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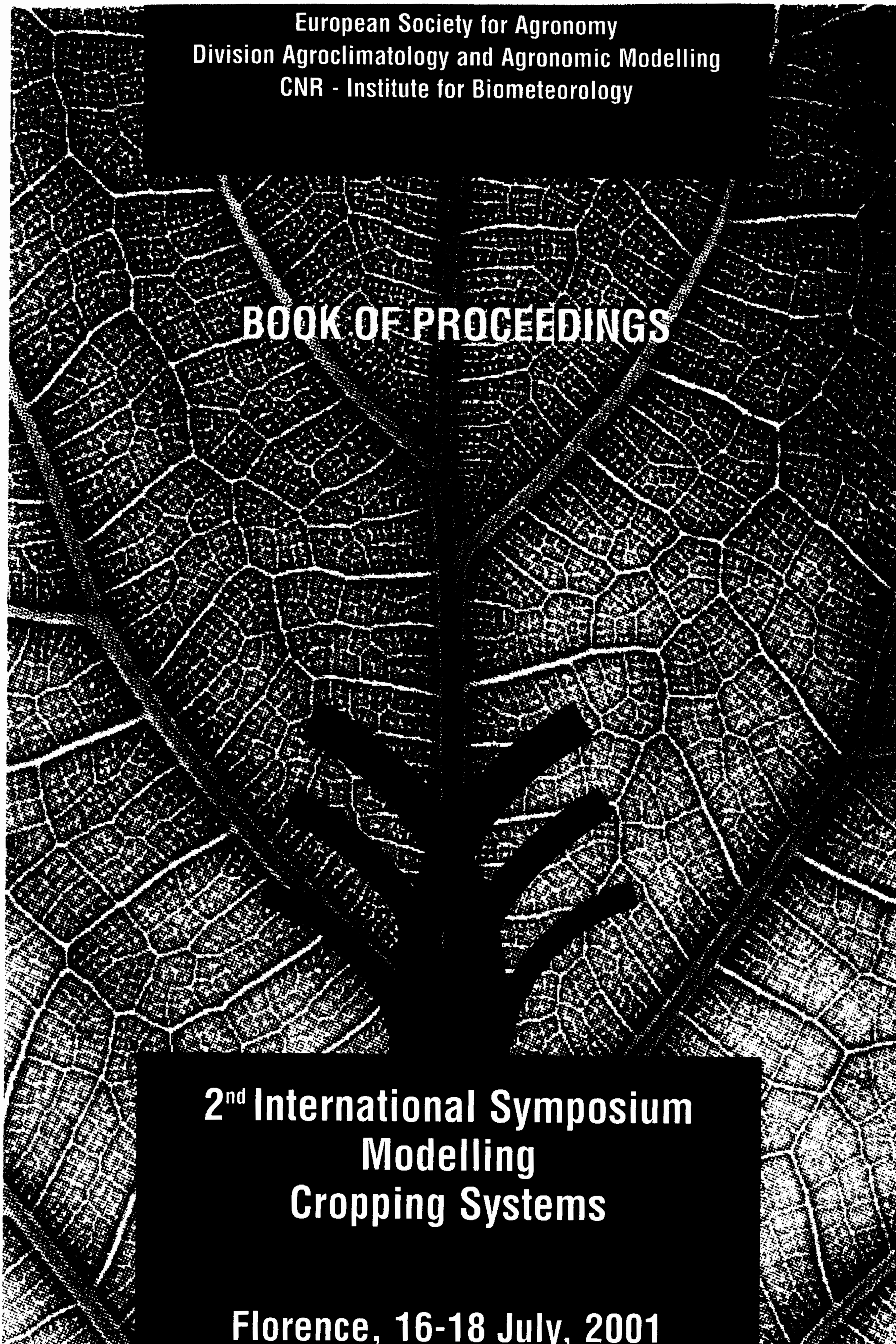

BOOK OF PROCEEDINGS

2nd International Symposium Modelling Cropping Systems

Florence, 16-18 July, 2001

Italy

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COORDINATORS: Marco Bindi and Marcello Donatelli

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USING SIMULATION MODELS TO SET UP AGROECOLOGICAL INDICATORS OF FARMING SYSTEMS

