

**INTERDISCIPLINARY RESEARCH: A SWOT ANALYSIS AND ITS ROLE  
IN AGRICULTURAL RESEARCH IN MEXICO**

**LA INVESTIGACIÓN INTERDISCIPLINARIA: UN ANÁLISIS FODA Y SU  
PAPEL EN LA INVESTIGACIÓN AGRÍCOLA EN MÉXICO**

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**SUMMARY**

The aims of this paper are first of all, to discuss definitions concerning multidisciplinary, interdisciplinary and transdisciplinary research and to review their main characteristics. Secondly, a SWOT (strengths, weaknesses, opportunities, and threats) analysis of the interdisciplinary/multidisciplinary research was carried out. Finally, the role and contribution of these kinds of research by agricultural universities and research centers in Mexico is mentioned. The SWOT analysis shows weaknesses and potentials of interdisciplinary research and actions that should be implemented to promote these approaches. Research carried out by these teams is contributing to bridge concepts, theory and methods of different disciplines to solve problems that a single discipline cannot solve.

**Key words:** Interdisciplinary, multidisciplinary, SWOT analysis, agroecosystems.

**RESUMEN**

Los objetivos de este trabajo son, primero discutir definiciones relacionadas a investigación multidisciplinaria, interdisciplinaria y transdisciplinaria y revisar sus principales características. Segundo, un análisis FODA (fortalezas, oportunidades, debilidades y amenazas) de la investigación interdisciplinaria/multidisciplinaria es llevado a cabo. Finalmente, el papel y la contribución de este tipo de investigaciones hecha por las universidades y centros de investigación agrícola en México es mencionado. Este trabajo determina que se requiere llevar a cabo más estudios con características eminentemente interdisciplinarios, multidisciplinarios o transdisciplinarios para entender problemas complejos de la agricultura. El análisis FODA muestra las debilidades y potencialidades de la investigación interdisciplinaria y se incluyen acciones que pudieran ser implementadas para promover estos enfoques. Se concluye que la investigación llevada a cabo por este tipo de equipos de investigación aunque de forma lenta pero esta contribuyendo a enlazar conceptos, teoría y métodos de diversas disciplinas para resolver problemas que una sola disciplina no puede resolver.

**Palabras clave:** Interdisciplinaria, multidisciplinaria, análisis FODA, agroecosistemas.

**INTRODUCTION**

The high specialization of modern disciplines has resulted in a growing knowledge fragmentation causing intercommunication problems. Common terms used in certain disciplines have frequently a very specific meaning. As a result of that there is a dialogue barrier of what is perceived as the most important and valid within the context of each discipline. For economists, it tends to be market, economic efficiency and profitability, while for agronomists, the concern is on technological aspects related to their development, diffusion, adoption and achieving high productivity among others. For biologists, the main concerns are

biodiversity, ecological changes and conservation and finally, for sociologists, concerns are to be equity, indigenous knowledge and culture. Thus, to create a common language between the disciplines that allows the study of complex problems of the current world reality and even for the future is needed. Nowadays, there are more coincidences between disciplines that were thought irreconcilable in the past. Emerging disciplines such as ecological economics, agroecology and others are being recognized for their integrationist approach.

The objectives of this paper are: first, to analyze the main characteristics of unidisciplinary, multi-

disciplinary and interdisciplinary research (IR). Second, a SWOT (strengths, weaknesses, opportunities and threats) analysis of the IR is presented and commented. Finally, the role and importance of the multidisciplinary and IR in Mexican universities and research centers is discussed.

**Definition of Terms**

Very often multidisciplinary and IR are confused and sometimes are used as synonymous. This is even more marked when a transdisciplinary concept is introduced. All of them contribute undoubtedly to knowledge generation through different approaches. Each of these approaches is defined briefly below.

Multidisciplinary research has been defined by Vedeld (1994) as “research in which the researchers work in a parallel way on a certain topic”. In this kind of research scientists from different disciplines are invited to work together and the topic assigned to each one is always according to their particular academic background, skills or professional experience. It means, that different methods or approaches are partially applied to a common problem. Lockeretz (1991) has identified four types of multidisciplinary research: additive, integrated, nondisciplinary and synthetic. The first two are also described as extensive and intensive multidisciplinary research, respectively.

