

Contributions to the INIFAP technology transfer 35 years after its creation

Contribuições para a transferência de tecnologia INIFAP 35 anos após a sua criação

DOI:10.34117/bjdv8n4-429

Recebimento dos originais: 21/02/2022

Aceitação para publicação: 31/03/2022

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ABSTRACT

The main contributions that INIFAP has made in the transfer of technologies and knowledge, in support of the rural population of Mexico, are presented, the most outstanding models within the national and international scope that researchers have put into operation and their main results are detailed. Undoubtedly, the institutional contributions to the programs of the Ministry of Agriculture and Rural Development have marked a watershed between the traditional models or what "what occurred to him" to the researcher in contrast to the participatory and inclusive models to contribute to the substantial improvement of the productive processes, the family economy and for the agribusiness.

Keywords: inifap, technology transfer, successful models

RESUMO

São apresentadas as principais contribuições que o INIFAP tem feito na transferência de tecnologias e conhecimentos, em apoio à população rural do México, os modelos mais notáveis dentro do âmbito nacional e internacional que os investigadores puseram em funcionamento e os seus principais resultados são detalhados. Sem dúvida, as contribuições institucionais para os programas do Ministério da Agricultura e Desenvolvimento Rural marcaram um divisor de águas entre os modelos tradicionais ou o que "lhe ocorreu" ao investigador, em contraste com os modelos participativos e inclusivos para contribuir para a melhoria substancial dos processos produtivos, da economia familiar e para o agronegócio.

Palavras-chave: inifap, transferência de tecnologia, modelos de sucesso

1 INTRODUCTION

Technology transfer starts from the prolegomena of communication as indicated by the Aristotelian rhetoric where "... Someone says something, through a medium and someone captures it" for their benefit, Cadena, *et al.*, (2018). The concept of technology transfer is based on the fact that knowledge is generated, for its evaluation and later to be used in a different context, therefore, all knowledge can be re-evaluated anywhere in the

world based on a communication process. The present study is a succinct compilation of the contributions that the National Institute of Forestry, Agricultural and Livestock Research (INIFAP) has carried out in favor of the Mexican rural population, throughout its history, they are not all the actions that have been carried out, but if the most important at the national level, 14 technology transfer models have been developed and operationalized, which stand out for their contribution to the transfer and management of innovation in the agricultural and forestry areas.

2 BACKGROUND OF THE THREE RESEARCH INSTITUTES IN MEXICO

“...Agricultural research began in 1907 with the creation of the Central Agricultural Experimental Station of San Jacinto, Federal District, attached to the National School of Agriculture, today the Autonomous University of Chapingo (UACH). In 1908 three experimental stations were established in Tabasco, San Luis Potosí and Oaxaca. In the 1930s, the Department of Experimental Fields was created under the General Directorate of Agriculture of the then Secretary of Agriculture and Development, which founded the Directorate of Experimental Fields in 1940. In 1943, the Office of Special Studies (OEE) was created through an agreement between the Ministry of Agriculture and Livestock (SAG) and the Rockefeller Foundation, with the purpose of carrying out research on basic crops through bilateral cooperation projects, with the purpose of modernizing agricultural research in corn and beans. In 1947 the Directorate of Experimental Fields was transformed into the Agricultural Research Institute (IIA), which focused on the development of open-pollinated maize varieties for rainfed areas. In 1960, the National Institute for Agricultural Research (INIA) was created with the merger of the IIA and OEE...” (Cruz and Reyes, 2020).

In 1941, by presidential agreement, the Livestock Institute (IP) was created, which in 1947 changed its name to the Direction of Livestock Research. In 1962, the Ministry of Agriculture and Livestock (SAG) established a cooperative program with the Rockefeller Foundation to create the National Center for Livestock Research (CNIP). Starting in 1968, as the National Livestock Research Institute (INIP), it was the unit in charge of researching and studying the problems that were holding back the development of livestock farming, as well as generating, developing and adapting the necessary technology to overcome them. Significant advances were made in the control of diseases such as classical swine fever, paralytic rabies in cattle and Venezuelan equine encephalitis, and foot-and-mouth disease.

