

# Development and evaluation of fuzzy-logic based agroecosystem sustainability indicators

## Abstract

Transformation of natural ecosystem into agricultural systems alters the absolute magnitude of the energy flow and its partition through the abiotic and biotic ecosystem components affecting vital functions. Agricultural production involves activities, such as, tillage and pesticide use that depending on the agronomic management tactics may alter more or less vital functions in the ecosystems. The primary objective of this thesis is to analyze the effects of tillage and pesticide use on agroecosystems' functions, using a set of agricultural sustainability indicators. In order to achieve this objective, two field-scale indicators were developed: 1) the Tillage Index (L), which assess the potential agriculture impact based on tillage implements characteristics and field erodability and 2) the Pesticides Index (P) that was built taking into account the toxicity and the applied rate of the different pesticides. Both indicators are fuzzy logic-based, a structure that allows them to synthesize the knowledge and the existing uncertainty about the potential impact of each agricultural practice. The indicators were applied on a set of 15 agricultural fields, distributed in three different sites, in the Inland Pampa (Argentina). These fields were characterized by a set of variables: 1) soil bulk density, 2) soil aggregate stability, 3) total soil carbon (CT), 4) labile fraction of CT, and 5) community parameters of soil arthropods. These variables were also measured in field margins, which had never been under agriculture. The results showed, more frequently, significant differences associated to physical and chemical soil variables than to the biological variables (abundance and diversity of microarthropods). No clear pattern of differences between the agricultural fields and field margins was observed. Nevertheless, differences became apparent when multivariate analyses were used to study the association between indicators and variables. The tillage index (L) was among the best predictors of the environmental variability with respect to other management variables. Finally, the indicators were used on a database, comprising 106 farms from the Inland Pampa (Argentina) in order to make inferences about the present and future potential impact of the regional agricultural production models.

Keywords: agroecosystems, sustainability, pesticides, tillage, fuzzy logic, Argentina, Inland Pampa.