Interdisciplinary research can be defined as the conceptual and practical integration of more than one discipline to find solutions to complex problems that require the participation and interaction of different disciplines and has a common objective. Today, within IR not only scientific knowledge but also directly or indirectly indigenous or local knowledge are accepted (Figure 1). So, an interdisciplinary team is a group of

academics or researchers trained in different fields of knowledge (with contrasting conceptual and theoretical backgrounds) organized in a common effort to find a solution to a common problem, based on strong intercommunication. Thus the key ingredient for a truly interdisciplinary work is interaction and the hope that this interaction leads to synthesis and synergism. Johnson (1971, cited in Lockeretz, 1991) used the interdisciplinary term to define “research that does not lie within any discipline rather than combining several” and Rhoades *et al.*, (1986) described it “as the interaction between the component disciplines”.

Intradisciplinary research refers to the integration of theories and knowledge belonging to the same discipline and this can be either multidisciplinary or interdisciplinary. e.g. an intradisciplinary team formed by pythopatologists, entomologists, and hydrologists working on the common problem and all of them from the same discipline (agriculture).

Transdisciplinarity is the expansion of the interdisciplinary approach towards participation. This approach is expected to lead to new approaches in environmental and agricultural research as a prerequisite to a more holistic assessment. At present, there are a number of different transdisciplinary definitions. The coincidences between the several definitions indicated by the UNESCO (<http://mirror-us.unesco.org/>) can be summarized as follow: “a process and method of research based on an intellectual disciplinary fusion where disciplinary limits are transcended with the purpose of solving and achieving a better understanding of the complex problems from multiple perspectives and generate, transform and integrate theories in an emergent knowledge”.

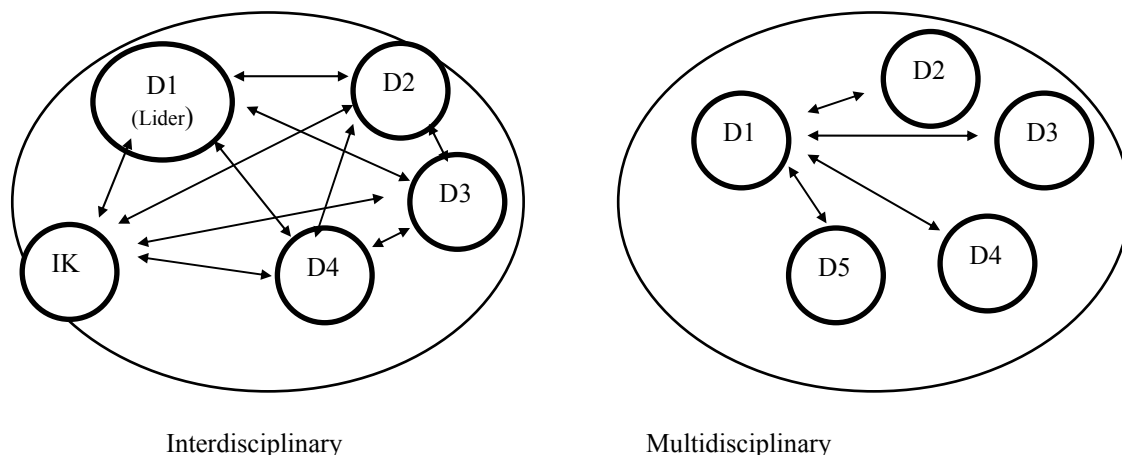


Figure 1. Interaction between the members of interdisciplinary and multidisciplinary research teams. D= Discipline; IK= Indigenous knowledge

Many scholars agree about the importance of the research carried out by teams as an appropriate method to cope with the complexity of the current world in terms of ecosystems (Elliot and Cole, 1989), agroecosystems (Conway and Barbier, 1990), rural development (King, 1999), landscape management (Van Mansvelt, 1997), sustainability (Altieri, 1989; Lockeretz, 1991), environmental problems (Kaufmann and Cleveland, 1995; Batabyal 2000) and natural resources management (Janssen and Goldsworthy, 1996). Multi- and IR have been strongly considered to address a wide range of agricultural and ecological problems, particularly when their solution does not depend on the participation of just a single discipline. In this sense, IR initiatives are being greatly accepted not only within the agronomic, biological and environmental sciences but also within the education and biomedical sciences (Gershon, 2000).