On the other hand, long before the creation of the two previous institutes, the Mexican Forest Research Institute (IMIF) was founded; forestry research began on July 1, 1932 when it was created, however, the foundation of said institute was carried out until December 29, 1934, under the name of Forest, Hunting and Fishing Research Institute; Later, in 1960, under the Law, the creation of the National Forest Research Institute (INIF) was formalized, since it had operated as such since November 1958. Op. Cit.

In August 1985, with the merger of INIF, INIA and INIP, the National Institute of Forestry, Agricultural and Livestock Research (INIFAP) was created, with the aim of combining human resources and infrastructure in a single administration, and thereby strengthening the capacity generation of information and technology to respond to the demands of the sector and contribute to increasing productivity in the forestry, agricultural and livestock subsectors of the country. For it there are four institutional objectives, in which the third stands out, which highlights the promotion and support of technology transfer:

Objective 3: Promote and support the transfer of knowledge and forestry, agricultural and livestock technologies, according to the priority needs and demands of producers and society, as well as contribute to the training of human resources, (Cadena, *et al.*, 2015).

Since the creation of INIFAP, seven so-called linear transfer models have been implemented, as they are proposed from the point of view of those who promote it: 1. Traditional transfer model, 2. The general communication model, 3. The of the Institute of Agricultural Sciences and Technologies (ICTA) of Guatemala, C.A.; 4. The CGIAR producer farm research model, 5. The multimedia or innovation diffusion strategy, 6. The southern grain model, and 7. The technology showcase model; and seven more of a participatory nature: 1. MOCATT model, 2. Field Schools for areas with the presence of original peoples, 3. The innovation management model with competitiveness for marginalized areas, 4. Biospaces-school for the production of vegetables, based on the Field Schools; 5. The model with a micro-basin approach, 6. The experimental producer model for maize, 7. The GGAVATT model for livestock species) these models are widely discussed in Cadena *et al.*, (2009), Cadena *et al.*, (2017).

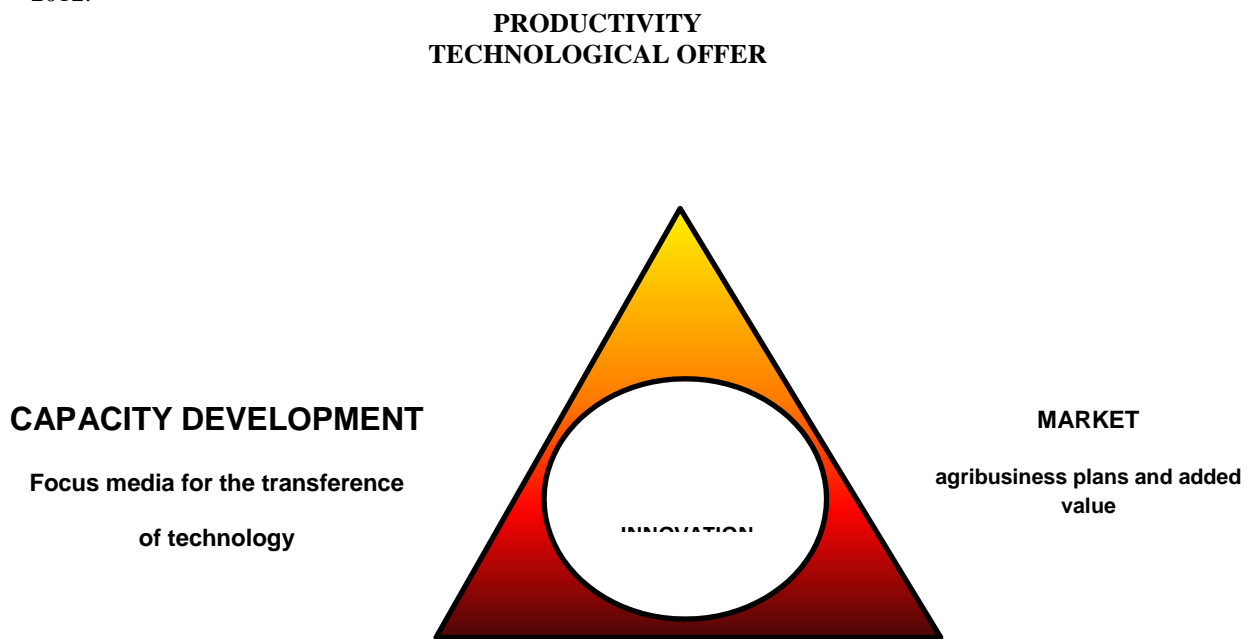
INIFAP's main contributions to technology transfer whose final destination is the rural population of Mexico can be summarized in the following technology transfer models developed and/or adapted to Mexican circumstances.