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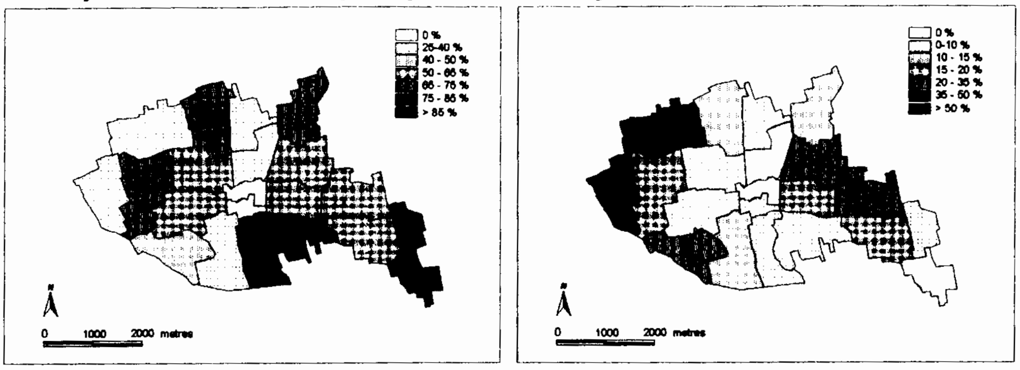
Introduction
In many intensified agroecosystems the efficiency of the production factors (i.e. water, fertilizers, pesticides) is often low, and this corresponds to a high risk of pollution. European Community policy has been training and supporting farmers with several documents/laws aiming at reducing negative effects on the environment of agricultural activities and setting alternatives to intensive farming system. Tools are needed nowadays to evaluate the achievement of objectives and/or for monitoring adequately and globally farmer activities at regional scale. Direct measurements at field scale can be too costly and time consuming. Simulation models for multi-objective evaluation are not yet available and, if so, they would be too complex and requiring too many input variables and parameters. Bockstaller et al (1997) proposed a set of agro-ecological indicators (AEIs), calculated with data available on farm and expressed on a scale between 0 and 10. These AEIs match the criteria provided by OECD (1999) for the ideal indicator (simple, representative of environmental conditions, allowing comparisons, theoretically well founded, with a threshold or reference value). The aim of this paper is to present the results of the application of two selected AEIs (crop diversity and crop sequence indicators) to farms belonging to the South Milano Agricultural Park (SMAP), in northern Italy.

Methods
An extensive farm survey is ongoing in the SMAP to build an integrated agricultural information system. SMAP (48,000 ha wide, including about 1300 farms) surrounds the city of Milano. The survey integrates existing data related to environment and agriculture with newly collected information about agricultural practices. During the 3-year project, one interview is being made to each farmer to collect average information about crop, husbandry, equipment, buildings, irrigation, bulletins of soil analyses. The information system includes a georeferenced farm database and many existing thematic maps. All the data are entered in a flexible database created on purpose (Bechini and Zanichelli, 2000). The data were extracted from the database and elaborated with specific queries to match the calculation requirements for the AEIs. The analysis was carried out on a subset of the available data (50 farms belonging to the municipalities of Corbetta and Rosate, in the western and south-western area of the Park, respectively). The crop diversity indicator (CDI) and the crop sequence indicator (CSI) (Bockstaller and Girardin, 2000) were used. The CDI assigns higher values to farms with "smaller" plots and where more species are cultivated. The original limits for the fuzzy rule to describe "small" and "big" fields (5 and 15 ha) were reduced for this study (to 1.7 and 5 ha), to deal with the unvailability of true field sizes (the size of cadastral parcels is available instead). The CSI parameterizes the effects of a crop on the following one (including effects on soil structure, diseases, parasites, weeds, nitrogen in residues) and the number of crops in rotation in the last four years. CSIs calculated for all rotations are averaged within each farm and calculated at farm level. The effects of previous crop on following crop were parameterized for crops not listed by Bockstaller and Girardin (2000).

Results
Agricultural area is mainly cultivated at Rosate with rice and maize (Figure 1), which together account for 87% of the total agricultural area and with maize, winter cereals, forage crops and

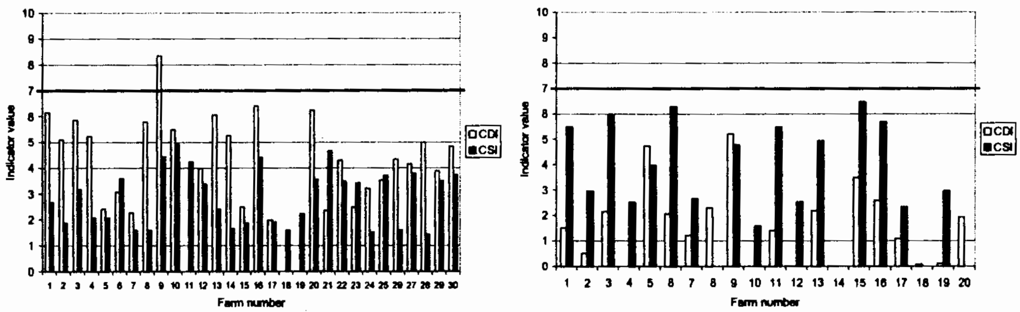
set-aside at Corbetta (88%). At Rosate crop rotations are relatively simple and frequently include several years of rice followed by few years of other crops (e.g. maize).



(a) (b)

Figure 1. Percentage of polygon area cultivated with (a) rice and (b) maize at Rosate.

In Figure 2 the calculated indicators are shown. On average, CDI is lower at Rosate than at Corbetta, where water availability and coarse soils do not allow rice to be cultivated as at Rosate. Higher scores are assigned to farms which cultivate at least 3 crops on small parcels. Seven farms cultivate only one species: they get a score equal to zero (no crop diversity). The lowest scores are assigned to farms where one crop occupies most of farm area.



(a) (b)

Figure 2. Indicator values for the farms at Corbetta (a) and Rosate (b).

Higher values of CSI are assigned to farms with longer and more diversified rotations (e.g. maize/barley/wheat/oat for farm #9 and maize/rice/soybean/rape-seed/rice for farm #16 at Corbetta; maize/maize-Italian ryegrass/barley/set-aside for farm #6 at Rosate).

Conclusions

A dedicated information system was used to assess agricultural practices at regional level with detailed agronomic information. The dataset and its structure were suited to calculate the indicators of crop diversity and crop sequence. The values of these indicators show the relative simplicity of farming systems belonging to the study area. These AEIs will soon be calculated for the whole Park as the database will be completed.

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