General characteristics of unidisciplinary, multidisciplinary, interdisciplinary and trans-

disciplinary research are shown in Table 1. It can be seen that IR uses holistic and integral approaches and also emergent and innovative methods. While multidisciplinary research uses partially reductionist methods although the approach could be integral. The distinction between multi- and IR can also be made in terms of the objectives and the level of interaction and intercommunication.

A better understanding of the socio-economic and ecological phenomena cannot be properly achieved by using conventional methods due to the complexity and the multiple factors involved. Thus, interdisciplinary approach provides a theoretical and methodological framework to analyze and obtain a better comprehensive explanation of complex, multi-dimensional phenomenon and to describe interrelations among different units of analysis.

Table 1. Comparison among unidisciplinary, multidisciplinary, interdisciplinary and transdisciplinary research.

Feature	Unidisciplinary	Multidisciplinary	Interdisciplinary	Transdisciplinary
Objective	Individual	According to academic background and task assigned (partial)	Common to the whole team	Identified and common to stakeholders
Approach	Reductionist, atomist	Integral	Integral, holistic	Integral and Reductionistic
Problems	Single (in relation to the number of elements involved)	Relatively complex (different factors or system elements are analyzed at the same time in a parallel way)	Complex (different factors or system elements are analyzed in a parallel or sequential way)	The problem suggest the team members, it can be simple and complex.
Leadership	Unnecessary	Partially needed	Needed	Shared by stakeholders
Methods used	Reductionist /traditional	Partially reductionist	Emergent/ integrationists/innovative	Emergent as the problem needs it
Work perception	Individualistic	Individualistic	Team	Team
Interaction level	Low or inapplicable	Low and relatively high	High	Common language
Results interpretation	Narrow	Narrow	More complete and integrative	Clear and ready to use by stakeholders
Publications	Individual	Individual or team	Team	Team and individual
Sort of publication	Formal	Formal and informal	Formal and informal	Formal and informal
Decision-making	Individual	By leader or partially individual	As a team or by the leader	Done by stakeholders

### **General characteristics of interdisciplinary teams.**

What are the key elements required for empowering IR and teams? How can interdisciplinary teams be more efficient, have synergetic properties and a real interdisciplinary function? How can we recognize that the involved disciplines are the right ones? There is always a cost involved in not having the right disciplines –in relation to the problems to solve- in the sense that motivation would be lower and lack of the right knowledge required. If there is a defined “optimal size”, what is the right size of an interdisciplinary team? Some criteria should be considered e.g. the number of elements under study, the level of understanding and the required detail, the project scale and the budget available. Surely there are no rules on this respect, but obviously an adequate interdisciplinary team will have an important effect - directly or indirectly- on good results and efficient work.

Normally, the type of problem and the research purpose partially determine the members to be involved in the team and even its size. In other words, it determine what could be the academic profile -in terms of knowledge, skills, disciplinary background, and attitude- that should be met by any person who would be integrated into an interdisciplinary team. Indeed, a structural interdisciplinary team or statutory integrated is not a guarantee of a genuine interdisciplinary work (Lockeretz, 1991). It is a process that is achieved and consolidated gradually. It can not be assigned by mandate but by self-conviction of the participants who agree on the necessity and importance of being integrated to solve problems, which are beyond one discipline.

An interdisciplinary team emerges frequently by the leadership or proposal of the scientist who has either the highest reputation or is more experienced. This scientist conceives that the problems addressed demand the participation of other specialists and then the need to form a research team that allows problems to be addressed in a much more efficient way. This person, due to natural leadership and work capacity is likely to become the team leader, but even more if the initial financial support is obtained through his effort. In addition, the leadership position is given to him in acknowledgement of his initiative or for forming the research team.

It is hoped that interdisciplinary teams should be constituted by members from different disciplines in a very complementary way and avoiding as much as possible redundancy. According to the systems theory (Bertalanffy, 1973), the integration of different scientists will result in much more than the mere sum of the members and that this complementarity will lead to a synergetic effect and also to holistic analysis

of the problems investigated. Thus, the specialist is required who, from a disciplinary point of view, can analyze and respond to the problems addressed but under an integral approach.

