MEMORANDUM OF UNDERSTANDING BETWEEN CIRAD-CA AND CIMMYT REGARDING THE PROJECT:

"IMPACTS OF, AND FACTORS CONDUCTING TO THE ADOPTION OF CONSERVATION TILLAGE ON RAINFED MAIZE-BASED PRODUCTION SYSTEMS"

Whereas the Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, the Institut Français de Recherche scientifique pour le Developpement en Cooperation and the Institut National de la Recherche Agronomique have concluded an Agreement of Cooperation with CIMMYT on the 15th of September 1986,

Whereas the Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD) and the International Maize and Wheat Improvement Center (CIMMYT) are desirous of assisting and cooperating with each other for better service to the farmers of the semi-arid tropics with particular reference to the Latin American region,

Whereas CIMMYT and CIRAD-CA have collaborated for the last 4 years within the framework of the Project entitled "Conservation tillage for rainfed maize in Mexico" under the MOU signed on the 12 th of january 1994.

CIRAD and CIMMYT have arrived at the following memorandum of understanding, in order to execute the project "*Impacts of, and factors conducting to the adoption of conservation tillage on rainfed maize-based production systems*", under the umbrella of the referred Agreement of Cooperation.

Between CIMMYT represented by its Director General, Timothy Reeves, of the first part, and CIRAD, represented by Hubert Manichon, Director of the Annual Crops Department, of the second part,

CLAUSE I

CIMMYT is interested in continuing collaboration with CIRAD-CA, within the framework of the project "*Impacts of, and factors conducting to the adoption of conservation tillage on rainfed maize-based production systems*". The description of the scope and objectives of this project is presented in the Technical Annex attached to this memorandum.

CLAUSE 2

a. Damien Jourdain is proposed by CIRAD-CA, and accepted by CIMMYT, as an Associate Scientist, to work at CIMMYT Economics Program.

b. Damien Jourdain is a CIRAD-CA scientist and will be managed in accordance with CIRAD rules. However, during his assignment at CIMMYT, he will comply with CIMMYT's General Administrative Policy.

c. The assignment of Damien Jourdain is not a secondment with CIMMYT. CIRAD will provide him guidance and support through the CIRAD-CA Corporate Office in Montpellier, CIRAD Representative in Latin America, and other CIRAD-CA scientists based overseas.

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d. Damien Jourdain will be available, at CIRAD request and with the agreement of CIMMYT, for short term consultancies, which shall not impede the progress of the joint project.

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CLAUSE 3

Duration: this MOU is concluded for a period of two years, starting on the 15th of August 1997. At the end of this period, collaborative work achievements will be jointly reviewed, and the MOU possibly extended or renewed.

CLAUSE 4

CIMMYT and CIRAD will nominate a Coordinating Committee, through at least two representatives, one from each, nominated by the Director General of CIMMYT and by the Director of CIRAD-CA, respectively.

The Coordinating Committee will review, at the end of each year, the development of their collaboration regarding the "*Impacts of, and factors conducting to the adoption of conservation tillage on rainfed maize-based production systems*" project, and will precise the program and the budget of the following year. Details for managing the joint Project will be recorded by exchange of letters between the two parts and such letters will form part of this understanding.

CLAUSE 5

CIRAD-CA will pay salary, insurance and allowances of Damien Jourdain who will work full time on the project for its duration. He will be considered as a CIRAD-CA/CIMMYT Economist.

CIMMYT will provide Damien Jourdain with an office in El Batan, project car, computer, operating research expenses, access to library-based information services, to CIMMYT's climatic databases, geographic information systems and analyses, to germplasm collections and germplasm products, and to CIMMYT's facilities for training courses or meetings.

CLAUSE 6

Utilization of results: Scientific utilization in the form of presentations at scientific meetings and publications in bulletins and journals will be in accordance with the CIMMYT-CIRAD/INRA/ORSTOM Agreement of Cooperation of the 15th of September 1986. CIMMYT and CIRAD will co-edit such publications.

CLAUSE 7

a. Technologies, methods, and materials made available by one of the parties under the present protocol will remain the property of the party.

b. Exchanges and loans of techniques and materials between parties will be made free of charge, insofar as they are intended for research purposes only.

