy [1], Mouret, Jean-Claude [2], Le Velly Ronan[3]

[1] Inra, Umr Innovation, Montpellier, France émail : hammond@supagro.inra.fr
[2] Inra, Umr Innovation, Montpellier, France [3] Supagro, Umr Innovation, Montpellier, France

Keywords: rice, sustainability, organic farming, Camargue, verbatim

Introduction

Sustainability of the rice production system is a concern generally shared by all professional and institutional stakeholders of the Camargue territory. A study carried out in 2010 and 2011 by the INRA and financed by FranceAgriMer aimed at analyzing the opinions of rice producers concerning the constraints, assets and conditions of implementation of a sustainable rice production. The question of sustainability in its agronomic, economic, social and environmental implications was addressed. The practices and perceptions of organic farming were commented on and expressed by the farmers themselves in this more general framework of sustainability.

Method

50 rice producers, i.e. 25% of Camargue rice growers took part in the study. The panel of participants sought to represent the diversity of farmers, production systems and their geographical locations in Camargue. The interviews concerned the itineraries of the farmers and their farms, the activities and current or past practices, their short, medium and long term projections.

Results and discussion: Results presented here are not complete considering the wealth of material collected, but the aim is to enlighten the main issues of the current debate.

1. Sustainability of the farm

1.1. First criterion of sustainability: economic viability

- **Situation of French rice productions in the global market**

For rice producers, the primary criterion of sustainability of their farm is economic viability.
Their concern is about their inability to influence the globalized market. "*French rice growers have no weight on the rice market. They have no power over the sale of their product.*"; "*The sector doesn't care about Camargue rice. Collectors are not looking for a rice, but for the lowest possible price.*"
They denounce a system that relies on globalization of markets to turn rice into a mass product and does not allow them to be distinguished from other productions. "*The organization of commercialization absolutely does not want the consumer to know the producer.*"

- **Difficulties specific to the organic market:** i) fear that the market for organic products would blend in with the market for conventional products: "*Mass market retailing tries to pull "organic" into the perverse system of "conventional" where there is no price. It's unacceptable!*"
- ii) The expansion limits of organic market: some rice producers think that the market for organic is a niche market for the most well-off social categories, that this mode of production cannot develop on a large scale, in a nutshell, that it is not affordable for all consumers.
- *"You cannot feed the planet with "organic" rice. It is too expensive for the consumer, yields and surfaces are much smaller. "Organic" is more for the posh 16th arrondissement, Neuilly sur Seine!"*
- They think that many consumers of organic products first and foremost look for low prices without concern for the origins or conditions of production. "*Food is not a priority. Consumers are not ready to devote money to that, they want cheap organic.*"

1.2. Levers and constraints for environment-friendly rice production

· **The motivations to transition to organic farming:** i) Concerns about the toxicity of phytosanitary products for health and environment: "*We switched to "organic" because we saw that with the chemical products we were using in conventional farming, there were no more snails, no more lizards, nothing! And after the treatments, we had skin and throat irritations. We didn't want to keep working like that.*"

· ii) The quest for an economic niche market… and the promotion of an image: "*Having a niche of "organic" rice in Camargue is good for the image of Camargue rice*."

· **First obstacle to the development of organic rice farming: weed control** "*For farms who have transitioned to organic, the first and second year are wonderful, harvests are great, it's clean. Then, after the third year, you sort of have to look for the rice! It's just weeds all over!"*

To control the development of weeds, farmers set up crop rotations, but this entails many problems: the development of new crops requires new equipment and technical competences, the crops introduced do not necessarily find outlets, they are not necessarily profitable from an economic standpoint and can deeply disrupt the organization of the farm: "*Rotation with alfalfa or another legume is interesting in the fight against weeds and to provide nitrogen. But I'm not equipped to grow legumes and rapeseed doesn't pay off", "there was a time in Camargue when each farm had its livestock, but the fall of market prices for that meat led to give up that activity."*

For many rice growers, producing with organic methods means conducting an associated animal breeding activity and some think it is not their trade.

· **The change of practices: between regression and upgrading of the trade**

For some, the perspective of switching to organic sounds like a regression: "*Organic, it's a bit like saying: we'll switch off the light and live with candles. We're all going to get back to horses, hoe the rice fields and transplant. It's a postcard vision.*"

For others on the contrary, this change is synonymous with reconquest of the trade. They must reconnect with the basics of agronomy: "*We are truly in agronomics, let's reread Soltner*[1]*"* They are proud: "*It is respectful and modern farming. Organic gives back dignity to the farmer's trade."*

2. Inadequacy of public policies

Some express their unease with regard to the dependency on public aid: "*If we want the premium, we have to do rice"*. The CAP subsidies are often considered as necessary but hardly desirable and not adapted to the development of organic production. "*People who practice organic farming do not receive enough aid, because in organic, with the rotations, you can only grow rice every 5 years."*

Farmers underline the evolutions of public policies pinpointing inconsistencies whose responsibility is blamed on them. "*Right now for society, we are the polluters, but farmers were encouraged to apply fertilizers, products, it's the method, it's modern agriculture. Now, they're asking the same people to produce differently. They do not understand."*

They consider that political directions are not always very clear and supported by appropriate measures. "*Do they want farmers to produce or to do landscape maintenance? Decision-makers must say what they want and they must supply the means to achieve it."*

3. The role of research

The role of agronomic research has often been evoked and namely to test the organic methods of weed control. Rice producers are looking for "pragmatic" and collective research, conducted in collaboration with them, in real conditions. There was talk of the creation of a pilot farm. For many, the solution was in the creation of a synergy around adapted research and setting up of financial aid to face the risks incurred.

Conclusion: The development of sustainable rice production proves difficult for rice growers because it forces them to rethink their professional activity entirely, both on a personal level (in terms of competence, risk taking, etc.) and on a collective level, with the need to rethink their situation vis-à-vis markets. **They underline the crucial role of research and development institutes as well as adapted public policies to help them take up the challenge**.

Bibliography

Mouret J-C et al., 2011, Analysis of the opinions of Camargue rice producers on the sustainability of agricultural production systems: report on a scientific study, FranceAgrimer

Le Velly et al., 2012 Une riziculture durable ? Analyse compréhensive des points de vue des riziculteurs camarguais : *paper proposed for a special issue on organic rice production in Cahiers Agricultures*

Ekibio : Transformation and commercialisation company

Perreol, Denis

Perception of living forces in rice crops

Volkmann João Batista Amadeo

Alimentos Volkmann, Brazil
Fazenda Capão Alto das Criúvas – Sentinela do Sul - Rio Grande do Sul – Brasil

volkmannjb@volkmann.com.br
www.volkmann.com.br

Key words: biodynamic, rice, living forces

Introduction

The environment where rice crops grow are of a very special peculiarity. They are ecosystems closely linked to water resources, are vallyes where soils are made of solids coming from the mountains. We can say that rice crop soils are the most fertile soils in the world, with extreme vitality (the rice plant adapts nutrient absortion). Culturally, rice was domesticated in the east and adapted to western culture. The western culture has a reserach methodology linked to rice crops grown in dry soil, withe wheat, barley, oats and corn crops. To quietly observe with attention these aquatic environments, leads us to a new way to study these environments full of vitality.

Results and Conclusions

The environment where rice crops grow is especially peculiar. Are ecosystems closely linked to water courses, are valleys where soils are built with solids coming from the mountains. It can be affirmed that rice crop soils are the most fertile soils in the world with extreme vitality (the rice plant adapts nutrient absorption).

Rice was domesticated in the East and adapted to Western culture. The Western culture has a research methodology linked to rice crops grown in dry soil, with wheat, barley, oats and corn crops. A quiet and deep observation of these aquatic environments, leads us to a new way to study these environments full of vitality.

We can ask ourselves which elements are needed in order to germinate a seed. We immediately recall warmth, air (O_2), water and soil itself, where plants are going to grow.

Soils at the border of rivers are normally humid as they receive the benefits of floods. The water element is naturally present in these soils. When farmers cultivate the soil, they bring the air element in this environment; therefore, a vital impulse starts the germination process of the seeds already present in the soil. In few days, the dark soil turns green, covered by new plants. Modifying the equilibrium of the four elements -soil, water, air, warmth- the farmer floods the paddock for 21 days (a solar day), all the seeds that started the germination process start to develop foliar area and seeds that did not germinate will start dormancy because of lack of O_2. Plants regarded as unwanted before (red rice, echinochloa) will be biomass builders (green manure). That biomass is incorporated to the inundated soil producing available amino acids for the new rice plants. That decomposition process of biomass needs guidance and it is here that the spiritual knowledge of biodynamic agriculture can contribute in a beneficial way. At this moment we do not want putrefaction but humus formation (OBS: use of preparations).

In this flooding period of 21 days, several phenomena occur. Besides of inducting seed dormancy, pH turns neutral because of saturation of bases. With pH neutralization, nutrients are available for plants, making the ideal environment for rice.

Keeping soil inundated along and after the biomass incorporation, other plants emergency is controlled efficiently and rice can be sown pre-germinated or sowing plantings. In case of pre-germinated rice seeds it is important to clarify that rice can develop radicle when water has a concentration of O_2 above 4 ppm and develop an epicotyl (foliar area) with levels of O_2 dissolved in water with values over 6 ppm. Because of this, pre-germinated rice follows its growing process on water lays. After sowing, the application of biodynamic preparation 500 is done to favor the link of the plant to the soil, promoting initial rooting (during the crop cycle we can still promote living N and reduce emission of CH_4 (methane) accordingly to the water lay management).

Crop management works together with the vital rhythm and it can be perceived by the leaves coloration. At this initial foliar development, the application of biodynamic preparation 501 is done. In the first weeks, the young plants continue developing until certain point that we notice a vigor loss and an apparent growing stagnation. Leaves loose the green intensity and when we examine roots, we notice that some pests are interested on roots. In some points, the worm of <u>*Oryzophagus oryzae*</u> start to eat the new roots of rice, then, it is time to drain off the paddock, eliminating the water lay to inhibit the development of the insect (in crops that use chemical pesticides carbamates are applied in the water). This drainage demand wisdom and patience from the farmer to assist calmly the plant suffering. The process of vitality loss is intensified due to the lack of water, and it is important to be patient and trust that it is the right decision. At this state it can be applied again the biodynamic preparation of horn and manure – prep. 500- to stimulate root renovation. When water is back, a vitality explosion takes the rice crop, an intense green is disseminated and the plant reacts with intensity. This sudden change from flooding to dry soils and again flooding strengthening not only worm control but also reduces significantly the emission of methane in the cropping system and stimulate the formation of life nitrogen. The drainage stimulates change in soil life, anaerobic microorganisms die and immediately a new aerobic life is installed in the soil. With a new flooding in the paddock, another change occurs: aerobic microorganisms are substituted by anaerobic ones. Life and death shifts creating a rich soup of microorganisms’ decomposition with high levels of nitrogen that collaborate with rice growth.

This is the fundamental aspect in current times, the application of soluble nitrogen in fields with organic matter rich soils stimulate the burning of existing soil carbon. Humus is kept due to the C/N ratio in these soils is very high, at the moment nitrogen is brought in from outside, we are feeding microorganisms to decompose organic matter promoting emission of CO_2. With the current knowledge we can affirm that it is extremely harmful for global warming, the indiscriminate application of nitrogen in rice crops.

Plant growth comes to an end and we start a new stage of the plant, where it prepares for flowering and in this stage, the water lay is elevated to protect the environment from temperature oscillations which are harmful for flowering. The elevation of the water lay also protects rice from the rice stink bug (pentatomidae) attack which needs a low water lay to suck the stem at the moment the rice panicle emerges. At the stage of grain growth, we can promote again drainage and floodings to favour the grain quality and the plant can receive again an application of preparation of horn and silica –preparation 501- which improves the grain taste and quality. Harvest is done preferably with dry soil allowing straw collect for silage. This straw can be used to feed animals or for building purposes.

Riet vell, SA

Cirera Martínez, Juan Carlos
Riet vell, SA, Amposta, Tarragona, Espagne
e-mail: jccirera@seo.org

Organic Rice Value Chain Development In Cambodia

Sokundarun, Lim, CEDAC/Program Coordinator

Email: sokundarun@cedac.org.kh ; website : www.cedac.org.kh

Keywords
Cambodia Organic Rice Value Chain

Introduction

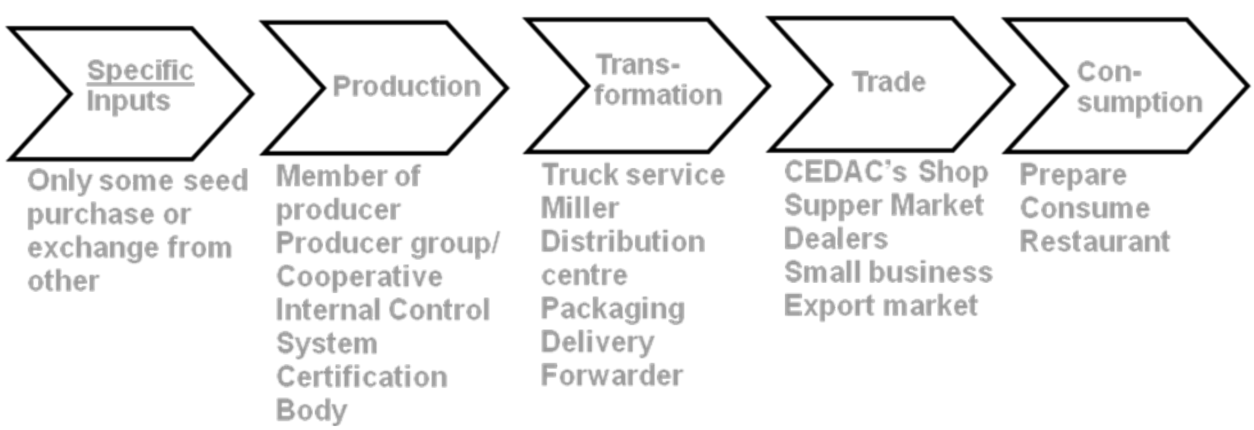
CEDAC, founded in 1997, is one of the leading NGOs in Cambodia involved in rural development. Since the year 2000, CEDAC has promoted *systematic rice intensification* (SRI) as a way to enhance rice production and to improve farmers' income. Presently, CEDAC collaborates with about 140,000 farmers in 22 provinces in Cambodia who participate in 30 field programs. The programs cover various aspects of rural development, however most farmers are also engaged in improving rice cultivation.