A requirement for a genuine interdisciplinary work requires that newcomers would be willing to participate and also they should be truly convinced of the potentials and opportunities that can be obtained from working as a team. This work demands also practical, conceptual and consensual co-operation. Each member should be familiar with the key concepts or to have a minimum knowledge of the disciplines involved in the study to build a common language and bridge concepts, theory and methodology through an interdisciplinary dialogue. This allows a more fruitful understanding among the team-mates and solution to the problems can be found in a more efficient way.

In practical terms it is possible to use different methods to solve similar problems. In other words, disciplinary methods or emergent methods that came from the integration of different disciplines can be used. In addition, team-mates can assume different roles in the solution of the problem, where the final result –success or failure- is the responsibility of each member. This kind of research demands the same scientific rigour as any other research and frequently innovative methods of evaluation and analysis are needed. Within IR the team should share infrastructure, human, financial, information and any other resource available to develop the study.

Generally, the nature of the research problem determines the characteristics - qualitative and quantitative - of the research team. It implies that interdisciplinary teams should have great flexibility in relation to the number of members and a strong relation to the research develops. Perhaps at the initial or at the last stages of the project, a bigger or smaller number of specialists are required, and frequently depending on the sort of study.

IR seeks, as in other types of research, to publish findings in a formal and/or informal way. Informal publication (report and newspaper) or diffusion (radio and television) is particularly needed when IR attempts to solve rural problems and the results will be used by local people, authorities or decision-makers. Formal publications (magazines, journals or proceedings) are also needed to interchange information and ideas with other colleges.

The results published must be related to rules previously established by the team. e.g. the author can be assigned in terms of physical and/or intellectual effort developed, by alphabetical order or by team agreement.

## **The role of interdisciplinarity in agricultural research**

IR has started to be used in agricultural sciences as a part of the research in farming systems research (FSR) and FSR has been characterized as an interactive strategy that use interdisciplinary teams and the integration of experimental station research with socio-economic investigations and on-farm trials of technologies in the field (Hildebrand 2000; Jones and Wallace, 1986).

The necessity to use IR in the agricultural sciences has been to perceive correctly the social, economic and ecological problems related to agriculture and rural development. Agricultural problems do not only demand technical solutions; its problems do not just relate to profitability, low technological adoption, soil productivity or social aspects but with the whole. Agriculture includes ecosystems, agroecosystems and socio-economic systems and therefore qualitative and quantitative paradigms and methods should be used to analyze the subjective and objective ingredients of these complex systems.

Research on sustainable agriculture or sustainable development is always related to multi- or interdisciplinarity (Gliessman, 1998). Indeed, to achieve the interaction among different dimensions (social, economic and ecological) and its goals, interdisciplinary and multidisciplinary research has been considered as the right method.

### **The leadership within interdisciplinary teams**

In the initial stage of the team integration, usually the scientist with highest experience and highest academic level assumes a "natural leadership". However, as the team integration process develops the leader position can be rotated and young members can assume from time to time the leadership by organizing work meetings and other activities for the team. This kind of training promotes a spirit of leadership among the young or new researchers.

The structure of a research team with interdisciplinary characteristics is a process at which the optimum integration level is reached when the members perceive that they have reached a high level of intercommunication, and co-operation. This can also be proved through the scientific acknowledgement of their findings, through the financial support and most importantly in seeing the application of the results or technological development generated by the team. Interdisciplinary team integration does not mean homogenization, uniformity or annulation of individuals; on the contrary, it means a great diversity of opinions that confer on this type of research a very wealthy approach. Particularly when there is a true and

real disciplinary heterogeneity and a great homogeneity in terms of objectives and goals that the team is attempting to achieve.

### **A SWOT analysis of interdisciplinary research of agricultural team works in Mexico.**

The SWOT analysis has been a useful tool for industry (Johnson et al., 1989). The SWOT analysis is a general tool used in the preliminary stages of decision-making and as a precursor to strategic planning in various kinds of applications. Nowadays the SWOT analysis method has transcended the administration sphere and is being used in other fields. A SWOT analysis of the interdisciplinary research in Mexico is shown as result of a research done by e-mail with research institutions.

#### **Weaknesses and threats**

There is very little IR on the agricultural and ecological fields in Mexico. In other words, scientists working in an interdisciplinary way are few for many reasons. But probably the most serious problem is the scarcity of interaction between research teams that allow ideas, work methodologies and experiences to be interchanged. Network creation could be a very effective way to strengthen communication among the research groups. This isolation could be also avoided through formal and informal meetings or events that allow ideas and experiences to be interchanged. This type of meetings (virtual or real) could allow groups to find coincidences and can bring opportunities to discuss approaches and for a great interdisciplinary dialogue.