3 INNOVATION MANAGEMENT MODEL WITH COMPETITIVENESS FOR SMALL PRODUCERS

This model was developed in areas of high and very high marginalization in areas of the south southeast of Mexico, and later it was taken to the countries of Nicaragua, Belize, Paraguay and Brazil, it was proposed to manage innovation in said areas, which is widely documented in Cadena, *et al.*, (2018); Cadena, *et al.*, (2019), this consists of three lines of work: the technological offer, the development of capacities through a multimedia strategy and the development of agribusiness plans with added value to primary products. In three countries: Paraguay, Nicaragua, and Mexico, there is ample potential for producers or farmers in marginalized rural areas to have access to the market, provided that they are encouraged to initiate technological innovation processes themselves and, with it, access to a better life.

It is important to identify and inventory the local potential resources to generate businesses taking into account the market, without the cultivation or plantation being an imposition but rather a technological adaptation to what they already know and have in their environment, because if human capacities are improved of rural actors and the availability of knowledge is facilitated, it is possible to access higher levels of competitiveness. In addition to the FIELD SCHOOLS, a fundamental pillar of "learn-doing" requires more activities that reinforce the capacities of producers to achieve their empowerment and sustainability. The proposed model was well received among the participating groups and only one is expected. Escalation among the industry organizations in each country where organized groups and professional service providers are included so that the innovation of the management model to be replicated is made, Cadena, *et al.*, (2019).

Figure 1. Innovation management model for small producers, generated in Mexico. Source: Cadena, *et al.*, 2012.



Some results with this transfer model: agribusinesses were created in each state and country where it was tested, the applications of agroindustrial inputs were reduced and yields per hectare or per square meter of tomato *Lycopersicon solanum*, *Zea mays* corn, vegetables among others increased. *Capsicum* spp; and some Cucurbitaceae and with it, the decrease with the application of insecticides for production. For example, an agribusiness with Hass avocado was achieved in Chiapas, where the R B/C was 4.39 in a 12-year prospective, significantly increasing the value of the land, and in Nicaragua, in addition to increasing and organizing *Musa paradisiaca* banana producers, It was possible to incorporate the agribusiness career in the curricular program of the International University of Agriculture and Livestock, of Rivas Nicaragua where students leave with a business portfolio to graduate, and all this after sharing the model with the teaching team of that university.

4 THE FIELD SCHOOLS IN THE INIFAP

Braun *et al.*, 2006, document that the Field Schools (ECAS) were developed in the 80's in Indonesia as a response to the serious losses in the rice crop, caused by a plague, and the indiscriminate use of pesticides. For this, the ECAS were implemented to improve the analysis capacity and decision making of the producers, to break the dependence on pesticides. With the above, greater relevance was given to agroecological

aspects, as well as to the training of promoters; On this last point, Morales *et al.*, (2015), point out that it can be a factor for the massification or application on a larger scale of the technologies that are promoted.

The term "Field Schools" is based on the approach of learning by doing, that is, together with theoretical information, high importance is given to field work, where an exchange of experiences, knowledge and knowledge among the participants (Escobar, 2012). According to Morales *et al.*, (2015), the model is based on training in three scenarios, in a "school plot" where technicians and promoters attend, later these actors carry out the replication of what they have learned with the members of the community. or the Field Schools, and finally the technician visits each producer in his plot, to carry out the technical support. A training session is carried out in three moments: theory, practice and reflection- agreements. The theory is the introductory and informative phase of the fundamentals and advantages, as well as the motivation of the training topic. Later, the group moves to a plot to carry out the training, which begins with the practical exemplification of what was presented in the theoretical phase, to give way to the participation of the attendees. At the end of the practice, the group returns to the place where the theory session was held, to carry out the reflection phase - and agreements, to carry out a brief evaluation of the activity carried out, as well as the definition of the activity of technical support in the plots of the producers.