In the course of the promotion of ecological sound agricultural practices, an increasing number of farmers have been able to shift to organic rice cultivation. In the year 2004, CEDAC began to assist farmers in the marketing of organic rice and created the Natural Agri-Product Marketing Program (NAP). NAP aims to ensure that small farmers can obtain higher prices for their organic products. The number of farmers as well as the supply of organic rice has increased considerably from year to year. In fact, for the last two years the quantities have tripled compared to the preceding business year. As more farmers shift to organic practices, CEDAC expects a significant growth of the organic rice sector also in the next following years.

In 2009, CEDAC setup a social enterprise namely SAHAKREAS CEDAC and registered in the ministry of commerce in purpose of doing marketing and trade of organic agriculture products and especially organic rice. The main market of organic rice is 70% at domestic and 30% export to USA and EU.

Methodology and Objectives

The value chain of organic rice support by CEDAC



The main objectives of supporting organic rice producer groups as follows:

- To strengthening capacity of small farmers in collective selling or producer group cooperative in order to bargaining power on the market intermediation and generate more income
- To support farmers on the technical aspect for producing organic paddy rice in which adopted to the standard of organic certification and demand and requirement of the market
- To promote sustainable agriculture with organic approach model and food safety in Cambodia

Results and discussions

Since 2003, CEDAC had supported to establish only 18 organic rice producer groups, 253 member and only in 3 provinces. Currently, CEDAC have supported to setup 322 organic rice producers groups, 2668 members, located in 322 villages, 94 communes, 28 districts and 7 provinces such as Kampot, Takeo, Kampong Spue, Kampong Chhnang, Kampong Cham, Kampong Thom and Prey Veng with 1293 hectare of cultivation surface. Furthermore, those 322 producer groups have been formed into 29 cluster or cooperative and 6 federations.

In 2011-2012, CEDAC assists about 2,259 small organic rice households, organized in almost 322 producer groups, which are supplied about 2,000 tons of organic paddy (chiefly Jasmine rice). As this rice is mainly grown in the rainfed areas, rice production is limited to one season per year.

Concerning the special area for the international inspection, CEDAC was chosen Takeo and Kompong Spue province that collected 330 ton for applying and getting certificate from the international organic certification body BCS.

Based on the observation, all producer groups have well done on the internal control system recording in which providing good validation process for the internal and external inspector to apply organic certificate.

Figure or Table

Table: Summary results of organic rice produce and sale in 2011-2012

No.	Province	No. District	No. Commune	Total member	Member who sold paddy	Amount of paddy rice (kg)	No. of bag
1	Takeo	1	8	447	278	393,079	4,713
2	Kampong Spue	5	18	1,033	654	1,506,518	18,184
3	Kampong Thom	2	5	206	14	10,643	116
4	Kampong Chhnang	2	8	325	11	18,002	211
5	Kampong Cham	1	3	73	11	6,611	73
6	Kampot	2	5	175	53	29,108	340
Total	6	13	47	2,259	1,021	1,963,961	23,637

Conclusion

Based on the results of producer groups and procurement, we provide a conclusion as follows:

- We have setup producer groups as planning and provide capacity building on time in which support to member producer good quality of paddy rice, enhance productivities, got organic certificate, got fair trade certificate and sell with better price.

- We have well organized the structure of producer groups to mobilize members, planning, collecting and selling that responsible by cluster or cooperative. The internal control system is also functioning with good record to make the validation of application for certification running smoothly and successfully.

Regional conversion to organic farming in Camargue, South of France.

Delmotte, Sylvestre[1,2], Lacombe Camille[1], Mailly Florine[1], Mouret, Jean-Claude[1] Lopez-Ridaura Santiago[1],.

[1] UMR 951 Innovation, INRA, Montpellier, France. [2] Farming System Ecology, Wageningen University, The Netherlands.

Introduction

European agricultural systems are in constant evolution under the joint effects of multiple factors of change, some exogenous to agricultural systems, such as the evolution of agricultural markets, the changes of public policies or climate change, and some are endogenous changes such as the development of new techniques and practices. Systems in organic farming (OF) are good examples of systems offering an alternative to conventional systems which are currently growing fast due to both the development of new techniques and to a favorable political and economic context. However, the development of these systems remains limited and slow, for various reasons.

In the Mediterranean basin, the Camargue is a small region within the Rhone delta, characterized by a relatively flat and low altitude landscape. The proximity of the sea and the important evapo-transpiration entail soil salinization. Farm lands there are in direct relationship with natural spaces whose patrimonial interest is world famous. The impacts of flooded rice fields (the territory's main crop) on the natural environment are a recurrent source of concern. The development of organic farming is considered as a means of reducing the negative external parameters of agriculture on natural environments, which in turn raises questions regarding the other possible consequences of a regional development of organic farming in the territory. Identifying the obstacles and possible levers to the development of these systems, and assessing the consequences of an important development of OF could help local stakeholders in this territory in their reflection. The aim of this communication is to draw a summary of the knowledge about obstacles and levers to the development of Organic Rice Production (ORP) in Camargue and to assess the possible consequences or a regional development of OF. This communication is based on various works recently undertaken in Camargue: surveys with farmers and territory stakeholders to identify the obstacles and levers to the development of OF at various levels, an in-depth study of constraints related to the various types of soil and lastly, a work of construction and integrated assessment of scenarii related to the development of ORP.

Materials and methods

Through numerous research projects conducted in Camargue (see Mouret et al., this conference), valuable knowledge was acquired on technical systems in conventional and organic farming as well as on the stakeholders involved in agricultural production. A summary of this knowledge helped identify the obstacles and levers to the development of ORP on three levels: the level of the plot and the technical system of ORP, the level of the farm and management of crop rotation and lastly, the level of the territory and the elements of the politico-economic context of ORP. 22 interviews were conducted with 14 farmers and 8 territorial stakeholders (local authorities, consultants and stakeholders of the sector) to collect their opinions on the various obstacles and levers at these different levels. Among the obstacles, adjusting the constraints of OF to the type of soil and in particular to the problem of salinization of lowlands on the one hand, and the challenges of profitability of ORP cultivation systems on the other hand have each been researched.

The first study was conducted using the concepts of rules of decision-making by farm operators to define their crop rotations. It helped quantify the constraints and rotation possibilities per type of soil as present in Camargue. This study was based on surveys conducted in farms as well as on the observation of interactive simulation sessions and on the analysis of the farmers' experience feedback on these simulations (Maily 2011). Last, taking these constraints into account, scenarii were elaborated and assessed with farmers and local stakeholders of the Camargue territory. These scenarii dealt with the evolution of the territory's farming systems in a context of a reform of the CAP entailing the suppression of the subsidy for rice production. One of the strategies considered by farmers and stakeholders of the territory was to develop systems in OF. The issues of profitability of OF systems, trajectories of possible conversion and the impacts of sustainable development on various metrics at the scale of the territory were addressed, using different models. (Delmotte, 2011).

Results and discussions

At plot level, obstacles to the development of organic rice production remain: the difficulty of managing weeds and in particular, *scirpus maritimus*, impacts rice productivity in OF and the seed stock of weeds that keep growing year after year. The absence of varieties specifically selected for organic rice production and the low quality of available seeds (cleanliness, germination rate) are the second factors evoked by farmers. Lastly, the climate of Camargue and its temperature constraints is the third factor limiting the agronomic performance of rice in OF. The possible levers identified are related to the development of specific techniques for weed control as well as the development of short cycle varieties adapted to the local context and to ORP. At farm level, the constraints identified are related to the low performance of cultivation systems, including the performance of rice in an organic system, but also the performance of other cultures, and to the difficulty of identifying adapted cultivation and crop rotation systems, namely for farms where a large proportion of soils have frequent salt reemergence. The change of rotation when converting to ORP (extension, diversification) represents a risk and can otherwise induce slower amortization of investments necessary for rice cultivation and can require the reorganization of work at the level of the farm. At the level of the territory, constraints identified regarding the development of OF are related to the low level of technical support and the absence of networking among the stakeholders, to public policies that are not very encouraging and to markets, outlets or sector organizations which remain largely opaque to the farmers. In the face of all these constraints, there are many possible levers. Surveys on constraints related to soil types helped formalize the timeframe for minimal and maximal return of organic rice per soil type and confirmed the impossibility of defining a sustainable rotation from the point of view of salinity and weed management on lowlands, which represent some 20% of surfaces cultivated in Camargue. These works made it possible to estimate the maximum possible square footage in ORP from an agronomic point of view at the level of the territory. From a current surface of about 20000ha, if all of Camargue's agriculture was organic, the surface of rice fields would not exceed 13000ha in the case it was technically possible to plant rice twice in sequence and where the maximum return time was 4 years for weed control.

Sessions of simulation with local stakeholders made it possible to highlight different conversion strategies and identify cultivation systems which are more or less profitable depending on market prices. Conversion can be partial, with the introduction of alfalfa and durum wheat in rotation with rice in the case of a farm with livestock, or systems including other legumes (e.g. peas, lentils) in rotation with rice for farms without animal breeding. By combining various approaches at the level of the plot, the farm and the territory, and involving the various territorial stakeholders by means of surveys and simulation sessions, this study contributed to highlighting different obstacles and levers to the conversion to OF. Further research is required to support the latter in their reflection and in the implementation of action plans to serve the development of OF in this territory.

References

Delmotte, S. (2011). Evaluation participative de scénarios : quelles perspectives pour les systèmes agricoles camarguais? PhD dissertation, SupAgro Montpellier, 380p. http://tel.archives-ouvertes.fr/tel-00664304

Mailly, F. (2011). Détérminants et règles de décision des agriculteurs pour la définition de l'assolement. Application aux cas d'exploitations rizicoles camarguaises. End of curriculum internship report, ISARA Lyon,

J-C Mouret, R Hammond, S Ridaura, S Delmotte. 2012. Approaches and methods to produce technical references and to support organic rice producers in Camargue. This conference.

The need for sustainable diets to support optimal nutrition and health

Lairon, Denis

Research Director at INSERM (National Institute of health and medical research)

Joint Research Unit INSERM 1063 / INRA 1260, Nutrition, Faculty of medicine, Aix-Marseille University, Marseille, France.

Key words. Sustainable diet, nutrition, rice, human health, diseases.

Introduction.

The present paper aims at identifying some key aspects basing the need to improve the dietary and nutritional status of people, prevent non-communicable diseases and support the present and long-term sustainable agriculture and food systems. The case of rice is exemplified.

Data and point of view.

It is time to face the evidence of a worldwide unsustainable food system, leaving 1 billion of chronically under-nourished people, 2 billions with nutritional deficiencies and 2.5 billions with overweight and obesity. Its complexity makes it extremely fragile to any climatic, socio-economic, political or financial crisis. Thus, we urgently needs appropriate understanding and new strategies to really accommodate present and future population needs and well-being. Sustainable diets have been defined as follows (FAO, 2010): " Sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources « . In that context, to face increasing problems such as food unsecurity, nutrition-related diseases and ecological damages we urgently need sustainable diet systems, ie both sustainable stapple food production, sustainable food consumption patterns and sustainable food quality.

Rice is the first important staple food for humans worldwide. This thus implies that local low-imput/ agro-ecological rice production systems are developed as well as short-distance production-consumption nets for accessibility to foods and fair trade. Nutrition education about appropriate food choices, compatible with cultural heritages and ecological constraints, remains essential everywhere. This raises another major challenge worldwide given refined white rice is essentially a good source of energy, while unrefined/brown rice is in addition an important source of numerous minerals and vitamins, phyto-active compounds and dietary fibers: all of them are essential to get a high nutrient density, prevent non-communicable diseases and sustain human health. It is noteworthy that refined grains have been involved in the etiology of several cancers, cardio-vascular diseases and type 2 diabetes whereas unrefined whole-grains have been shown to reduce the risk of developing such diseases. Several recent studies have shown that an important daily intake of refined white rice is associated with an increased risk of type 2 diabetes in the USA and asian countries. Because the vast majority of toxic pesticides residues found in conventional unrefined rice are present at the kernel surface it is of key importance to develop alternative production systems with minimal or no use of such pesticides: this notably supports the need for developing agro-ecological/organic systems of production and storage.

Authorities should urgently support fair, culturally-appropriated, biodiversity-based, eco-friendly, sustainable rice production/consumption and diets in all parts of the world.

References

Lairon D., 2010. Nutritional quality and safety of organic food. A review. Agron Sustain Dev. 30: 33-41.

Sun Q, Spiegelman D, van Dam RM, Holmes MD, Malik VS, Willett WC, Hu FB., 2010.