Some research administrators and even scientists frequently have a misconception about IR and very often it is thought that this is not as serious a research as the unidisciplinary research. This kind of prejudice partly explains why sometimes policy-makers give insufficient support to this sort of research. In addition, if one has decided to become involved in interdisciplinary work, it obviously needs a lot of courage to accept criticisms and to be severely self-critical. Although the criticisms sometimes become very severe, this should be given always in a constructive context or what Rhoades *et al.*, (1986) euphemistically called "*constructive conflicts*" which can derive sometimes in severe discussions and difficult interaction but which can be very stimulating and inspiring.

Another challenge that the IR faces is when findings of this kind of work will be published. For example, scientists often face regulatory problems from the editors of journals or scientific magazines. It is known that many journals have a very established and specific field (Entomology, Physiology, Phytopathology, etc.) which is not usually compatible for emerging and

integrative fields. In addition, these journals have a certain type of reader, who most times is very specific. Under such circumstances, publishers very often reject interdisciplinary contributions as they feel they may not be very appropriate for their captive readership. Fortunately today there are more international journals and forums that acknowledge this type of research and wish to include it.

Different causes have discouraged interdisciplinary work. One is the institutional criteria on which interdisciplinary work is evaluated not only by national institutions but also by the home institution. So, the criteria frequently used to evaluate research, to assign scientific awards or grants are basically those which have been used to evaluate unidisciplinary research. Unfortunately and very often research carried out by teams is evaluated with criteria perfectly established to evaluate unidisciplinary research. It means that there are not criteria *ad hoc* to evaluate research carried out by teams. Indeed the criteria to evaluate this type of work are still at an embryonic stage and it may take some years before a fully and well-developed evaluation system is established. Table 2 shows –from our point of view the SWOT analysis of IR.

Another challenge that this type of research faces is not only to find the personnel willing to participate in interdisciplinary work but also to match the ideal characteristics for this type of work (critical and self-critical capacity, willingness to work as a team and for the team, attitude towards conciliating interests, and wish to share experiences and knowledge, etc). In addition, personnel with the ideal characteristics will not always be willing to participate or are busy in their investigations or are not fully convinced of the advantages of the interdisciplinary work. Additionally, many of them prefer to be specialized in their discipline, adopting an individualistic position and hoping on being recognized for their investigations to access a better academic or administrative position, instead of seeing his work "diluted" or just be one of the team.

Due to the fact that IR demands a constant interaction between the team-mates, a lack of friendship and of solidarity between them can result in a weak team operation and sometimes this leads to total or partial team disintegration.

### **Strengths and opportunities**

The contribution made by the unidisciplinary research and reductionist approaches is not denied. However,

now it is accepted that the solution of the problems that humanity faces in terms of sustainability demands innovative and integrationist approaches. In the agricultural context, the elements that make the whole are not independent from each other. Mainly if agriculture is conceived as a system formed by different elements, such as institutions, society, biotic and abiotic resources. Then the solutions to the problems related to the different elements interaction and dimensions should be found through integral approaches. In other words, holistic and systemic approaches can contribute to a better understanding and answer the complex problems of agriculture. Thus IR can have an important role and great potential in giving answers not only to agriculture problems but also to the problems derived from agriculture.

### **Some examples of interdisciplinary research in Mexico**

A successful IR needs and demands that this type of research be promoted at undergraduate and postgraduate level. Universities should promote not only unidisciplinary work but also interdisciplinary work as a strategy to promote different approaches to assess the reality. Training students in just one field is important, but to prepare students to develop IR could be even more important, especially for countries with a great diversity of agroecological habitats, cultures, agricultural purposes and considering that the processes that take place in agriculture are much more complex than we normally think, particularly in tropical environments. Hence agreeing to develop and promote this kind of research has real justification.