Moreover:

c. Results of the research executed in common will be owned by both parties.

d. Each party may jointly or independently provide free of charge to any third party, the use of the results of the research executed in common, without possible opposition from the other, as far as they are used for research purposes only.

e. Each party may jointly or independently, with the agreement of the other party, contract to any third party the use against financial compensations of the results of the research executed in common. In this case, the generated revenues will be equally shared between CIRAD-CA and ICRAF.

CLAUSE 9

For general implementation and monitoring of the project, both parts will follow the terms of the articles of the Agreement of Cooperation between CIMMYT, CIRAD, INRA and ORSTOM

CLAUSE 10

This understanding can be modified at any time by both parties by mutual written agreement.

IN WITNESS WHEREOF, the parties hereto have caused this Memorandum to be duly executed from the 15th of August 1997.

CIRAD-CA
By: for **Hubert MANICHON**
Director

Dated this 10th day of July, 1997

CIMMYT
By: **Timothy REEVES**
General Director

Dated this 25th day of July, 1997

Technical Annex

Presentation of the Project :

"Impacts of, and factors conducting to the adoption of conservation tillage on rainfed maize-based production systems".

1. Background

During recent decades there has been an increasing awareness of the problem of natural resources depletion, in particular with regard to water and soils. This is happening because agricultural land is either farmed more intensively, or because new lands brought into production are of poorer quality.

CIMMYT has invested time and resources in various countries in order to develop techniques that are increasing the productivity of maize-based farming systems, while maintaining/improving their resource base. Among them, one promising management technique relies on conservation tillage for rainfed maize and has been studied in Mexico and several Central American countries (Erenstein, 1996; Sain and Barreto, 1996; Scopel, 1994; van Nieuwkoop et al., 1994).

The research proposed here is part of this effort to better understand the agronomic, environmental and economic consequences, as well as the factors conducting to the adoption of conservation tillage. The objective of the research is to determine where this technical solution is likely to be adopted, and where its overall impact will benefit farmers and society as a whole.

2. Three components of the research

The research proposed here can be decomposed into three main aspects. The three components are discussed in the following subsections.

2.1. Effects of the technique at the farm level

Conservation tillage has mainly been studied at the enterprise or at the plot levels. Therefore, the proposed research will focus on effects at the farm level: farm economic results, necessary investments, labor and cash requirements, interactions with livestock activities. A sample of differentiated farming systems will be studied in the province of Jalisco, Mexico, in the two districts of Cd. Guzman and Cd. San Gabriel. Thus the research will follow-up of work conducted since 1995 (Erenstein and Scopel, 1996; Glo and Martin, 1995; Stephan, 1996). The farm-level study will focus on two areas:

(1) *Identification of farming systems*: a survey of 142 farmers in the two districts of Guzman and San Gabriel, Jalisco province, Mexico was conducted in 1995. The survey identified seven production systems, in which maize is cultivated following four different cropping systems (Glo and Martin, 1995). The 1995 study was carried out just after the Mexican economic crisis of December 1994, while the NAFTA agreement was being initiated. In their conclusion, the authors predicted rapid changes in maize-based production systems (de Janvry and Sadoulet, 1995). Since 1995, a number of external changes have occurred such as the improvement in the availability of contractors for operating direct seeding, as well price increases for pesticides and fertilizers. A survey conducted on the same panel of farmers to follow their evolution should bring interesting insights.

(2) *Economic results at the farm level and expected impact of adoption of conservation tillage* for each identified farming systems. Since 1996, CIRAD and INIFAP are conducting in-depth analysis of 14 farms households to understand their decision-making process in the context of rapid economic change. The data obtained from this study could serve as the basis of economic calculus at the farm level. If deemed necessary for statistical purposes, these 14 farms will be included in a larger sample of farms. The impact would be evaluated at the farm level, in terms of economic results, and factor constraints. A more detailed study on the impact on human health and the environment would be part of the second component.

Expected outputs include classifications of production systems using multivariate statistical analysis (factor analysis and cluster analysis), and economic calculus (profitability analysis) at the farm-level for each identified group.