The Field Schools in Mexico, as a model, were initially used by members of non-governmental organizations, as well as academic institutions, such as the Universidad Autónoma Chapingo and the Colegio de la Frontera Sur. Meanwhile, in INIFAP, they began in the Mazateca, Cuicateca and Mixe indigenous regions of the state of Oaxaca. From 2002 to 2005, work was carried out on the methodological adaptation of the Field Schools, to the context of the original population of Oaxaca, through work with 24 community promoters in the same number of communities, with the total participation of 280 producers, from the Mixteco, Nahuatl, Mixe and Cuicatecos ethnic groups (Morales and Galomo, 2006; Morales, 2007).

In this period, two studies of technology adoption were carried out with the participating producers, Orozco *et al.*, 2008, documents that, in a comparison between participating and non-participating producers, as well as the period of knowledge at the beginning and at the end of the process of training, finding that the participants started with an initial score of 8, and ended with 70 points, this is 62% of adoption for the learning of the Field Schools. As for the non-participants, they showed an initial score of 8.3 and

ended with 8.6 regarding knowledge about the promoted technology, Milpa Intercalado con Frutales (MIAF). On the other hand, Gaytán *et al.*, 2008, states that in the training process, 63% adoption of the components promoted in the ECAS was achieved, likewise 60% of the trained producers shared their knowledge with their peers.

The model was used in various programs and projects. In 2008, with the support of the National Institute for the Development of Capacities of the Rural Sector A.C. It was documented as the technology transfer model aimed at food security in the productive units of rural areas with high and very high marginalization in the states of Oaxaca, Chiapas and Quintana Roo. In the period 2010 to 2012, FORDECYT - CONACYT financed a project that allowed the generation of an innovation management model for economic and social development in marginalized areas of the south-east of Mexico. In addition to its application in the program to increase the production of corn and beans (PIMAF) in the state of Guerrero, the FAO PROTIERRAS project in Oaxaca and Hidalgo, as well as the technological, organizational and commercial innovation project. Elements for overcoming poverty in the states of Chiapas, Oaxaca and Guerrero, and in 2020 it began its application in the Production for Well-being Program. In this scenario, various technology adoption studies have been carried out with the application of the Field Schools model, such as in the production of corn in the town of Tlalcozotitlán, municipality of Copalillo, Guerrero, where it was possible to increase the production of corn, 0.9 t ha⁻¹ to 2.03 t ha⁻¹ with the components of incorporation of mycorrhizae, organic fertilizers, topological arrangement, pest control with pheromones and plant extracts and mineral broths (Noriega *et al.*, 2019). The training method has been applied to other crops, such as the production of tomato *Lycopersicon solanum* in a protected environment in communities in the state of Oaxaca, with the promotion of components such as varieties, soil disinfection, production of seedlings and planting in trays, transplantation, tutoring, pruning, nutritional monitoring, pollination, pest and disease control, and harvest. Participating producers adopted an average of 46% of the promoted components, increasing yields from 5.34 kg/m⁻² to 12 kg/m⁻² (Ortíz *et al.*, 2013).

In Mexican lemon, the training method was applied to improve the profitability of the integrated management system of lemon *Citrus aurantifolia* in the state of Guerrero, which involved the use of improved and certified plant components, training and rejuvenation pruning, health and fruiting, balanced chemical fertilization, flowering induction, pest and disease management, the adoption percentages were 88% adoption of

these components, with higher adoption in pruning and fertilization (Vásquez *et al.*, 2020).