White rice, brown rice, and risk of type 2 diabetes in US men and women. Arch Intern Med. 170(11):961-9.

Hu EA, Pan A, Malik V, Sun Q., 2012.White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review. BMJ. Mar 15;344:e1454. doi: 10.1136/bmj.e1454. Review

Public Policies

Lifran, Robert
Inra, Montpellier, France
e-mail: lifran@supagro.inra.fr

Dynamics of the world market What perspectives for [2]>organic rice?

Lançon, F

ART-Dev Department
Acteurs, Ressources, Territoires dans le Développement
Stakeholders, Resources, Territories in Development
(UMR #5281 – University of Montpellier 3, CNRS, CIRAD),France

Statistics at national as well as international level do not make it possible to assess clearly and reliably the weight of organic rice compared to the overall rice production and exchanges. The little data compiled by organic products producers and distributors' professional organizations (see other presentations) give an indication of the strong growth of this sector in the various production areas. But these data also confirm the marginal weight of organic rice, a few percentage points in the total production volume, all the more so in the volume of international exchanges. However, the relevance of organic rice cannot be summed up simply by assessing its weight in the total volume of the global rice market. We believe it is just as relevant, if not more, to consider the development of organic rice in the perspective of the growth dynamics of global production in order to underline why the emergence of this type of rice is part of an increasing segmentation of rice markets. This contextualization of the development of organic rice will recall the main characteristics of the global rice economy and further by highlighting why the development of organic rice is able to address the changes of consumers' preference criteria.

Rice, corn and wheat are the staple cereals for the planet's diet. However, the singularity of rice lies in the fact it is almost exclusively used for human food whereas most of the corn production and a growing proportion of wheat are used as animal fodder or for other agro-industrial uses (sweetener, fuel…). Rice also differs from the other two global cereals in the form in which it is consumed. Indeed, whereas corn and wheat are used in the form of flour for the preparation of more elaborate food products, rice is consumed as husked grains, more or less polished (the proportion of rice turned into flour or distilled is low and limited to Asian countries). To some extent, rice remains a food product with little transformation all the way to the consumer's plate, whereas wheat and corn are more used as food raw materials. The consumer is therefore more able to appraise certain quality attributes (shape, color, texture, taste…) in the case of rice more than with other cereals.

Rice remains above all a cereal of the Asian continent, which accounted for 84% of the world consumption over the last decade. However, if Asia still dominates the global rice economy, the fastest growth rates in rice demand are recorded outside Asian countries. Thus, while per capita consumption tends to plateau in Asian countries, or even to decrease for the richest social categories, in Northern Europe, per capita consumption was multiplied by 6 between the sixties and the last decade; in sub-Saharan Africa, per capita consumption was multiplied by 3. The rise in consumption being more moderate in the Middle East and Latin America. This growth of the non-Asian demand translated into an intensification of global exchanges because most of the areas where the demand for rice increased are not self-sufficient. Thus the global market of rice experienced an accelerated growth, going from 5 million tons in the sixties to 15 million tons in the nineties and exceed 30 million tons in the last decade. This strong growth should however be put in perspective since these global exchanges still represent less than 10% of the global production, the bulk of global demand (in China and

India in particular) being satisfied primarily by local production. This global rice market, however residual, is a good indicator of the evolution of the status of rice in eating habits, in particular in areas with a strong growth of consumption.

Whereas during the eighties and nineties, global rice exchanges were essentially analyzed in terms of food security and dependency, we now see that other factors are starting to influence the configuration of these flows. Overall, it is noticed that consumers are increasingly demanding with regard to quality, even in regions where rice remains first and foremost a staple food, all the more so in high income countries where consumption growth corresponds to a process of diversification of diet styles. Thus, parboiled rice represents an increasing part of sub-Saharan African imports because its culinary properties (less sticky grains) satisfy the demands of some consumers. In these markets which used to be somewhat undemanding in terms of quality, growing demand is observed for fragrant rice, as whole grains or as broken rice. Increasing demands on the part of consumers in these mass markets also entail the emergence of brands in the distribution circuits for imported and local rice and of more sophisticated packagings (5kg bags).

In high income markets as well, there is an increasing segmentation of the rice market based on qualities that refer more and more to the origin of the rice, where fragrant rice (Basmati, Thai) are taking up more and more space on shelves, but also based on the ease of cooking (fast cooking rice…). Surveys indicate that more than 500 new rice references have been introduced on the market in 2010, vs less than 300 in 2007 (Datamonitor, 2012);
This diversification in the rice offer is observed in Europe but also in Asia, where it is even more the hallmark of a change in the status of rice in dietary habits.

Thus, in all areas where rice is consumed, those where it is still a mass consumption product as well as those where it participates in the diversification of dietary styles, an increasing segmentation of the rice market is observed depending on the organoleptic qualities, the packaging and transformation processes. This evolution can only be favorable to the sustainable development of the demand for organic rice, which thus participates in the diversification of the types of rice proposed to consumers who are increasingly demanding about quality and ready to try novelties.

References,
Lançon F., 2011, LE Riz, Un produit vivrier local ou une céréale globale ?, DEMETER report 2012

FAOSTAT, www.faostat.org FAO 2012

Katie Page, 2012, Consumer Trends In Specialty Rice, Rice Trade Outlook Conference 2012, Marseille

FIELD TRIP IN CAMARGUE

Communications index

Ducks to weed rice fields: a promising crop-animal farming forCamargue organic rice producers

Falconnier, Gatien[1]., Mouret, Jean-Claude[2]., Hammond, Roy [2].

[1] Icrisat Bamako, BP 320, Bamako Mali, g.falconnier@icrisatml.org
[2] Unité Mixte de Recherche Innovation, INRA-SAD, 2 place Pierre Viala 34060 Montpellier Cedex 2, France

Keywords
Crop-animal farming integration, weed control, agronomic diagnosis

A partnership between researchers and farmers to innovate in the management of weeds:

European agriculture must now face the need to invent less polluting and more sustainable cultivation systems. In Camargue, rice producers have embraced that approach. In partnership with the Institut National de Recherche Agronomique (INRA / *National institute for agronomic research*) and France Agrimer, they are experimenting alternatives to chemical weed control agents. In 2011, the INRA carried out the agronomic diagnosis of a farmer's innovation: the introduction of ducks in the rice fields. In Japan, this technique is applied after rice transplanting. In Camargue, rice seeds are broadcast after immersion of the field. Adapting the Japanese technique to the Camargue context proved a genuine challenge: the farmer opted for line sowing, i.e. buried and dry sowing, to later allow the ducks to move around the rice field between the lines of rice. He also selected a race of non-flying Mulard ducks; among which only the males are of interest to producers of foie gras. The purpose of this communication is to assess the agronomic relevance of this technique as an alternative to chemical weed control agents. The agronomic diagnosis made it possible to measure the effect of the sowing method on the emergence of weeds (compared to the stock already present in the soil) and to observe the ducks' capacity to eat them up without damaging the rice. The study was centered on barnyard grass (*Echinocloa Crus-Galli*), main weed of Camargue (Carlin et al, 2004).

An agronomic diagnosis to quantify the evolution of plant population:

The program includes a plot with row planting of dry buried rice seeds, chosen by the farmer in view of duck introduction into the plot and 3 plots with broadcast seeding after immersion (without ducks). The technical method implemented by the farmer in each plot was reported by the farmer in a survey. The agronomic monitoring of plots was performed at the level of a $100m^2$ station in each plot. In the plot intended to welcome the ducks, there were two stations: a "control" station, closed off to prevent intrusion of the ducks and a station accessible to the ducks. Determination of the average stock of weed seeds (0-5 cm layer) was performed after greenhouse germination and counting of seedlings on samples from each station. The sample consisted in 8 blocks (50 cm^2 by 5 cm in depth) taken from the station's diagonal lines. The densities of rice and weed populations were determined by counting on 4 blocks of 0.5 m^2 (row planting) and 0.25 m^2 (broadcast seeding) in each station. The barnyard grass germination was calculated as the ratio: density of barnyard grass at 2-3 leaf stage / barnyard grass seed stock in the 0-5 cm layer. Before harvest, the dry matter (DM) of the barnyard grass at the level of each plot was measured per harvest, drying and weighing. The DM/density of barnyard grass at 2-3 leaf stage was used to estimate the average weight of a barnyard grass plant before harvest.

A sowing method which boosts the emergence of barnyard grass… which feeds the ducks!

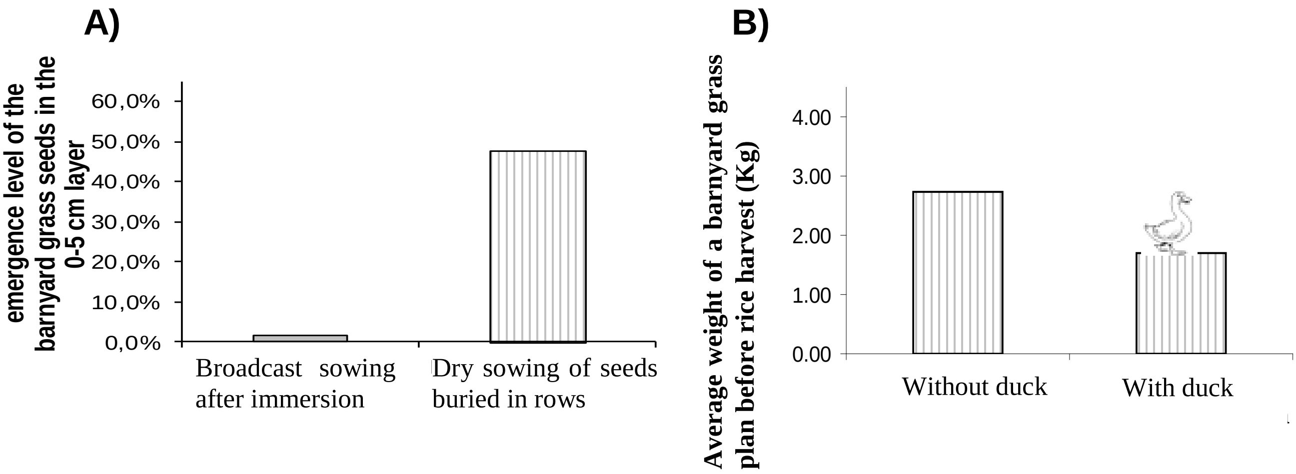


Figure 1: A) Influence of the sowing method on the emergence of the barnyard grass seeds in the 0-5 cm layer. The results shows that dry sowing of seeds buried in rows, to allow the ducks to cruise around the plot, greatly boosts the emergence of barnyard grass as compared to broadcast sowing after immersion.

B) Weight of a barnyard grass plant before the rice harvest, with or without ducks in the plot with row planting. This result shows that the ducks cut off the stalks of barnyard grass, trample them and thus limit their growth.

Our results show a 47.8% average emergence of barnyard grass seeds in the plot where rice is sown in line to welcome the ducks, against a mere 1.5% in plots where the seed was broadcast after immersion (Figure 1A). This rate of emergence in the row-planted rice plot corresponds to an average density of 131.5/m^2 barnyard grass at stage 2-3 leaf of the rice. This high density of barnyard grass at stage 2-3 leaves of the rice is accounted for by a weak competition from the rice, sown at low density, but also by a period of 12 dry days after sowing the rice. Indeed, dry soil proved favorable to the emergence of the barnyard grass. In the plots with broadcast seeding, the 15 cm of water at the moment of sowing prevented the emergence of the barnyard grass. As a matter of fact, under a 2-3 cm waterbed, the absence of oxygen prevents the emergence of barnyard grass (Chauhan et Johnson, 2011. The type of sowing chosen by the farmer to allow the entry of ducks therefore does not seem to be favorable to the primary aim which was to fight off barnyard grass. However, our results showed that in a row-planted plot with dry buried seeds, the average weight of the barnyard grass plant is lower by 1 kg in the presence of ducks (Fig 1B). The ducks cannot totally kill the barnyard grass as was expected by the farmer in view of results achieved in Japan (Tanveer et al., 2005). In fact, when the ducks were introduced in the plots, the barnyard grass was too developed to be completely eaten up. But the ducks cut the stalks of barnyard grass, trampled them, leaving dirty water behind, thus stopping their development. At harvest, the biomass of barnyard grass in the station with ducks was lower than in the station without ducks (2.46 t/ha vs 2.97 t/ha) and the rice yield was improved by 24% (2.85 t/ha vs 2.25 t/ha). We have thus highlighted the relevance of adaptation choices made by the farmer: in spite of a strong density of barnyard grass in the beginning, related to the sowing method, the ducks made it possible to curb their development and thus, to reduce the competition they impose on rice. Moreover, duck integration in rice fields offers interesting perspectives: the farmer chose to sell some of them to have a return on investment and keep the rest so that they would eat up the grains of barnyard grass during the winter. The economic assessment over several crop cycles of this rice-duck farming interaction remains to be analyzed.

Bibliographic references

Carlin, A. et al. 2004. Riziculture biologique - Maîtrise des mauvaises herbes en Camargue. Questionnements et débats techniques, diversité des pratiques et premiers résultats de recherche. INRA Umr Innovation.

Chauhan, B.S., et Johnson D.E. 2011. Ecological studies on Echinochloa crus-galli and the implications for weed management in direct-seeded rice. Crop Protection 30(11): 1385-1391.

Tanveer, H.S et al. 2005. Effect of Integrated Rice-Duck Farming on RiceYield, Farm Productivity and Rice-Provisioning Ability of Farmers. Asian Journal of Agriculture and Development 2(1&2): 79-86.