2.2. Conservation tillage and weed control

This component will be based on cross-country comparisons of several Central American countries and Mexico. Adoption of conservation tillage practices is likely to have an impact on the level of weeds and insects infesting maize. In the case of pests, although trials do not show any significant impact on pests levels, many farmers relate the presence of various pests directly to the presence of the crop residue as mulch, and hence tend to burn the residues(Erenstein, 1997). In the case of weeds, the absence of tillage will increase the populations of annual grassy weeds and perennials. Moreover, the presence of crop residues on the soil will diminish herbicide efficacy, and dosages will have to be increased. Therefore, pesticide and especially herbicide use is a significant and growing component of the conservation tillage technology on maize. This will have several consequences that should be carefully studied: (a) Profitability associated with conservation tillage will be related to the relative prices of labor and pesticides. A cross-country comparison of pesticides/herbicides use patterns should clarify this point. (b) On-site and off-site impacts of pesticides are dependent upon their proper use. Farmers perceptions, knowledge and pesticide use practices should be carefully monitored to anticipate the impact of conservation tillage, on human health and the environment. (c) In terms of sustainability of farming systems, the gains made on the water and soil conservation components are diminished by the increasing reliance on agrochemicals. The impacts of these new external inputs on the productivity and sustainability of the systems should be evaluated, incorporating producer's costs and benefits as well as social costs and benefits (Pingali and Roger, 1995; Rola and Pingali, 1993).

Consequently, several aspects of the use of herbicides could be evaluated:

a) *Pesticides use: farmers perceptions, actual knowledge and practices.* Improper use of pesticide would greatly reduce the effectiveness of weed control, and hence of conservation tillage. Furthermore, the negative impact on human health and the environment could be greater if these pesticides are not properly used. Therefore, it is critical to evaluate farmers pesticide use practices.

a) Use of herbicides: on-farm costs, and comparisons with mechanical control. In a first approach, only on-farm costs and benefits would be considered.

a) Pesticides use and human health impact: the potential for direct exposure to farm workers and rural residents will be increased due to higher pesticides rates, enhanced volatilization losses and off-site drift from aerial applications.

a) Pesticides use and environmental impact. Surface runoff water and sediment volumes transporting pesticides should decrease, and degradation process might be accelerated with the conservation of crop residues. However, this would in turn increase potential threat to groundwater from mobile pesticides.

Impacts on human health and on the environment may need to be developed further if results of preliminary studies indicate that heavy use of pesticides is either hazardous to humans and animals, or damaging for the environment.

2.3. Factors conducting to adoption

Ultimately, improved management techniques can provide the expected benefits to farmers only if they are being adopted. Farmers' adoption of technologies involves the interaction of a number of environmental, agronomic and socioeconomic factors (Feder et al., 1985; Rogers, 1983). Further studies of factors conducting to farmer's adoption of conservation techniques are necessary. For that purpose, cross countries comparisons of adoption patterns will provide insights into the influence of production factors (inputs, labor, etc.) prices, agricultural policies have on the diffusion of these techniques.
Many empirical studies have attempted to analyze the factors conducting to technology adoption, by focusing on the relationship between key variables, e.g. farm size, risk, human capital, labor, and adoption behavior. Empirical techniques presented in the recent literature could be tested:

Partial adoption of the technique (Akinola and Young, 1985; Barham et al., 1995; Smale et al., 1995; Smale et al., 1994). Direct seeding requires special equipment that is non-divisible by nature, leaving little space for partial adoption. However, since the seeding operation can be contracted, it is possible for farmers to adopt the technique only on one part of its farm.

Adaptation of the technique to farmer's needs. Farmers take up information related to the technique and may fine-tune it to their needs and constraints. For example, although the package proposes the conservation of crop residues as well as no-tillage, it was observed that some farmers conserve crop residues, but do till before seeding.

Dynamic process / Learning (Foster and Rozenweig, 1995; Leathers and Smale, 1991; Tsur et al., 1990). Farmers are not immediately efficient at using new techniques. Hence, the process of learning should affect the adoption pattern.

Interrelation between practices (Rauniyar and Goode, 1992; Rauniyar and Goode, 1996). As developed earlier, the adoption of will induce changes in terms of constraints (cash, labor, etc.), as well as mastering the use of pesticides.

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