In the community of San Lorenzo Jilotepequillo, Oaxaca, the training method was applied to native Chontal women, producers of flowers, of the Lily or liliun (*Lilium* sp), and Lisianthus (*Eustoma grandiflorum*) species, promoting the preparation and use technologies of plant extracts, ash broth, sulfocalcic broth, Bordeaux broth, soil disinfection, preparation and use of bocashi fertilizer, 54% adoption of the promoted components was obtained. The training model has also been applied in backyard vegetable production. In the community of San José del Carmen, municipality of San Cristóbal de las Casas, Chiapas, various technologies were promoted, such as double excavation biointensive beds, preparation and use of bocashi fertilizer, planting species such as cabbage (*Brassica oleracea* L.), lettuce (*Letuca sativa*), radish *Raphanus sativus*, onion (*Allium cepa*), carrot (*Daucus carota* subsp maximus), beet (*Beta vulgaris*) and coriander (*Coriandrum sativus*), testing different associations and crop rotations, elaboration and use of extracts vegetables, placement of attractive traps for pests, as well as a rainwater harvesting system and its management system. The volume of vegetable production increased, 88% with respect to its initial production, as well as the diversification of species. 94% of the production was for self-consumption and the rest for sale in the same community. (Martínez *et al.*, 2019), although no wealth was created from the sale of the products, at least a contribution to food self-sufficiency is achieved in that region. In the state of Guerrero, the technologies promoted included the establishment of seedbeds, a shade house with Agribon fabric, the production and application of agroecological fertilizers, the production and use of Bordeaux mixture, ash and calcium sulphide broth, installation of a drip irrigation system, yellow traps with adhered oil for pest monitoring and control, fertilization with compost and bat guano, with the training of field schools, vegetable production increased by 120 %, up to 2.2 kg/m⁻². In the case of the production of tomato *Lycopersicon solanum* and onion *Allium cepa*, most of the production was marketed, which contributed to the income of the participating families (Vásquez *et al.*, 2019).

5 SCHOOL BIOSPACE

A variant of the previous model and as an alternative to contribute to the reduction of climate change and the scarcity of resources, especially water, in addition to the fact that each day there is a greater increase in environmental temperature and a decrease in

relative humidity, which causes imbalance between the vapor pressure and the metabolism of plants, mainly fruit vegetables, favoring a condition of stress and permanent weakness, predisposing them to diseases and pests, on the other hand and due to this situation, pathogens and disease vectors show ample capacity of adaptation, being increasingly difficult to control (Garzón, 2001). For this reason, the protection of crops through Biospaces and “shade houses” contributes to reestablishing the balance between the environment and plants. Biospace is a concept that, in conjunction with agronomic practices, regulates the quantity and quality of light, temperature and humidity, in areas with high irradiance and temperature, and low relative humidity, to favor the growth and development of plants (Bustamante, 2001). Two components are fundamental in the concept of Biospace: 1) Protection by means of a high-density white mesh with 50% transmission of Rachel type, with an opening of 2x3 mm holes, whose function is to regulate the climate by reducing solar radiation and increasing of relative humidity, 2) Specific agronomic management, which includes genetic material, topological planting arrangements, pruning systems, nutrition through fertigation, integrated management of pests and diseases and harvest (Bravo *et al.*, 2006).

To promote the transfer of this technology, from 2005 to 2009, 13 School Biospaces were established in the state of Oaxaca and Morelos. The operational mechanics consisted of the integration of the groups and the constitution of the Field School; The first step is the construction of the warehouse and then the start of production. Each group forms a minimum organizational structure for the activities. The training is given through an interactive process of the participants, producers, researchers and technicians with a "learn by doing" approach, the sessions are periodic during the crop cycle considering two phases: it is necessary that the participants consider the importance of carry out the initial diagnoses of soil and water since the nutritional program depends on it, that they learn to take soil samples and water diagnosis, the participants learned to take the sample and the interpretation of the results issued by the laboratory to define the nutrition of plants in their various phenological stages. It is also important to do the tutoring and phytosanitary pruning, in addition to producing your own seedling in order to reduce costs, through this transfer model.

Regarding crop protection, the producers learned to identify the main pests that affect the crop, such as the whitefly *Bemisia tabaci*, which is the main vector that transmits viruses, *Agrotis* spp cutworms and *Acari* or *Acarina* mites. However, because the Biospace conditions allow insect populations to be kept low, these were not

significant, which allowed a reduction in insecticide applications in relation to open-air production (from 20 applications to five on average).