The nature reserve in Camargue

Coulet, Eric[1], Chérain, Yves[1], Chéiro,Anaïs[1]

[1] SNPN – Réserve Nationale de Camargue

The Société Nationale de Protection de la Nature (National Society for the Protection of Nature) has been managing the Réserve de Camargue territory since 1927, with a strong policy of scientific data collection prior to any intervention on ecosystems. Management is carried out in a spirit of tolerance and open-mindedness , which, without jeopardizing its choices and analyses has always enabled it to live harmoniously side by side with the other stakeholders in the Delta, with their occasionally conflicting interests: The Camargue nature reserve is one of the stakeholders of the Camargue rural world whose aim is clearly to assess the health of the heart of the Camargue, itself a good indicator of the health of the Delta as a whole.

The nature reserve and rice

In this context, the impact of agricultural discharges at the Vaccarès, in the nature reserve (spills prohibited since 1909!) has become an ever more sensitive issue over the past twenty years, growing from the stage of contamination to the stage of pollution. This input of clear water is essentially channelled through a single overflow canal (the others spill the water to the Rhône through pumps) and it concerns one of the Camargue watershed: the Fumemorte. Emergency action is now required, but should be carried out with major precautions, given the history and the complexity of the problem: we started from the hypothesis that there are multiple reasons causing damage to the Vaccarès ecosystem, possibly with synergies between the problems and one amplifier, in all likelihood, the rise of level of the sea and the resulting non "rinsing" of ponds.

We therefore have:

- Several "potential suspects": fertilizers, phytosanitary products…
- Aggravating circumstances (amplifier): non-rinsing of ponds, accumulation of certain products
- An indicator: the proliferation of cyanobacteria

We therefore decided to set up several actions ranging from the increase in the possibilities of discharge into the sea to the reduction of the water volumes used in rice fields, through a better control of consumption and new techniques (dry seeding in particular), and a reference document on "inputs" that we (the SNPN) are drafting about the Vaccarès. This reference document, based on a monthly analysis of phytosanitary products present in the ponds as well as fertilizers (nitrogen, phosphorus) is associated to fine measurements of the parameters of the physical and biotic environment (eelgrass beds, benthos, fish, phytoplankton). This operation which will be used to assess the results of the overall operation started in 2011 with funding from the Water Agency in the framework of the "Delta Agreements".

Camargue Regional Natural Parc

Vianet régis[1]

[1] Parc Naturel Régional de Camargue, France

The Parc Naturel Régional de Camargue (Camargue Regional Natural Parc) was established in 1970 and now covers all the territory around the Rhone Delta, located in the Bouches du Rhône Département. Thus, more than 110 000 ha of territories that are both fragile and remarkable with a rich natural and cultural heritage are preserved, while at the same time human activities and economic development demonstrating respect for the environment can be pursued. The action of the Parc thus ensures sustainable protection and management of the natural, cultural and landscape heritage which is the hallmark of France's largest wet area. It also participates in the land planning and harmonious economic development of the classified area. It promotes innovation projects and experiments new management methods. Lastly, it participates in missions aiming at welcoming and educating the public on territory-related topics.

With regard to the natural heritage, the Parc actively participates in the preservation of the natural spaces that cover 53% of its territory. It promotes concrete measures of preservation of nature, namely through the recovery of dunes, direct management of natural areas, the fight against invading species and the preservation of bird nesting sites… Water being present everywhere in the Camargue, the Parc committed to ensuring a comprehensive control of the management of water throughout its territory. Thus all stakeholders of the water issue meet around the "*Contrat de Delta*" (Delta Agreement) project which aims at preserving the quality of water and aquatic environments of the territory. The Parc is setting up a genuine landscaping policy through the landscaping and urban planning charter which is established in the framework of a wide concertation with all stakeholders. It supports various actions intended to reconcile agriculture and environment, and more specifically, quality approaches, through actions targeting bull breeding farms and rice production, two agricultural activities that really shape the identity of the Pays d'Arles. The Parc also relies on innovative approaches to develop sustainable tourism by awarding the label "Parc Naturel Régional de Camargue" which is the hallmark of added value in the eyes of ever more quality conscious visitors. It also implements the European charter of sustainable tourism. From the point of view of culture and education, it is promoting the territory's cultural development through the *Musée de la Camargue* (Museum of Camargue) and steers actions of territorial education available to the inhabitants, to young visitors, socio-professionals and all visitors. The Parc participates in numerous local events aimed at informing and sensitizing the public. Thus, like all other Natural Regional Parcs in France, the Parc Naturel Régional de Camargue aims at promoting the natural, cultural and human heritage of its territory which is a showcase for the Mediterranean wetlands.

POSTERS

Control of the emergence of weeds with mulching in rain-fed rice fields in Madagascar

Naudin, K. 1, Irintsoa Rasolofo, L2., Rakotomalala Andriamarosata, J. 3, Douzet, Jean-Marie. 1, Scopel, E. 1,

[1] CIRAD, UPR Systèmes de Culture Annuels, F- 34398 Montpellier, France, naudin@cirad.fr
[2] Université d'Antananarivo, ESSA, Département « Agriculture », 101, Antananarivo,Madagascar
[3] Institut supérieur polytechnique de Madagascar 101, Antananarivo, Madagascar

Keywords: Rain-fed rice, mulch, weeds, conservation agriculture

Introduction

Conservation agriculture (CA) started being tested in 1998 in the region of Lake Alaotra. In this region in 2010-2011, 2000 farmers applied CA on part of their land. One of the three principles of CA is to keep a permanent cover on the soil (FAO, 2012), which has an effect on weeds thanks to various mechanisms. We studied one of these mechanisms: the direct effect on the emergence of weeds (Teasdale and Mohler, 2000). We noted two types of mulch frequently used as organic cover in rain-fed rice fields in CA in the region of Lake Alaotra: a mixture of corn + cowpea residues (*Zea Maize* + *Dolichos lablab*) and residues of stylosanthes (S*tylosanthes guianensis*, CIAT 184). Several levels of soil cover were compared. As a matter of fact, in practice, farmers do not always manage to produce and keep enough residues on the soil to ensure complete cover (Naudin et al, 2011).

Method

This study was carried out during the rainy season in 2010-2011 and 2011-2012 on the CALA experimental station in Ambohitsilaozana, 17°41'25"S, 48°27'35"E, on downhill colluviums. The 2011-2012 experiment was set up at some fifty meters from the 2010-2011 installation. The previous rotation before the two experiments were a fallow of about 3 years after corn cropping. Over the two years, the experiment was separated into four distinct blocks. Each block had elementary 1m^2 plots, including two coverless control plots and 7 plots with increasing cover rates for each of the types of cover (corn+cowpea and stylosanthes). The rates of coverage in 2010-2011 were respectively for the corn+cowpea: 16, 37, 55, 68, 90, 97, 99 %; for the stylosanthes: 14, 32, 49, 62, 86, 95, 99 %. In 2011-2012, the rate of coverage was the same for the two types of cover: 30, 60, 80, 90, 99 %, as well as two other treatments at more than 100% soil coverage. "150%" correspond to 1.5 times the amount of biomass to reach 99%, "200%" correspond to double the amount of biomass to reach 99% of soil coverage. The amount required to reach these various levels of coverage was calculated using the established mulch-cover ratio (Gregory 1982), locally calibrated for the type of residue (Naudin et al.). The residue came from the crops of the neighboring plots. The emergence of weeds was observed in squares of 50cm x 50 cm in the middle of the 1m^2 plots (Teasdale and Mohler, 2000). Once a week, the weeds emerging above the soil or the mulch were removed carefully, separating monocots from dicots. The observations took place over 3 months and a half, starting at the beginning of the rainy season.

Results and discussion

With regard to the treatments without cover, the total of weeds emerged in a 0.25 m^2 square was respectively 116 for dicots and 90 for monocots in 2010-2011, then 140 and 210 in 2011-2012.

The main species present were *Amaranthus hybridus, Ageratum conyzoïdes, Tridax procumbens, Commelina benghalensis, Euphorbia hirta, Sida* sp., *Eleusine indica, Digitaria* sp., *Mitracarpus hirtus, Dolichos lablab, Macroptillium atropurpureum, Cyperus sp.*

The 2010-2011 observation season was dryer than the 2011-2012 season. In 2010-2011, mulching seems to have had a beneficial effect on the soil's hydric content and consequently on the emergence of weeds. As a matter of fact, on the treatment with stylosanthes mulch, the treatment with 32% soil cover presents almost twice the emergence rate, for dicots and monocots alike. Besides, it takes a 90% soil cover in corn+cowpea to achieve a significant reduction of emergence compared to the coverless control plot (data not shown here). For the stylosanthes cover, it takes a 95% cover to see an effect. With monocots, even at 99% of soil cover, there are not significantly less weeds than on the coverless control. Lastly, in 2011-2012, even with a mulch quantity double the quantity required to cover 99%, cyperus still managed to emerge through the mulch. The difference in plant association between weeds present in a partial or total cover still needs to be studied.

In conclusion, growing rain-fed rice with direct sowing in a mulch can only have an effect on the emergence of weeds with large quantities of biomass which is often beyond reach at the farmer's level. However, techniques of conservation agriculture have other effects on germination, rise, growth and development of weeds that now need to be known better, for instance: the physical "anti-stain" or allelopathic effect resulting from the presence of cover crops in the year preceding the rice cropping, or the effect of not working the soil on the infestation potential of the weed seed stock.

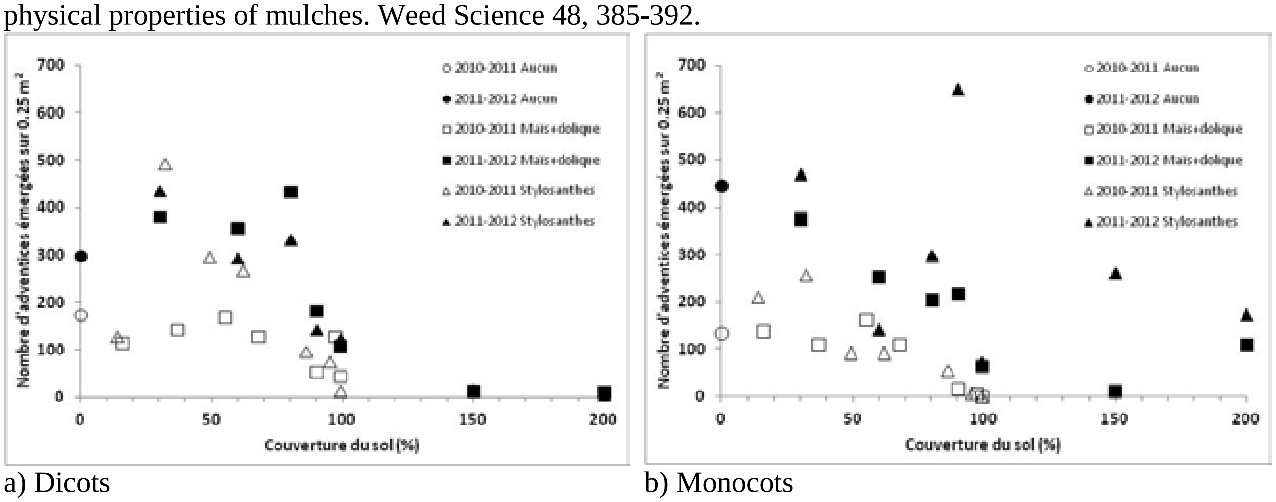
Bibliographic references

FAO:AG:Conservation agriculture [WWW Document], 2012. . URL http://www.fao.org/ag/ca/

Gregory, 1982. Soil cover prediction with various amounts and types of crop residue. Transactions of the ASAE 25, 1333-13337.

Naudin, K., Scopel, E., Andriamandroso, A.L.H., Rakotosolofo, M., Andriamarosoa Ratsimbazafy, N.R.S., Rakotozandriny, J.N., Salgado, P., Giller, K.E., 2011. Trade-offs between biomass use and soil cover. The case of rice-based cropping systems in the lake Alaotra region of Madagascar. Experimental Agriculture 48, 194-209.

Teasdale, J.R., Mohler, C.L., 2000. The quantitative relationship between weed emergence and the physical properties of mulches. Weed Science 48, 385-392.



a) Dicots b) Monocots

Figure 1. Cumulated emergence of dicots (a) and monocots (b) from 04/01/2011 to 01/03/2011 (2010-2011) and from 25/11/11 to 16/03/11 (2011-2012) in a 50cm x 50 cm square depending on the soil's cover rate per type. Two types of residues corn+cowpea and stylosanthes, compared to exposed soil (none). Each dot is the average of 4 repeats for the mulch-based treatments and 8 for the exposed soil treatments.

Control of the emergence of weeds with mulching in rain-fed rice fields in Madagascar
Influence of *Scirpus maritimus* population on rice under organic production in Southern Spain.

Aguilar Portero, M., Aguilar Blanes, M., Ortíz Romero, C., Fernández Ramírez, J.L.

IFAPA, Centro Las Torres-Tomejil, manuel.aguilar.portero@juntadeandalucia.es

Keywords
Organic rice, weeds, *Scirpus maritimus*, hand weeding cost.

1. Introduction.

In Andalusia (Southern Spain) rice surface under organic production occupies only about 300 has. Weeds (*Echinochloa spp.*, *Scirpus maritimus* and *Cyperus difformis*) are the most important problems in this kind of production. In order to know the agronomical and economical responses of rice to both high and low levels of Scirpus maritimus a study was carried out in Guadalquivir Marshlands rice area (Seville) during 2008 and 2009.

