Intercropping of cereals and grain legumes in European organic farming systems – INTERCROP

Cultures mixtes et légumineuses à graines dans les systèmes de production biologique européens – INTERCROP

by Natalia BELLOSTAS* and Erik Steen JENSEN*

INTERCROP is a cost-shared project co-funded by the European Community under the 5th Framework Programme of RTD. It brings together scientists from seven institutions in Denmark, France, Germany, Italy and UK, who have complementary and internationally respected expertise in different aspects of the project, including crop ecology, plant nutritional physiology, nutrient cycling, grain quality, cropping systems research, crop modelling and organic farming. This multidisciplinary European consortium started its activities in January 2003 and for three years it will conduct research on intercropping, facilitating the exchange and synthesis of existing knowledge in order to make recommendations for using intercropping as an environment-friendly plant production method for organic farming under different regional conditions.

INTERCROP consists of six inter-related workpackages made up of specific tasks which involve several partners. The project's core experiment is a field trial in which pea and barley are intercropped with spring sowing and compared with pea and barley in pure stands. To compare the performance of intercropping in organic farming situations across Europe, all INTERCROP partners have established this experiment at organic sites using the same cultivars.

Acronym: INTERCROP

Full title: Intercropping of cereals and grain legumes for increased production, weed control, improved product quality and prevention of N-losses in European organic systems (Shared Costs Project QLK5-2002-02352)

Coordinator: Erik Steen Jensen, Risø National Laboratory, Denmark. (erik.s.Jensen@risoe.dk)

Partnership: 7 partners from 5 European countries

Duration: 1 January 2003 to 31 December 2005 (36 months)

Objective: To increase the knowledge and awareness of the multifunctional role of intercrops in organic farming systems under different agro-ecological conditions in Europe by the determination of their yield advantages, their stability compared to sole crops, the suppression of pest, diseases and weeds and the potential for minimizing the risk of N-leaching.

Web: http://www.intercrop.dk

(Photo Audrey Dibet, ESA-Angers, France)

Intercrop of pea and barley at Angers, France, May 2003.

Survey and demonstration on-farm

During this first year, almost 100 organic farmers across Europe were interviewed about intercropping. The survey of farms in different countries was based on a standard questionnaire covering subjects including farm structure, crop rotation, fertiliser use, plant protection methods and type of intercrop.

In the final year of the project, on-farm demonstrations will aim to increase awareness and provide advice on intercropping, especially cereal–grain legume systems, in organic farming.

Agronomic performance and yield stability

The main objective is to determine the agronomic performance of cereal–grain legume intercrops in terms of yield advantage, and to study the yield stability compared with associated sole crops. In the basic field trial, measurements such as leaf area index, dry matter production and grain yield are taken each year by all partners. At some sites there is a series of extra designs within the basic field trial and these allow for the collection of additional information about specific strategies for optimising the use of environmental resources by the intercrop.

Other objectives of this workpackage are to determine the effects of soil fertility on competitive interactions in intercrops as well as to evaluate new intercropping designs.

Nutrient acquisition, nitrogen (N) loss and N in the following crop

The ability of grain legumes to fix atmospheric N_2 is a key factor in the N dynamics of legume–cereal intercrops. In this workpackage, total N acquisition and soil N are determined annually in the intercrops and sole crops in order to estimate N balances, effects of intercropping on post-harvest N dynamics in the soil and the potential risks of N leaching. The N_2 fixed from the atmosphere

*Plant Research Department,
Risø National Laboratory, Roskilde, Denmark.
Email: natalia.bellostas.muguerza@risoe.dk;
erik.s.jensen@risoe.dk

and taken up from the soil are also estimated using ^{15}N isotope techniques. N accumulation in a following crop (autumn established cereal) as influenced by the pre-crop is determined and its economic effects are estimated. The acquisition of other nutrients such as phosphorous (P), potassium (K) and sulphur (S) by the intercrop is also monitored.