Regarding post-harvest handling, the change of the packing system from wooden boxes known as "huacales" to 20-kilo plastic boxes known as "taras" was mainly considered. Productivity was variable, highlighting Ayoquezco de Aldama and San Antonino Castillo Velasco, where the highest productivity was obtained (Table 1).

Table 1. Yield of tomato obtained in 12 School Biospaces in Oaxaca

Biospace and greenhouse	T/ship or space	Kg/m ²	T ha ⁻¹
San Antonino Castillo Velasco I	35.0	17.5	175.0
San Pablo Huixtepec I	24.5	12.25	122.5
San Agustín Amatengo	13.5	6.75	67.5
Zimatlán de Álvarez	14.5	7.25	72.5
Santa María Camotlán I	30.0	15.0	150.0
Santa María Camotlán II	27.0	13.5	135.0
San Antonino Castillo Velasco II	35.0	14.0	140.0
San Pablo Huixtepec II	25.0	12.5	125.0
San Dionicio Ocotepc	10.2	16.0	160.0
San Juan Guelavia	6	16.0	160.0
San Agustín Amatengo	11.1	18.5	185.0

On average, a Cost Benefit Ratio (CBR) of 2.0 was obtained, which, according to Gittinger (1983) and Rodríguez *et al.*, (2006), indicates that for each peso invested, 2.0 pesos are generated; the Internal Rate of Return (IRR). It was 36%, therefore the activity presented high profitability. The model showed its effectiveness by contributing to the rescue of horticulture in Oaxaca, generating higher family income, inducing self-employment and family roots, and the most important thing is that it contributes to protected and safe agriculture.

6 INIFAP PARTICIPATION IN SECTORAL PROGRAMS

In 2008, the General Livestock Coordination of SAGARPA invited INIFAP to participate in the National System of Evaluation Centers as a Specialized Livestock Technical Unit (UTEP). Defined as a research or educational entity responsible for the generation of technology and methodology, training, technical support and accreditation of the professional service providers (PSP) that participate in it. Within the framework of the Capacity Development and Rural Extension Component, the areas of intervention of the UTEP are summarized in: Design of the Intervention Model for Livestock Services; Certification of Labor Competences; Development of New Professional Capacities, Impartation of the

diplomas in Training of Consultants of Livestock Companies dedicated to the Breeding and Development of Cattle for Meat and Training of Consultants in the Intervention Strategy with Groups of Agricultural Producers. Technical Assistance and Training in support of the beneficiaries of the Livestock Program (PROGAN). Training for Groups and Organizations supported by FONAES; Beekeeping Confederation of Foundations Produces (COFUPRO).

At the end of 2010, the Specialized Agricultural Technical Unit (UTEA) was implemented through a collaboration agreement between INIFAP and the General Directorate of Rural Extensionism of SAGARPA, within the framework of the Capacity Development and Rural Extensionism Component. It was integrated with an INIFAP researcher as representative of the UTEA by state of the Mexican Republic and began activities to support the development of capacities of agricultural professional service providers. In 2011, the continuity of the UTEA was agreed with the National Institute for the Development of Capacities of the Rural Sector, A.C. (INCA Rural) and for its operation the following areas of intervention were proposed: Design of the Training Strategy, Technical Support, Supervision and Evaluation of Agricultural Services. Design of technical support strategy for the Strategic Project to Support the Productive Chain of Corn and Bean Producers (PROMAF) together with MasAgro for its operation in the Node Model (HUB). Joint monitoring and evaluation strategy: INCA, UTEA-INIFAP and CIMMYT.

As a result of the intervention of the UTEA in 2011, training and technical support were provided to 1,099 PSP, from the Capacity Development Program and the Strategic Program to Support the Productive Chain of Corn and Bean Producers (PROMAF). Through UTEA, INIFAP designed and conducted, under the responsibility of its researchers, 25 maize and bean research platforms throughout the country, incorporated into MasAgro's "Conservation Agriculture" component. For 2012, UTEA continued the operation of the 25 Research Platforms established in most of the national territory, providing technical support and training to 1,044 professionals in the sector, of which 77% were PSPs; 14% PROMAF trainers and 9% officials. Likewise, in demonstration field events, INIFAP assisted 1,399 participants, of which 69% were PSPs, 26% producers, and 5% decision makers. When considered as a process of planning, monitoring and permanent evaluation, the design is comprehensive, inclusive and participatory; that is to say, the process involves all the actors: SAGARPA, State Governments, Evaluation and Follow-up Commissions (CECS), Providers of

Professional Agricultural and Livestock Services, Producer Groups in general and individual Producers, as well as Trainers appointed by the CECS.