2. Methodology.

In 2008 we chose a plot (10 has.) with a high *Scirpus maritimus* population level while in 2009 the experimental plot had a low *S. maritimus* level (as a reference, the Specific Regulation of Integrated Rice Production in Andalusia fixes the threshold for insecticide application in 0,1 plants/m^2). In the first year the chosen variety was SP-601 (hybrid long grain). In the second year the grown variety was Bomba (round grain, low grain yield potential but high grain quality). Several agronomical parameters were taken into account (see tables). In addition, hand weeding costs were also recorded. All agronomical practices were carried out according to organic production norms. Hand weeding was carried out to control the diverse weed population (90% of these individuals are *Echinochloa sp*., followed by some plants of wild rice and *Scirpus maritimus*). Weed population was sampled three times each year, prior to each hand weeding operation (sampling dates: 06.25, 08.05 and 08.16 in 2008, and 06.23, 07.28 and 09.04 in 2009), with rice at early tillering stage, panicle iniciation and rough grain phenological stages.

3. Results and discussions

In 2008, SP-601 got a very low grain yield because of a very high weed infestation. In order to clean the plot 26.8 hand weeding working days were necessary (each working day costs 55€, with a total cost of 1474€). In that conditions rice culture is not economically possible. On the contrary, in 2009, Bomba reached a good grain yield with a low hand weeding cost. It is important to point out that *Echinochloa spp.* and *Scirpus maritimus* are susceptible to be weeded by hand (specially *Echinochloa spp.*). That is not possible in case of *Cyperus difformis*, given the size and big population of this weed.
We conclude that from an economical point of view, in addition to a very low level of *Cyperus difformis* to carry out rice organic production in Southern Spain, low levels of *Echinochloa spp.* and specially of *Scirpus maritimus* are necessary. Although the influence of the cultivar factor exists, it was not significant with regard to the population evolution of *Scirpus maritimus*.

4. Tables.

Table 1. Weed population evolution (plants/m^2) and hand weeding costs in rice under organic production. Seville 2008.

Hand weeding sampling time	***Echinochloa sp.***	***Scirpus maritimus***	***Ammania coccinea* and *robusta***	***Typha angustifolia***	***Bergia capensis***	**Other***	**Total (plants / m^2)**	**Working days**	**Costs (55€ / working day)**
Prior to 1st hand weeding	0	39	3	0	0	8	50	8,5	467,5
Prior to 2nd hand weeding	0	41	0	0	0	0	41	18,3	1006,5
Prior to 3rd hand weeding	0	16	0	0	0	1	17		
Total	0	96	3	0	0	9	108	26,8	1474

* Cyperus difformis was not present in 2008 campaign

Table 2. Weed population evolution (plants/ha) and hand weeding costs in rice under organic production. Seville 2009.

Hand weeding sampling time	***Echinochloa sp.***	***Scirpus maritimus***	***Cyperus difformis***	***Typha angustifolia***	***Polygonon monspeliensis***	**Total (plants / ha)**	**Working days**	**Costs (55€ / working day)**
Prior to 1st hand weeding	167	83	0	0	167	417	0,8	44
Prior to 2nd hand weeding	10	1944	2	765	3	2723	3,2	176
Prior to 3rd hand weeding	2	817	1	85	1	906	2,5	137,5
Total	179	2844	3	850	171	4046	6,5	357,5

Table 3. Agronomical response to both high (2008, cultivar SP-601) weed infection level and low level (2009, cultivar Bomba) in rice under organic production. Seville.

Variety	**Days to heading**	**Plant height (cm.)**	**Lodging (%)**	**Yield components**				**Grain humidity at harvest**	**Industrial yield**		**Grain yield (Kg. / ha) at 14% grain humidity**
				Panicles / m^2	Grains / panicle	1000 grain weight	Blank grains		Total (%)	Whole grains (%)	
SP-601	104	67	0	159	69	19,7	9,6	20,8	71,8	68,2	1974
Bomba	92	119	75	253	69	27,4	3,6	20,4	74,6	66,4	4256

Response of the rice cultivar Bomba to different rates of nitrogen fertilizer in organic production.

Aguilar Portero, M.; Rivas Vañó, E.; Gutiérrez Ruíz, M.V.; Aguilar Blanes, M. and Fernández Ramírez, J.L.

IFAPA, Centro Las Torres-Tomejil, manuel.aguilar.portero@juntadeandalucia.es

Keywords

Rice, organic, weed, nitrogen rate, Guadalquivir River Marshlands.

Introduction.

Rice organic production avoids the use of pesticides and chemical fertilizers obtained by synthesis (non natural source). The rice production area of Seville, adjacent to the Doñana National Park, is an ecosystem indispensable for feeding, protecting and reproducing the wide and huge fauna of the Guadalquivir River marshlands. The cropping practices used, increasingly more respectful toward the environment, will strengthen even more the existent relation of synergism between both ecosystems.

The aim of the study was to know the response of cultivar Bomba to different rates of organic fertilizer. Given its low potential grain yield and its well known tendence to lodge, we used fertilization doses lower than those used for other cultivars. “Bomba” was chosen due to its excellent culinary quality and its high commercial value.

Several agronomic and physiologic parameters were registered in order to get a better interpretation of the yield results to be obtained.

Methodology

The trial field was located in Aználcazar (Sevilla), in two plots with a surface of 11,27 and 11,40 ha. The study was carried out during the 2009 and 2010 campaigns.

The tested cultivar was Bomba (round grain). Seeding rate was 195 Kg./ha, slightly over the seeding rate used under integrated production, aiming to get a faster field coverage to minimize the competence of weeds.

Three nitrogen rates were tested: 1000, 1500 and 2000 kg/ha. of the organic fertilizer Agrimartin Humifen (3.5-4-4), applied before seeding as basal dressing, which means 35, 52.5 and 70 Kg. N/ha. Preseeding fertilisation was carried out the 05.20.2009 and 05.19.2010. Seeding operation was performed the 05.25.2009 and 05.24.2010.

The experimental design used was a randomized block with four replications. Elemental plot area was 495 m^2 (6,60m x 75,0 m). The 12 elemental plots were delimited using sticks and flags to fit the described plots size. Given the possible displacement of the applied fertilization into adjoining elemental plots, prior to harvest a conventional combine harvested the limits of each elemental plots to clean the displacement areas.

The parameters registered were (per elemental plot): days to heading, plant height (cm.), lodging (%), grain yield (kg/ha. at 14% grain humidity), yield components (panicles per square meter, grains per panicle, blank grains expressed as percentage, 1000 grain weight), industrial yield (%), incidence of pest and diseases and weed control through sampling and identification.

Cropping practices (fertilization, irrigation, applications, etc.) were those usually used in the rice area, in accordance with the conditions of organic culture. Preseeding tillages were practiced in a more intense way than usual to eliminate the weeds and reduce their competition with the crop, specially during the first crop stages.

The incidence of pests and diseases, as well as the damages observed, was low. The presence of adult individuals was detected using pheromones traps. Auxiliary fauna was used against aphids.

Identification and control of weeds was carried out by taking samples of each elemental plot prior to each hand weeding operation.

Results and discussions

With regard to both days to heading and plant height no significant differences were found among the three tested treatments (see Tables). Significant differences were found in grains per panicle in the higher treatment.

With regard to grain yield, significant differences were also found with the treatment C. In this treatment grain yield was clearly higher than A and B treatments, consisting of 1000 and 1500 Kg. /ha of fertilizer, respectively. In our study conditions, no significant differences were found between treatments A and B.

A low incidence of *Scirpus maritimus* was observed, as well as an even lower infestation of *Echinochloa* sp. and *Cyperus diformis*. Therefore, the chosen plots were exceptionally "clean" of weeds, appropriate for organic production.

We can conclude that the most advisable nitrogen rate for this variety ranges between 60 and 70 Kg. N/ha. Higher rates would increase the risk of plant lodging, as usually happens, for this cultivar, under integrated production.

4. Tables.

Table 1. Agronomic response of rice (Bomba) to different fertilization rates. Mean values of 2009 and 2010 campaigns.

Fertilization rate	Days to heading	Plant height (cm)	Yield components				Grain moisture at harvest		Industrial yield			Grain yield	
			panicles /m^2	Grains /panicle	1000 grain weight (g)	Blank grains (%)	%	% Mean	Total (%)	Whole grains (%)	% mean (whole grains)	kg/ha (14% grain humidity)	% Mean
A (35 kg. N)	92	1.14	238	54	27	5	20.2	99.7	74.2	66.6	99.5	2,995	84.7
B (52,5 kg. N)	92	1.15	253	56	26.9	2	20.2	99.7	74.2	67.8	101.3	3,357	94.9
C (70 kg. N)	92	1.19	253	69	27.4	3.6	20.4	100.7	74.6	66.4	99.2	4,256	120.4
Mean	**92**	**1.16**	**248**	**60**	**27.1**	**3.5**	**20.3**		**74.3**	**66.9**		**3,536**	
LSD (95%)			**73**	**9**	**2**	**-**			**-**	**2.2**		**552**	
CV (%)			**17**	**9.2**	**4.3**	**-**			**-**	**1.9**		**8**	

Table 2. Weed population evolution and hand weeding costs under organic production. Mean values of the campaigns 2009 and 2010.

Sampling time	***Scirpus maritimus***	***Typha angustifolia***	***Cyperus difformis***	***Polygonon monspeliensis***	***Echinochloa* sp.**	**Total (plants/ha)**	**Working days /ha**
Prior to 1st picking out	83	0	0	167	167	417	**0.8**
Prior to 2nd picking out	1944	765	2	3	10	2723	**3.2**
Prior to 3rd picking out	817	85	1	1	2	906	**2.5**
Total	**2844**	**850**	**3**	**171**	**179**	**4046**	**6.5**

Pig slurry as nitrogen fertilizer on rice crops

Ortiz, C.[1], Català, MM.[2], Pla, E.[2], Tomàs, N.[2], Murillo, G.[1]

1DAAM. Departament d'Agricultura, Ramaderia, Pesca, Alimentació i Medi Natural. carlos.ortiz@gencat.cat

[2]IRTA. Institut de Recerca i Tecnologia Agroalimentàries.

Keywords

Rice, nitrogen, organic fertilizer, pig slurry, manure

Introduction

Catalonia is the first Spanish region in the national register of pigs (26.3% of the national register) (MARM, 2010) with a census higher than 25 millions. The use of pig slurry (PS) as fertilizer is the most common recycling methodology in corn, wheat, barley and olive orchards and could be a strategically alternative to apply on rice crops due to the proximity of a high density of farms to the Ebro Delta rice area. Nowadays, N P K nutrients as chemical fertilizers are the most used in the region. However, the world energetic crisis and the increasing cost of chemical fertilizers have encouraged the interest for the use of farmyard manure (Meelu O.P., Morris R.A. 1987) which can guarantee a larger amount of macro and micronutrients (Mn, Cu, Zn and Fe) with lower cost (Hesse P.R., 1984). Furthermore, it improves the physical properties of the soil and represents an environmental friendly agronomic practice, even allowed with organic agriculture under some conditions. As a consequence, these economic, agronomic and environmental advantages have encouraged the launch of actions involved in the promotion and diffusion of good agricultural practices, such as the proper management of cattle droppings in order to prevent water sources from nitrates pollution.

The essay aims at assessing the response of rice crop to the fertilization with PS and at establishing criteria for the dosage.

Methodology

The experimental site was located in a 2 ha-plot, in South-east of Catalonia (Spain) (40º43'58" N, 0º 45'56" E, at 0 meters above sea level) in Ebro Delta rice area. The medium-term organic and chemical fertilization field experiment was established in 2007; previously only mineral fertilized was used. The experimental design was laid out with a split-block with three replicates, in which the main plot and subplot were the basal and top dressing fertilization, respectively. The main plot area was 780 m^2 and the subplot area was 390 m^2. Rice variety used was Gleva, widely grown in Ebro Delta rice fields, at 182 kg seeds $ha^{-1.}$ Agronomic practices were identical to local management practices by commercial rice farmers.

The basal fertilization treatments were: control (no basal fertilization), mineral fertilization (120 Kg N ha^{-1} as ammonium sulphate at 21% N), low rate of PS (90 Kg N ha^{-1}), medium rate of PS (130 Kg N ha^{-1}) and high rate of PS (170 Kg N ha^{-1}). The control treatment was complemented with P and K as superphosphate at 18% and potassium chloride at 60%. The mineral treatment, commonly used in the region, was used to compare the results with the organic ones.

In the subplots, top dressing fertilization (40 Kg N ha^{-1}) with ammonium sulphate at panicle initiation (PI) was compared with no fertilizer application.

Paddy soil properties before experiment initiation were as follows: pH: 8.2, organic matter: 4.0 %, N Kjeldhal: 0.23 %, P: 37 mg kg^{-1}, K: 307 mg kg^{-1}, USDA classification: silty clay.

The annual average temperature is 18ºC.

The average N P K content of PS was 16.9, 1.7 and 11.2 %, respectively. More than 80% of total N of PS was in ammonium N, what made it immediately available for rice crops.

Results and discussions

The different strategies of fertilization studied did not affect either the seedling establishment, or development of pests and diseases or weeds infestation. Mineral fertilization and high rate of PS gave the highest panicle density, but only with significantly different with the check (Figure 1). As expected, lower yields were observed in the check. As the doses of N increased yield increased, until it reached the maximum yield at 120-130 kg N ha^{-1} (Figure 2). However, attending to economical and environmental points of view, medium PS treatment is the optimum dose.