Intercropping for weed, pest and disease management

In the basic field trial, pests and diseases are monitored according to a series of protocols at the key physiological stages of the crops. Weed species, weed dry matter production and weed N content are also determined every year. A glasshouse study on root elongation was also conducted, based on the hypothesis that the reduced weed pressure often observed in intercrops is due to increased root competition for nutrients. Field pea, spring barley, white mustard and ryegrass were grown in rhizotrons and root elongation, root number and total length of secondary roots were measured.

Quality parameters in intercropped components and following crops

The different interaction mechanisms that occur between plant species when intercropped as well as the effect of the intercrop on the following crop in the rotation might influence grain quality. This workpackage aims to determine how intercropping affects the physical grain quality and the ratio of N and S concentrations in the grain of wheat and barley grown as, and after intercrops. The effects of intercropping on the protein quality of wheat for bread-making as well as on the feeding value of barley, wheat, pea and faba beans for livestock will also be studied.

Modelling

The aim is to adapt an existing simulation model for use with pea–barley intercropping and with a special emphasis on N uptake by the crops. The model STICS-intercrop derives from the monocrop version of STICS to which some adaptations, for the specific requirements of the intercrop, have been made during this first project year. The parameterisation of STICS-intercrop was based on a set of data obtained from a basic pea–barley experiment in which crops were grown in optimal conditions (neither abiotic nor biotic stresses). The model is validated with a set of data collected annually from the basic field trial by all partners. Although a first version is ready, new software is now being developed which will make the STICS-intercrop model suitable for use with different crops, various crop management methods (including low input farming) and different pedoclimatic situations.

A successful first year

All of the INTERCROP partners were successful in gathering the required data for each workpackage in a coordinated way, and this has provided a wealth of interesting new information which, after analysis, seems promising. During this first year partners have been very active in the dissemination of information about the activities being conducted in INTERCROP. Open field days to visit the different experiments were organised at the different sites, partners gave talks at popular and scientific levels, and scientific papers, based either fully or partially on the results, are in preparation for forthcoming conferences. Students have also been involved at different levels with the production of reports based on the project results.

In November 2003 INTERCROP opened its own website (www.intercrop.dk). The site contains all the project information and is updated frequently with new information from INTERCROP and other topics relating to intercropping and organic farming. ■

(Photo E. S. Jensen, Risø National Laboratory, Denmark)

Members of the INTERCROP project at the second annual meeting in Angers (France), 22–25 January, 2004.

What is intercropping?

Intercropping is defined as the growth of two or more crops simultaneously in the same field during a growing season and is the practical application of ecological principles such as diversity, crop interaction and other natural regulation mechanisms. This technique has been found to have many advantages, mainly related to the complementary use of environmental resources by the component crops. Increased and more stable yields, better nutrient recycling in the soil, better control of weeds, pests and diseases and an increased biodiversity are the advantages most commonly described. Cereals and legumes, both for forage and for grain, are the most common intercrops. The main advantage of the legume–cereal intercrop is the input of nitrogen to the system by the fixation of atmospheric N_2 by the legume, which may contribute to an increased quality of the intercrop components.

INTERCROP Partners

Coordinator: Erik Steen Jensen Plant Research Department, Risø National Laboratory, Denmark (erik.s.jensen@risoe.dk)

Mike J. Gooding Department of Agriculture, University of Reading, UK (M.J.Gooding@reading.ac.uk)

Yves Crozat Laboratoire d'Agronomie, Ecole Supérieure d'Agriculture d'Angers, France (y.crozat@esa-angers.educagri.fr)

Peter von Fragstein und Niemsdorff Department of Organic Farming and Cropping Systems. Kassel University, Germany (pvf@wiz.uni-kassel.de)

Nadine Brisson INRA, Avignon, France (brisson@avignon.inra.fr)

Michele Monti Department of Agrochemistry and Agrobiology, Università "Mediterranea" di Reggio Calabria, Italy (montim@unirc.it)

Sigurd Boisen Department of Animal Nutrition and Physiology, Danish Institute of Agricultural Sciences, Research Centre Foulum, Denmark (Sigurd.boisen@agrsci.dk)