In 2016, SAGARPA and INIFAP signed a collaboration agreement whose objective was for the Institute to provide methodological and technical support to the extension workers hired within the framework of the Extension Component, provided for in the Support Program for Small Producers. A regional approach was proposed in order to contribute to regional development, through linkage and cooperation in science, technology and capacity development, through the establishment and operation of four Regional Rural Extension Centers (CRE): North, Center, Gulf -Peninsula and Priority States (Chiapas, Guerrero, Michoacán and Oaxaca), in support of SAGARPA's Rural Extension Programs. In order to contribute to the strengthening of the Extension Component; education, training, monitoring, certification and support to extension workers and producers; Methodological and technical support for the work programs of the State Research and Transfer Groups (GEIT); Support the coordination and evaluation of GEIT training programs, (Vázquez, *et al.*, 2017)

Regarding the Strengthening of the Extension Component: the capacity development strategy for extension agents and producers was designed; in addition to the definition of the profiles of the extension agents; identify areas of opportunity; proposals and support tools for SAGARPA Programs, for which the following were considered: A cross-cutting strategy for rural extensionism; Monitor the state of agriculture at the national level; Gather, synthesize and analyze information on technology, economics and markets; Integration of economic and social information to studies of productive potential; methodological design for the preparation of diagnoses at the municipal level.

7 GGAVATT MODEL (Livestock Group for Technology Validation and Transfer)

Fifty years ago, a proposal began to provide alternatives to livestock production and productivity in the then National Institute of Livestock Research (INIP), as well as the search for improvements in the profitability of production units in a sustainable manner. This proposal becomes a strategy that seeks to facilitate and streamline the process of transferring knowledge and technologies to producers to improve the livestock production process in Mexico. The GGAVATT model is based on a teaching-learning process for adult producers in informal settings, based on an andragogic educational process. Most producers in the agricultural sector in Mexico are adults and to work with them in a training process it is necessary to take into account how an adult person learns,

favoring aspects such as learning by doing. In this teaching-learning process, experiences are shared and through the facilitation of the educational process, the possibility of developing the capacities and potential of the producers is given. The three actors that support the model are: The producer, the agents of change and the research and teaching institutions. (Roman *et al.*, 2018)

The objectives of the GGAVATT model are: “to facilitate the organization of producers in groups with common objectives; achieve changes in attitude, behavior and aptitude in producers that induce them to use and adopt technology; increase the productivity of the Livestock Production Units (UPP), so that they are profitable, competitive and sustainable; improve the standard of living of producers and their families; promote the conservation and optimal use of natural resources; strengthen the integration of livestock value chains; and provide feedback with demands and technological problems to research and teaching institutions”. (REDGATRO, 2018).

According to the data provided by REDGATRO (2018) “In the development and evolution of the GGAVATT model, four stages can be considered. The first one includes the years from 1970 to 1982, which is identified as "Laying the foundations". The second stage comprises from 1983 to 1989. In this period the "Formation of the GGAVATT Model" was carried out. From 1990 to 1996, the active participation of research and academic institutions, development and promotion, unions and producer organizations related to the livestock subsector stands out. Then, in the state of Veracruz, the Unique Program of Technology Validation and Transfer of Livestock Groups (PROGGAVATT) emerged, whose objective was to technify livestock through the use of the GGAVATT Model. The fourth stage comprises from 1997 to 2017 and is known as the "National Extension of the GGAVATT Model". INIFAP implemented a national strategy that made it possible to make the model sustainable, based on training and technological support. The most important part of this strategy was the preparation of manuals to train trainers and the formation of a group of instructors with the responsibility of training professionals who were interested in working with this model throughout the country and even in the GGAVATT methodology. Abroad as in the case of Belize with the production of hair sheep.