Although yield was increased in 300 kg ha^{-1}in plots with top dressing application of nitrogen at panicle initiation, there were no statistical differences.

No differences between treatments were found on rice quality after processing.

According to the results, the use of PS as basal fertilization instead of mineral fertilizer in direct seeded rice is a good agronomic practice that can be recommended to rice farmer to reduce input cost and to increase sustainability and profitability.

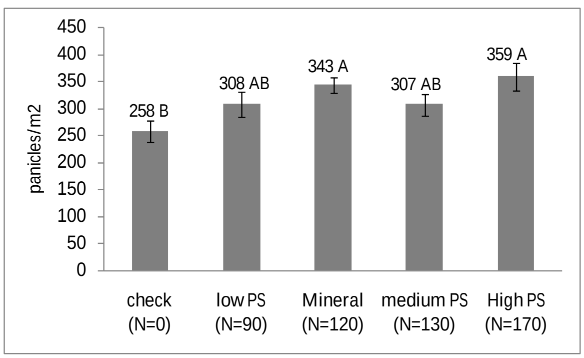


Figure 1. Effects of different basal fertilization treatments on panicle density. The values shown are the average of the five year period (2007-2011). Different letters differs significantly at P<0.05 (DMRT)

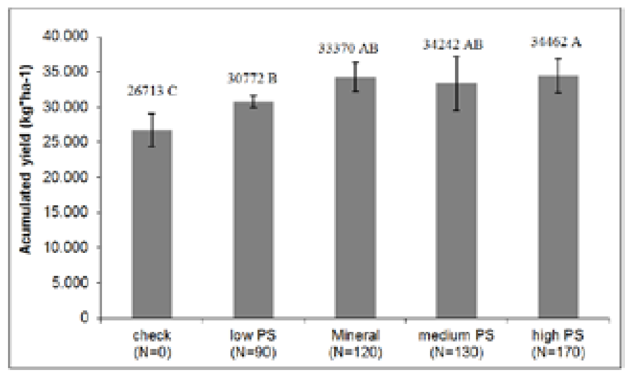


Figure 2. Effects of different basal fertilization treatments on accumulated grain yield during 5 years (2007-2011). Different letters differs significantly at P<0.05 (DMRT

References

Hesse P.R. 1984. Potential of organic materials for soil improvement. In organic matter and rice. IRRI. Los Baños, Laguna, Philippines. 35-42.

Ministerio de Medio Ambiente y Medio Rural y Marino. <http://www.marm.es>

Meelu O.P., Morris R.A. 1987. Integrated management of green manure, farmyard manure, and inorganic nitrogen fertilizers in rice and rice-based cropping sequences. In Efficiency of nitrogen fertilizers for rice. IRRI. Los Baños, Laguna, Philippines. 185-193.

Rice fertilization with chicken manure

Ortiz, C.[1], Català, MM.[2], Pla, E.[2], Tomàs, N.[2], Murillo, G.[1]

[1]DAAM. Departament d'Agricultura, Ramaderia, Pesca, Alimentació i Medi Natural. carlos.ortiz@gencat.cat
[2]IRTA. Institut de Recerca i Tecnologia Agroalimentàries.

Keywords
Rice, nitrogen, organic fertilizer, chicken manure

Introduction

High inputs of chemical nitrogen (N), phosphorus (P) and potassium (K) have been used globally to increase crop yields. This leads to a deterioration of soil quality due to the reduction of organic matter. The handling and use of manure produced on farms is a major environmental problem to be addressed. Improper handling or excessive application even in agricultural soils can produce adverse effects on water, in the atmosphere or in soil (Iguacel, F., 2006). Moreover, an advantage of farm application of organic wastes is that they usually provide a number of nutritive elements to crops with little added cost (Wen, G. et al, 1999). Worldwide concern generated by the energy crisis and environmental protection along with the current situation of the agricultural sector where the economic profitability of the crop is reducing, has promoted studies that focus on the use of profitability on nutrient content in manure.

The poultry sector in Spain is in fourth place in Europe, and Catalonia produces the 20% of the total Spanish amount. In the Ebro Delta, the poultry sector is particularly relevant and produces a waste of 51,786 tons year $^{-1}$ (DAAM, 2009). The lack of studies addressing the use of chicken manure (CM) in rice crops supports the need of this issue. Organic farming in Spain allows the use of CM as fertilizer, what makes results useful for organic or conventional rice production.

The objective of this study was to reveal the medium-term effects of chicken manure on rice and to establish a recommendation practice to both types of rice farmers.

Methodology

This field experiment was conducted in 2011, in the South-east of Catalonia (Spain) (40º42'29.73" N, 0º 37'59.74" E, at 2 meters above sea level) in a rice parcel of IRTA (Institut de Recerca i Tecnologia Agroalimentàries) in the Ebro Experiment Station. The experiment was laid out in a split-plot design with 3 replicates, the main factor was basal fertilization and the subplot was the top-dressing fertilization. Subplot size was 4.5 x 4.5 m. The 6 treatments studied were: T1 check (N=0), T2 150 kg N ha^{-1} (urea), T3 85 kg total N ha^{-1} (CM), T4 170 kg total N ha^{-1} (CM), T5 255 total kg N ha^{-1} (CM), T6 340 kg total N ha^{-1} (CM). The 2 subplots were: S1 Nitrogen fertilization at panicle initiation (PI) with ammonium sulfate (AS) at 40 kg N ha^{-1}, and S2 no N fertilization. The rice variety used was Gleva. The crop management was completed according to conventional farm practices but results can be applied also to organic farming.

Paddy soil properties before experiment initiation were as follows: pH: 8.4, organic matter: 2.34 %, N Kjeldhal: 0.15 %, P: 44 mg kg^{-1}, K: 158 mg kg^{-1}, USDA classification: silty clay loam.

The N P K content of CM was 17.8 (8.7 N-Organic + 9.1 N-NH_4^+), 13.4 and 9.7 %, respectively.

Plant response to fertilization strategies and soil fertility were monitored. Chlorophyll content in leaf was estimated weekly by using Spad-502, Minolta.

Results and discussions

Because the trial started in 2011, only preliminary results can be shown. The seedling establishment was not affected by the different strategies studied. As shown in Figure 1, higher level of unit spad was always obtained with urea fertilization. The effect of the contribution of 40 kg N ha^{-1} at PI provided an improvement in the nutritional status of the plant, showing statistical differences from 4 days after application until flowering.

Rice plants grew significantly taller from the rest of the treatments when urea fertilizer was applied. Blast incidence increased significantly in the urea treatment, but the infestation appeared at maturity and did not affect to yield.

Lower yield was obtained at N=0 and maximum yields were reached by using urea. For CM fertilization, while N input increased yield increased too. N content in CM was half organic and half inorganic but there was only response to the inorganic half. Even the inorganic part of the highest CM treatment obtained worse yields than the urea one. That will probably be due to the no availability of the organic forms (it's the first organic application), and it could be increased by important losses of N occurred during CM application.

There was no response to top-dressing fertilization.

For next season organic treatments it will be again necessary to determine the inorganic N content in the CM in order to dose the CM according to the same level of N inorganic than in 2011 and to avoid any cultural practice that increase N loses.

In general terms, the use of CM can be a useful fertilization strategy that allows the reduction of the cost, increases profitability and improves soil fertility, but more years are required to confirm them.

This trial was carried out with funding from the INIA. RTA2010-00126-CO2-02.

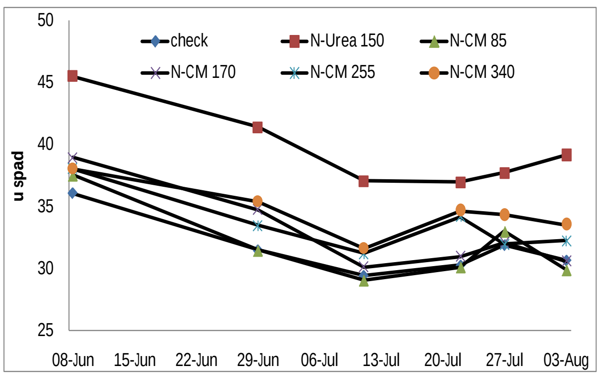


Figure 1. Chlorophyll content (u spad) response to N fertilization strategies.

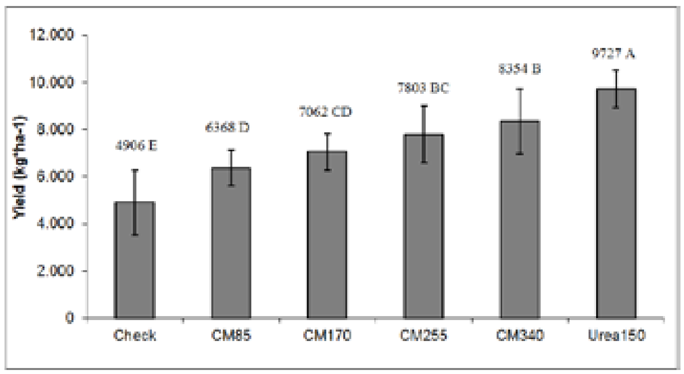


Figure 2. Effects of different basal fertilization treatments on yield (kg ha^{-1}). Vertical bars indicated standard error. Means followed by the same letter are not significantly different according to DMRT.

References

Iguacel, F., 2006. Capítulo 4. *Estiércoles y fertilización nitrogenada.* Fertilización Nitrogenada. Guía de actualización. Informaciones Técnicas. Centro de Transferencia Agroalimentario. Número Extraordinario. Gobierno de Aragón. 53-62.

Wen, G.; Bates, T.E.;Voroney, R.P.;Winter, J.P.; Schellenbert, M.P. 1999. *Influence of Application of Sewage Sludges, and Sludge and Manure Composts on Plant Ca and Mg Concentration and Soil Extractability in Field Experiments*. Nutri. Cycl. Agroecosyst., *55*, 51–56.

Influence of cropping practices on the use of rice fields by wintering wild ducks

Guillemain, Matthieu [1], Mouronval, Jean-Baptiste [1], Mesléard, François [2] & Gauther-Clerc, Michel [2]

[1] Office National de la Chasse et de la Faune Sauvage, CNERA Avifaune Migratrice, Le Sambuc, 13200 Arles, France (matthieu.guillemain@oncfs.gouv.fr)
[2] Centre de Recherche de la Tour du Valat, Le Sambuc, F-13200 Arles, France.

Keywords
Rice fields, Wintering, Anatidae, Hunting, Post-harvest practices

Introduction

After strong fluctuations in the course of the past fifty years, rice production now represents about 20 000 hectares in France, almost exclusively in Camargue. It is necessary for many Camargue farmers to operate clear water crops to desalt their fields and thus regularly grow wheat or oilseeds and protein crops, in rotation with rice. Rice fields make up a habitat used by a great number of waterbirds, anatidae and laro-limicolae, especially as a staging area, reproduction place or feeding site. With regard to wintering anatidae, the technical method and post-harvest cropping practices strongly influence the abundance and accessibility of food resources of birds, be they harvest residues (rice seeds not collected by the harvesters), weed seeds or invertebrates. Likewise, the crop's technical method (organic versus conventional method) can affect the quantity of resources available for the ducks in the rice fields. If the farmers can welcome the use of rice fields by waterbirds in the winter season, in particular because rice fields used as feeding areas can them become hunting areas, this should not disrupt the technical method and the agronomic results. For agronomic as well as economic reasons, Camargue rice producers often practice burning followed by plowing the plots very quickly after harvest (which helps reduce the amount of rice straw and husk first, then contributes to their decomposing), whereas this fall plowing of plots is one of the techniques least favorable to use of the plots by the birds. The farmers actually fear that the absence of plowing in the fall would make it difficult to prepare the soils in the spring and that extended flooding would prevent access to plots insufficiently dried in the spring for sowing. But alternative methods do exist and are used in other rice producing areas, such as North America. Besides, burning is forbidden in California's central valley where plot rolling and disking, followed by long flooding, or even just flooding, are favored to stimulate straw decomposing and limit the emergence of weeds.
Reckoning that rice fields can provide suitable habitat for waterbirds, and therefore to waterbird hunting, it seems possible to change practices in order to make Camargue rice plots more attractive to waterbirds. In response to fluctuations in commodity prices and to uncertainties regarding the future of rice production in the framework of the new CAP, some owners are also tempted to temporarily convert their rice fields into marshlands in order to draw income from gaming rather than from farming. However, this practice is curbed by farmers' fears regarding the capacity to revert to paddies later, should rice production prove more remunerative (namely due to the development of weeds).

Method

The general purpose of this project is to test alternative post-harvest practices different from the traditional Camargue burning-plowing, in particular through the introduction of winter flooding of plots, and to measure the consequences in terms of use of the plots by wintering ducks. Some practices which are beneficial in environmental terms (better air quality if there is no burning, better quality of the runoff water if plots are flooded, supply of a favorable habitat to wild fauna) could have limited effects in agronomic terms. This project therefore aims at applying different post-harvest treatments in an experimental way, such as flooding, plowing, disking, and burning, as well as a combination of these treatments, and to measure the consequences in terms of availability of resources for birds, presence (essentially at night) of ducks, and agronomic potential for the following season.

Rice-marshland-rice experimental reconversions are also under consideration to assess the relevance and constraints of such practices.