Progress in these type of approaches can be noted at various universities and research institutions in Mexico. e.g. the Instituto Politecnico Nacional, Universidad Autonoma Chapingo, Universidad Autonoma del Estado de Mexico, Colegio de la Frontera Sur, Colegio de Postgraduados through various undergraduate or postgraduate and research programs where interdisciplinary dialogue is practiced, taught and promoted, also concepts, theories and methodologies are developed. However, the amount of work developed by these and other institutions is not enough to cope with the agricultural and ecological problems. Certainly its consolidation and decisive support will reflect in a greater improvement in the rural and environmental context.

Table 2. A SWOT analysis of interdisciplinary research as reported by respondents.

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>▪ Allows new research methods to be built or generated</li> <li>▪ The results could have an extensive or a major scale application</li> <li>▪ Allows a better understanding of complex systems (agro-social-economics-ecological) as a whole</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>▪ Lack or very little acknowledgement of this kind of research</li> <li>▪ The analysis level is quite variable</li> <li>▪ Problems to obtain financial support due to the delay in obtaining results in the short-time</li> <li>▪ Conflicts to define “the better method” to address the problems under study</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>▪ To scientific creativity</li> <li>▪ To understand and accept different points of view or perceptions of the reality</li> <li>▪ Allows learning new research methods, skill and concepts</li> <li>▪ Efficient use of the resources available</li> <li>▪ Constant feedback</li> <li>▪ Allows a great critical and self-critical capacity to be developed</li> <li>▪ Allows a much better work organization</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>▪ Lack of intercommunication towards the interior and exterior</li> <li>▪ Very little acknowledgement of the interdisciplinary research merits</li> <li>▪ Conflicts between researchers on the quantitative and qualitative paradigm</li> <li>▪ The advance of the work depends on the work of others</li> <li>▪ Conflicts in authors</li> <li>▪ A weak or authoritarian leadership can lead to team disintegration</li> <li>▪ Institutional impediments to form research teams</li> </ul>

Scientific IR can be organized through research teams of variable geometry (Figure 2). It is known that in many research institutions one of the main concerns is lack of budget to carry out research. But through teams of variable geometry human and financial resources can be multiplied, where a key disciplinary scientist can play an important role in different research teams, through active participation.

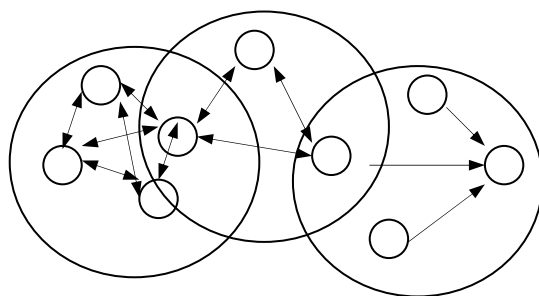


Figure 2. Research teams (interdisciplinary or multidisciplinary) of variable geometry

Finally, we believe that schools need to teach unidisciplinary research and to promote interdisciplinary work. Training students at graduate level on interdisciplinary work would help to establish in our institutions a body of interdisciplinary teams to attend complex problems. In summary, it is expected that interdisciplinarity, multidisciplinary and transdisciplinarity research will help to find alternative

solutions for the complex problems of the modern and changing world.

### CONCLUSIONS AND RECOMMENDATIONS

One of the weaknesses reported is that of the scarcity of interaction between research teams that allow ideas, work methodologies and experiences to be interchanged. Network creation could be a very effective way to strengthen communication among the research groups.

There exists a misconception about interdisciplinary research by some research administrators and even scientists that often think that this is not as serious research as the unidisciplinary research.

The national or home institution criteria used, frequently, to evaluate research, to assign scientific awards or grants are basically those which have been used to evaluate unidisciplinary research, not in group teams.

A prerequisite for genuine interdisciplinary work demands certain familiarity with key disciplinary concepts to avoid communication barriers.

The development of interdisciplinary work has proved, when the disciplinary approach is insufficient, the benefits and potential of this approach to address complex issues, analyzing interactions and at various dimensions or components in terms of sustainability.

Progress in interdisciplinary research can be noted at various universities and research institutions in Mexico, through various undergraduate or postgraduate and research programs where interdisciplinary dialogue is practiced, taught and promoted, also concepts, theories and methodologies are developed

Finally it is expected that this document will allow a better understanding of the research done by team work and its contribution to solve environmental and agricultural problems. It is hoped also that this could reflect in a great acknowledgement of the interdisciplinary and multidisciplinary research in universities, research centers, NGOs and financial institutions.

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