Results and discussion

This project will start in the fall of 2012, in the framework of a doctoral research jointly supervised by the *Office National de la Chasse et de la Faune Sauvage* and the *Centre de Recherche de la Tour du Valat*. The aim is namely to address such questions as:

1) Is the food availability for ducks wintering in the Camargue rice fields different according to the post-harvest cropping practices?
2) Do the wintering ducks use rice fields as nocturnal feeding areas if these offer sufficiently abundant food resources?
3) Does operating rice fields in a manner favorable to wintering anatidae represent a loss in agronomic terms and therefore a cost for the farmer?
4) Is it possible to switch regularly from rice cultivation to gaming marshlands and back?

This program should ultimately help propose specific rice field management measures particularly favorable to wintering birds and fauna.

Development of organic rain-fed rice in the region of Manakara (Madagascar)

Raveloson Ravaomanarivo Lala Harivelo[1], Ratnadass Alain[2].

[1]Departement of Entomology - Faculty of Science – University of Antananarivo; lravaomanarivo@gmail.com

[2]CIRAD, UR HortSys, Montpellier

Key words: organic rice production; soils ; aggressive bio-agents; rice varieties; cover crops

Introduction

In the region of Manakara (South-East of Madagascar), farmers make up the majority of the population. The scarcity of irrigable plots contributed to the development of rain-fed rice fields on the hills (*tanety*). The *tanety* are made up of poor ferralitic soils subjected to erosion. On top of the impact of climate hazards (irregular rainfalls with droughts and cyclones), this *tanety* rice cultivation system undergoes important pressure on the part of aggressive bio agents (helminthosporiosis, rice blast, stalk borers) (Ranaivoson, 2009). The farmers' low incomes prevent them from investing in farm equipment and inputs and the rice yield remains low.

This research aims at assessing the potential of conservation techniques in increasing the rice yield through the improvement of the soil's physico-chemical structure, the attenuation of climate effects, the control of aggressive bio agents, namely the stalk-borers *Maliarpha separatella* (Lepidoptera, Pyralidae) and *Sesamia calamistis* (Lepidoptera, Noctuidae) in the framework of the development of a rain-fed organic rice production.

Method

The experimental systems are made up of four blocks divided in basic plots of 5m x 5m elements. Two cultivation systems (plowing and DMC) and 4 rice varieties (B22, Sebota 68, Primavera, Fofifa 161) were compared. The plowing system is realized without cover crop and with rice-on-rice rotations. In DMC, stylosanthes (*Stylosanthes guianensis*) was put in place out of season and stripped at ground level then rolled before sowing the rice seeds. Seed dibbling was used on 20cm x 20cm distant lines. The seedlings were not treated with insecticides. Upon sowing, a mineral fertilizer composed of 300kg/ha of NPK 11-22-16 and 500kg/ha of dolomite was applied to each basic plot. It was completed during the cycle by two applications of urea at 80kg/ha. In plowing, herbicide treatment was performed a month and a half after sowing. No insecticide treatment was applied during the whole experience. The impact assessments of rice cultivation systems and rice varieties on the borer attacks was performed by means of rice samplings on $1m^2$ of surface per plot (except for PRIMAVERA & FOFIFA 161 in plowing).The rice plants thus sampled were dissected and the number of infested plants was noted. The grains were then pre-germinated, dried, winnowed and weighed in order to determine the yield.

Results and discussion

The rate of infestation by borers was lower in the plots with *Stylosanthes* and *Brachiaria* cover rather than with *Stylosanthes* alone. As a nitrogen-fixing legume, *S. guianensis* allows rapid soil enrichment (Husson et al., 2008), thus improving nitrogen nutrition of the rice.

This additional nitrogen contribution enhances a positive tactism of aggessive bio agents (Ratnaddass et al., 2012) probably including stalk borers, whence the high rates of infestation of rice grown on a plot with *Stylosanthes* as precedent.

The association of *Stylosanthes* to *Brachiaria* changes the attractiveness of rice for borers. As a matter of fact, *Brachiaria* is used in direct sowing as a “biological pump” to recycle and restore/mobilize nutritional elements of the soil, in particular phosporus (Husson et al., 2008). This association contributes to balancing the mineral nutrition of the rice which probably becomes less attractive for borers. The FOFIFA 161 and B22 varieties were the most badly attacked by the borers. The yield can drop significantly following damage caused by borers. These yield losses are high for the SEBOTA 68 and FOFIFA 161 varieties, low for the B22 variety.

Table 1: Impact of rice varieties and cultivation systems on borer infestation rates and yield

	Infestation rate (%)					Yield (T/Ha)				
Variety System	B22	Sebota 68	Prima vera	Fofifa 161	Average	B22	Sebota 68	Prima vera	Fofifa 161	Average
Plowing	49,63	51,05			50,35	2,97	2,77			2,87
Stylosanthes	45,78	38,35	53,98	69,03	46,04	2,15	3,71	2,22	2,53	2,82
Stylosanthes +Brachiaria	45,38	32,66	34,67	49,25	37,57	2,07	3,63	1,81	3,76	3,07
Average	46,93	40,68	44,33	59,14		2,40	3,37	2,02	3,15	

Conclusion: The choice of rice varieties less attractive to borers or more resistant to their attacks as well as cover crops improving the soil fertility, and the nutritional needs of the rice are an alternative solution to the use of insecticides, herbicides and chemical fertilizers for organic farming in the South-East region of Madagascar.

Bibliography

Husson O, Charpentier H, Razanamparany C, Moussa N, Michellon R, Naudin K, Razafintsalama H, Rakotoarinivo C, Rakotondramanana, Séguy L, 2008. Manuel pratique du semis direct à Madagascar. Volume III, Chapter 3.

Ranaivoson A, 2009. *Lutte agro écologique contre les Lépidoptères foreurs de tige du riz cultivé en bas fonds et sur tanety dans la région d’Ankepaka Manakara*. Master’s dissertation. Faculty of Science. University of Antananarivo.

Ratnadass A, Fernandes P, Avelino J, Habib R, 2012. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems. Agronomy for Sustainable Development 32 : 273 - 303. doi: 10.1007/s13593-011-0022-4

Consumption of organic rice in France

DIAGNE[1]N'Deye Magatte[1] , MOURET Jean-Claude [2], SIRIEIX Lucie [3]

[1] Sophomore student of Agronomy engineering course, Montpellier SupAgro, Montpellier, France
[2] Agronomist and researcher, INRA, Innovation Department, Montpellier, France.
[3] Lecturer, Montpellier SupAgro, Moisa Department, Montpellier, France.

Keywords: Conventional and organic rice, consumption, dry grocery organic products, rice production sector, distribution circuits, French rice market, cereals, brands, merchandizing, hypermarkets, specialized organic shops, direct sale, distributor brand, market share

Introduction:

Nowadays, there are few referenced documents exclusively dedicated to organic rice because this market is still an emerging market. In France, it is not very developed compared to the markets for organic eggs or organic milk. The aim of this work is therefore to analyze the evolution dynamics at work in the consumption of organic rice in France. The aim was to assess the situation of the organic rice production sector by reviewing the evolution of production, of distribution circuits and consumption of organic rice in the world, in Europe and mainly in France. The market being narrow, the research was first focused on the market of conventional rice and on the market of dry grocery organic products.

Method:

For this study, we first established a bibliographic review which helped draw a picture of the conventional and organic rice production sector in the world, in Europe and especially in France. Then, interviews with several partners of the rice production chain (rice producers, collectors, distributors, business managers) helped collect their opinions on the current state of the sector. In addition, we also studied the merchandizing of conventional and organic rice in hypermarkets and in specialty organic shops in the Hérault and the Gard. The additional study helped us draw a picture of current shelf organizations and brands on display.

Results and discussion:

Researchers think that rice cultivation in China, India and other tropical countries in Asia must have started 10 000 years ago. Ever since, rice has been grown in 112 countries, to the extent that it is one of the most produced cereals in the world. The **French market for conventional rice** in 2011 reached a sales turnover of 266 M€. Consumers are mainly people in the 35-49 age group, families with modest incomes and families with children. They buy around 5kg of rice per year. Their purchases exceed the national average by 30 to 50%. Single people consume less rice and 20% of them never buy rice. 90% of households buy rice (and 11% buy Camargue rice for less than about 2 kg). Lastly, for this staple, they spend 2€/year more than in 2007. Rice is a market dominated by distributor brands. Uncle Ben's holds 18% of the market. Panzani brands come far behind with 11% and 8% respectively. There are other brands selling rice, such as Riso Gallo, Vivien Paille, Perliz, Riz de Canavère, Rizôfruit, Riz Craf and Inariz. With regard to distribution circuits, rice is sold mainly in supermarkets and hypermarkets and in hard discount stores, at 76% and 6% respectively for each circuit.

The **French market for organic dry grocery products** is undergoing a mutation, namely with the slowing down of its growth and the increase in the share of mass distributors which is reaching a market share of almost 50%. In 2010, these products are the most frequently purchased by consumers of organic products: 53% report consuming them in France (of whom 39% consume pasta, rice, and other cereals). Distributor brands remain the market leaders, before Bjorg, Jardin Bio, Cereal Bio or alter Eco. But others, such as Priméal, Bongran, Markal, Celnat, Lima, Danival Bio,

Heureuse Camargue, La compagnie du Riz (with Autour du Riz), Céréco, Ofal Bio, Biothentic and Good Goût also offer this type of product. Organic products are sold in three distribution circuits: specialized organic shops, mass retailers of food and direct sale from the producer to the consumer. Lastly, it should be noted that the offer for organic products, all circuits considered, is largely dominated by grocery products and drinks.
What about the place of organic rice in the French market? Currently, there are no specific data on organic rice, but distribution channels are the same as for the other products: specialized shops for organic products, mass retailing and direct sales. Besides distributor brands, Taureau Ailé, Alter Eco, Priméal, Heureuse Camargue, Bjorg, Bongran, Markal, Celnat, Lima, Jardin Bio, Danival Bio, Autour du Riz, Vivien Paille, Riz de Canavère, and Mas du Bio have found a way into the breach of organic rice.

What do the stakeholders of the French organic rice sector think? First, they agree that **it is always possible to develop this market** because it does hold a future. The volumes of organic rice sold remain important even though since February 2012, there has been a stagnation, or even a drop in volumes because of the economic slump. Overall, the sales of Camargue rice have remained the same. This evolution is probably due to the fact that this rice is a local production, something that customers appreciate. Moreover, Camargue rice is very widely used in the baby food sector where product quality and regularity are very important. However, the most noticeable thing is an increase in the diversity of products sold. Close to 50% of the production of organic rice is used to make by-products based on organic rice. This branch is used only in the organic rice sector. This represents a competitive edge compared to the conventional sector. Moreover, experts think that it is important to collaborate with people who "share the same values", which is why the sectors prefer to sell in specialized shops (even if in terms of market share, mass retailing has gained a significant advantage). With regard to the price, the stakeholders of the sector believe that **the price of organic rice is tightly related to the price of conventional rice**, for two reasons: farmers compare prices and consumers already have purchasing habits regarding prices. Moreover, price is a limitating factor. Besides, the competition from Italian or Spanish organic rice is seen as unfair competition, something unfavorable to the Franco-French market.
The stakeholders believe that selling organic rice with a label certifying the geographical origin remains an interesting advantage. It provides better traceability of products. Traceability is very important in the eyes of customers, but the proliferation of labels should be avoided because they end up becoming a confusing maze for consumers. Lastly, the sector experts note that consumer **enthusiasm for organic products does not wane**. Consumers become aware of the negative effects of current conventional productions, which is why they are more receptive to the organic offer. In this regard, consumers also have to adapt their eating habits to organic products. For instance, it will become impossible in the future to consume as much meat if one wants to be consistent with a "genuine organic consumption". Besides, customers are sensitive to the quality associated with the brands they buy. The product's origin is also significant.

Should the market expand? Some think that organic products should not remain niche products.
Others think on the contrary that if all of Camargue was on organic farming, 40% of the production would not sell, which is why organic rice must remain a niche and quality product. As for the future perspectives of the organic rice sector, rice producers would like to see development solutions emerge. Growing organic products may actually represent more of a moral interest than a financial stake. However, that should not stop all stakeholders of the sector to make a decent living. An "organic network" could facilitate exchanges within the sector, in order to ease the collaboration between the stakeholders of the sector.

Conclusion:

At the end of this study, it seems relevant that industrial and commercial stakeholders should reinforce the sector's current offer. However, there are questions regarding the future of by-products. This work therefore represents a starting point of a reflection which should be extended on the market of organic rice. It would be interesting for scientific and agronomic organizations to continue the collection of material on this topic. In this regard, it could be possible to define more specific evolution dynamics of this type of consumption in Europe and possibly at the international level. Some ground work therefore remains to be carried out.

Bibliographic references:

· AgroBio. The market of organic products in France [online] (page viewed on 22/05/2012) http://www.penser-bio.fr/Le-marche-des-produits-biologiques-en-France.

· Bicard, D. (2011). Pâtes, riz, féculents… parés au décollage des prix. *LSA*, Hors-série, p.26-27.

· Esprit Santé. Son de riz bio - Huile de son de riz - Oryza sativa [online] (page viewed on 22/05/2012). http://www.espritsante.com/8-fiche-817- Son+de+riz+bio+Huile+de+son+de+riz+Oryza+sativa.html.

· FAO. Rice: FAO lowers its forecasts for 2012 [online] (page viewed on 17/08/2012) http://www.fao.org/news/story/fr/item/154126/icode/.

· FranceAgriMer. Evolution of rice purchases by husehods in France between 2007 and 2011 [online] (page viewed on 18/07/2012) http://www.franceagrimer.fr/content/download/16179/122236/file/conso_rizV2.pdf.

· FranceAgriMer. Situation memo on rice- Economic analysis of the rice sector by FranceAgriMer [online] (page viewed on 22/05/2012) http://www.franceagrimer.fr/content/download/15603/116807/file/Note%20de%20conjoncture%20riz%20-%20avril%202012.pdf.

· FranceAgriMer. A survey of rice consumption by households in France conducted by a department of FranceAgriMer [online] (page viewed on 01/07/2012) http://www.franceagrimer.fr/content/download/15874/119289/file/panel_comments-6.pdf.

· Lardon, L., Martin, E., Nouques, M. et al. (2000). Organic rice in Camargue: a sustainable crop? Project by Student Engineers. Montpellier : Montpellier SupAgro, 75p + ann.

· Vacheret, F. (2011). Les MDD dominent le marché du riz avec plus de 54% des volumes. *Linéaires,* February (266), p.90-94.

LIST OF PARTICIPANTS

List of participants

ABECASSIS Joël
Inra - FRANCE
Joel.Abecassis@supagro.inra.fr

AGUILAR PORTERO Manuel
Ifapa - SPAIN
manuel.aguilar.portero@juntadeandalucia.es

ALI Md. Akkas
IRRI - BANGLADESH
akkas.ali@irri.org

ALLARD Jean Pierre
EARL petit Peloux - FRANCE
jpa58@wanadoo.fr

ARZALIER Lise
Inra - FRANCE
arzalier@supagro.inra.fr

BARBIER Jean Marc
Inra - FRANCE
barbierj@supagro.inra.fr

BARRACU Francesco
Università degli studi di Sassari - ITALY
fbarracu@uniss.it

BARRY Mamadou Billo
Institut de Recherche Agronomique de Guinée - GUINEA
billobarry@hotmail.com

BAYOT Mathieu
JLine scrlfs - BELGIUM
mathieubayot@gmail.com

BELLON Stéphane
Inra - FRANCE
bellon@avignon.inra.fr

BLONDIN Bruno
SupAgro - FRANCE
Bruno.Blondin@supagro.inra.fr

BOCCHI Stefano
University of Milan - ITALY
stefano.bocchi@unimi.it

BOUCHEZ Grégoire
Sud et Bio - FRANCE
g.bouchez@biogard.fr

BRANDT Rita
UOL - BRAZIL
ritabrandt@uol.com.br

BURGEL Sophie
Inra - FRANCE
burgel@supagro.inra.fr

CABANTOUS Brigitte
Agropolis - FRANCE
cabantous@agropolis.fr

CAIMO DUC Rosalia
Soc Agr Terre di Lomellina s.s. - ITALY
rolias@virgilio.it

CALLET Francois
SAS domaine de gouine - FRANCE
fcallet55@orange.fr

CARTIER
Domaine de Beaujeu - FRANCE
domainedebeaujeu@yahoo.fr

CASTANIER Nicolas
Inra - FRANCE
nicolas.castanier@supagro.inra.fr

CFR Cfr
Centre Français du Riz - FRANCE
thomas.cfr@wanadoo.fr

CIRERA Juan Carlos
Riet Vell, S.A. - SPAIN
jccirera@seo.org

CLEMENT François
Société Commerciale Agricole de Distribution (SCAD) - FRANCE
francois.clement@scad.fr

COULOMBEL Aude
ITAB - FRANCE
aude.coulombel@itab.asso.fr

DELMOTTE Sylvestre
Inra - FRANCE
delmotte@supagro.inra.fr

DEMICHEL Annie
inra - FRANCE
annie.demichel@supagro.inra.fr

DIAGNE N'Deye Magatte
Inra - FRANCE
diagnen@supagro.inra.fr

DIENTA Oumar
CFPPA du GARD - FRANCE
oumardienta1@yahoo.fr

DU LAC Jacques
Scea Petit Mas de Cabane - FRANCE
jacques.m.dulac@gmail.com

DUFUMIER Marc
AgroParis Tech - FRANCE
Marc.Dufumier@agroparistech.fr

FALCONNIER Gatien
Icrisat Mali - MALI
falconniergatien@yahoo.fr

FAURE Guy
Cirad - FRANCE
guy.faure@cirad.fr

FILIPPIN Thierry
SCEA du cousse - FRANCE
filippin@free.fr

FOGLIATTO Silvia
Università di Torino - ITALY
silvia.fogliatto@unito.it

FURUNO Kumiko
 - JAPAN
furuno@d4.dion.ne.jp

FURUNO Takao
Japan Rice-Duck Farming Society - JAPAN
furuno@d4.dion.ne.jp

GARCIA Sylvie
Inra - FRANCE
garcias@supagro.inra.fr

Ghesquière Alain
IRD - FRANCE
alain.ghesquiere@ird.fr

GIBSON Jess
Lundberg Family Farms - UNITED STATES OF AMERICA
Jesterg7@hotmail.com

GINOUX ALAIN
 - FRANCE
ginoux.alain@wanadoo.fr

GOMEZ Luis
 - CUBA

GUENARD Jeremy
comptoir agricole du languedoc - FRANCE
jeremy.g@riz-madar.fr

GUILLEMAIN Matthieu
Office National de la Chasse et de la Faune Sauvage - FRANCE
matthieu.guillemain@oncfs.gouv.fr

GUILLOT Xavier
Ricard SA - FRANCE
xavier.guillot@ricard.fr

Guirot Valérie
EARL petit Peloux - FRANCE

HAEFLIGER Max
Civam Bio - FRANCE
biocivam.max@wanadoo.fr

HAMMOND Roy
Inra - FRANCE
hammond@supagro.inra.fr

HESZKYNÉ CZAKO Judit Ildiko
- HUNGARY
czjudi@gmail.com

HOKAZONO Shingo
National Agriculture and Food Research Organization (NARO) Japan - JAPAN
hokazo@affrc.go.jp

HOSSAIN Shaikh Tanveer
Friends In Village Development Bangladesh (FIVDB) - BANGLADESH
tanveer107@yahoo.com

KLERKX Laurens
Wageningen University - NETHERLANDS
Laurens.Klerkx@wur.nl

KLEVESTON Rene
EPAGRI - BRAZIL
renek@contato.net

KLEVESTON Fábio
EPAGRI - BRAZIL
fabiokleveston@yahoo.com.br

LACOMBE Camille
Inra - FRANCE
camille.lacombe@supagro.inra.fr

LACROTTE Hervé
entreprise agricole Lacrotte Hervé - FRANCE
herve.lacr@orange.fr

LAIRON Denis
Inserm - FRANCE
Denis.Lairon@univmed.fr

LALO Corinne
TF1 - FRANCE
clalo1@free.fr

LANCON Frederic
cirad - FRANCE
frederic.lancon@cirad.fr

LANNES Gilbert
cirad - FRANCE
gilbert.lannes@cirad.fr

LE BOURGEOIS Thomas
cirad - FRANCE
thomas.le_bourgeois@cirad.fr

LIFRAN Robert
inra - FRANCE
lifran@supagro.inra.fr

LOPEZ Lucas Jorge
Organic Latin America SA - ARGENTINA
llopez@organiclatinamerica.com.ar

LOPEZ RIDAURA Santiago
Inra - FRANCE
ridaura@supagro.inra.fr

LUNDBERG Jessica
Lundberg Family Farms - UNITED STATES OF AMERICA
Jessica@lundberg.com

LUU Paul
Agropolis International - FRANCE
paul.luu@agropolis.fr

MADE Caroline
VERSAILLES - UNITED KINGDOM
Caroline@versaillesltd.com

MAILLY Florine
inra - FRANCE
florine.mailly@supagro.inra.fr

MARSAL Núria
- SPAIN
numaca23@hotmail.com

MAUMEJEAN Ghislaine
EARL petit mas du Tort - FRANCE

MAUMEJEAN Robert
EARL petit mas du Tort - FRANCE

SRFF
SRFF (Syndicat des riziculteurs de France et Filières) - FRANCE
srff@wanadoo.fr

MENNELLA Delphine
Inra - FRANCE
mennelld@supagro.inra.fr

MESLÉARD François
Tour du Valat/Université d'Avignon - FRANCE
mesleard@tourduvalat.org

MEYNARD Jean-Marc
Inra - FRANCE
meynard@grignon.inra.fr

MICHEL Lisbeth
Inra - FRANCE
michel@supagro.inra.fr

MILESI Chloe
Chambre d'Agriculture des Bouches-du-Rhône - FRANCE
c.milesi@bouches-du-rhone.chambagri.fr

MONIER Christelle
Cirad - FRANCE
christelle.monier@cirad.fr

MONTI Tony
SARL manade du goupil - FRANCE
beatrice.u@cosec-gestion.fr

MOURET Jean-Claude
inra - FRANCE
mouret@supagro.inra.fr

NADDEO Edouard
Société Commerciale Agricole de Distribution (SCAD) - FRANCE
francois.clement@scad.fr

ORTIZ GAMA Carlos
DAAM - SPAIN
carlos.ortiz@gencat.cat

ORTIZ ROMERO Clemente
IFAPA - SPAIN
clemente.ortiz.romero@gmail.com

PENVERN Servane
Inra - FRANCE
servane.penvern@avignon.inra.fr

PERRÉOL Didier
Ekibio - FRANCE
didier.perreol@ekibio.fr

PERRIN COLINE
Inra - FRANCE
coline.perrin@supagro.inra.fr

PETIT Hélène
- FRANCE
petit.helen@wanadoo.fr

PIGOZZI Silvia
Fondation Cariplo - ITALY
silviapigozzi@fondazionecariplo.it

PITH Lyna
Provincial Department of Agriculture of Kep province, Cambodia - CAMBODIA
pith.lyna@gmail.com

PORRO Andrea
University of Milan - ITALY
andrea.porro@unimi.it

POUJOL Bernard
EARL mas neuf de la motte - FRANCE
cath.poujol@yahoo.fr

POUJOL Catherine
EARL mas neuf de la motte - FRANCE
cath.poujol@yahoo.fr

PY Alain
Inra - FRANCE
alain.py@supagro.inra.fr

RANDRIANARISON Lara Basilisse
Groupement SRI Madagascar - MADAGASCAR
groupementsrimada@moov.mg

RATNADASS Alain
Cirad - FRANCE
alain.ratnadass@cirad.fr

RAVAOMANARIVO Lala Harivelo
Université d'Antananarivo - MADAGASCAR
lravaomanarivo@gmail.com

RAVELONIRINA Edline
 - MADAGASCAR
edicoli02@yahoo.fr

REY Jean-Paul Yvann
EARL MAS DES JACQUINES - FRANCE

RIFFIOD Anaïs
Agence Bio - FRANCE
anais.riffiod@agencebio.org

RIVRY-FOURNIER Christine
Biofil Editions Fitaman - FRANCE
biofil@free.fr

ROBERI Francois
Agence de l'eau RMC - FRANCE
francois.roberi@eaurmc.fr

ROBIN Pascal
 - FRANCE
probin1@hotmail.fr

ROMANI Marco
Ente Nazionale Risi - ITALY
m.romani@enterisi.it

ROSSARD Annie
Inra - FRANCE
rossarda@supagro.inra.fr

ROUSSEL Gilles
GEA de la plaine d'Espeyran - FRANCE
espeyran@hotmail.fr

ROZIERE Jacques
Earl du mas de Marignan - FRANCE
masdelavigne@free.fr

ROZIERE Francoise
Earl du mas de Marignan - FRANCE
masdelavigne@free.fr

RUGET Françoise
 - FRANCE

SAINT MACARY Hervé
Cirad - FRANCE
herve.saint_macary@cirad.fr

SALSON Chantal
Agropolis International - FRANCE
salson@agropolis.fr

SILVIE Pierre
Cirad - FRANCE
pierre.silvie@cirad.fr

SIMON - KISS Ibolya
Irrigation Research Institute Hungary - HUNGARY
ibolya@vigoryza.hu

SINGH Yudhvir
Indian Agricultural Research Institute (CCUBGA) - INDIA
yvsingh63@yahoo.co.in

SOULARD Christophe
Inra - FRANCE
soulard@supagro.inra.fr

SPANU Antonino
Università degli studi di Sassari - ITALY
tspanu@uniss.it

SPEICH Pierre
FranceAgriMer - FRANCE
pierre.speich@franceagrimer.fr

STYGER Erika
Cornell University - UNITED STATES OF AMERICA
eds8@cornell.edu

TALIYIL Vanaja
KERALA AGRICULTURAL UNIVERSITY - INDIA
vtaliyil@yahoo.com

TASSABEHJI Ziad
VERSAILLES - UNITED KINGDOM
ziad@windcliffgroup.com

THOMAS CFR
CFR - FRANCE
thomas.cfr@wanadoo.fr

THOMAS Marc
SAS BIOSUD - FRANCE
marc.thomas@biosud.com

VADON Anne
Parc naturel régional de Camargue - FRANCE
agri.elevage@parc-camargue.fr

VIANET Régis
Parc naturel régional de Camargue - FRANCE
scientifique@parc-camargue.fr

VIDOTTO Francesco
Università di Torino - ITALY
francesco.vidotto@unito.it

VIEIRA CORRÊA DE OLIVEIRA André Luiz
Instituto Riograndense do Arroz - BRAZIL
andrezaooliveira@uol.com.br

VILLEMÉJEANNE Nathalie
Agropolis International - FRANCE
villemejeanne@agropolis.fr

VOLKMANN João Batista Amadeo
Alimentos Volkmann - BRAZIL
volkmannjb@volkmann.com.br

ZANON Bernard
Service territorial d'Arles - FRANCE
bernard.zanon@bouches-du-rhone.gouv.fr

AUTHORS INDEX

Authors index