In the year 1990, GGAVATT had been established, which were originally served by INIFAP, this, in the state of Veracruz. In 1991 it increased to 37, in 1992 to 67 and in 1993 there were already 79, while in the last years of 1997 and until 2017 there were 1500 GGAVATT groups. These groups belonged to the Dual Purpose Cattle, Dairy Cattle,

Sheep, Goats, Pigs and Poultry product systems. It was observed that 34% of the producers adopted the technologies recommended in the calendar of activities during the first year. In the second year the adoption increased to 66.6% and for the third year to 69.7%. In this stage, the state meetings of the GGAVATT begin.

The fourth stage lasted from 1997 to 2017 and is known as the "Extension of the GGAVAVTT Model". In this stage, INIFAP implemented a national strategy that allowed the sustainability of the model, for which training and technological support programs were designed. At this stage one of the most outstanding actions was the development of training for "Trainers" as well as the formation of a group of instructors who were responsible for training professionals interested in working with this model in the country in the GGAVATT methodology. In 1997, in addition to the National Livestock Research Meeting, the First National Meeting of GGAVATTs was organized in the Port of Veracruz, with the participation of more than a thousand producers from different states of the Mexican Republic. Simultaneously, GGAVATT State Meetings were organized.

Derived from the enthusiasm and interest aroused by this mass communication dynamic, an agreement was reached to establish the National Program for Technology Validation and Transfer (PRONAVATT). State technology transfer projects based on the GGAVATT model were established and groups were organized in all states. To ensure the success of this stage, PRONAVATT used the following strategies: Training and technological support through the preparation of GGAVATT methodology manuals, to train INIFAP trainers, who in turn trained other INIFAP researchers, as well as professionals from other institutions; strengthening of state capacity for technology transfer; interaction with the various Alianza para el Campo programs through the GGAVATT methodology; permanent promotion of the GGAVATT model methodology to sponsor its appropriation by producers, establishment of mechanisms that guarantee the articulation between technology generation, validation and transfer. As a result of the strategies, 2,400 agents of change were trained and 14,600 courses and workshops were held with advisors, researchers and producers; Similarly, on the land of the producers, 18,500 field demonstrations were established; With this, it was possible to consolidate the model at the national level with solid foundations. By 2006, there were 1,165 GGAVATTs nationwide, bringing together 17,095 producers and nearly 1,000 foreign exchange agents. The groups represent the main agri-food chains, (Vázquez, *et al.*, 2015)

Cattle for dual purpose, 41.1%; Cattle for meat, 22.8%; Goats for meat and milk, 10.7%; Cattle for milk, 10.1%; Poultry, 6.4%; Sheep for meat, 6.1%; pigs, 2.1%; Family Poultry, 0.5% and Aquaculture, 0.2%. In 2016, 179 INIFAP researchers participated directly through the Project "Support for Rural Extensionism of SAGARPA", providing follow-up and technical support to extensionists and GEITs, additionally 108 researchers participated supporting training actions, 82 modules and plots were established in 24 entities in the country and 38 fields and experimental sites of INIFAP, where demonstration events were held to support the development of capacities of extension agents and producers. On the other hand, at the National Technology Validation and Transfer Meetings held since 1997, work groups were held and successful GGAVATT's were presented. The producers mentioned that the success factors were: The adoption of technology; the organization, the training they received, when you have a secure market niche.

The GGAVATT model with the aforementioned results is an alternative for technology transfer mainly in the livestock area, but it requires technical advice, using support tools and comprehensive technology transfer strategies with trained and committed advisors, as well as the support of an institution that provide technical support, (Rodriguez, *et al.*, 2010).

8 STRATEGY FOR THE DEVELOPMENT OF CAPACITIES OF EXTENSION AGENTS AND PRODUCERS

This was implemented with the following methodological process: stage 1. Design and development of the training needs database, stage 2. Classification of training topics, stage 3. Grouping of technological topics by area and stage 4. Review and definition of technology training topics. As a result of the previous process, the following was obtained: 3,049 questionnaires applied to extension workers at the national level; 1,397 work programs, 32 state strategic plans, 48 state innovation agendas and 8,341 agricultural issues; 7193 livestock; 1568 themes of aquaculture and fishing.

9 TRANSFER WITH A PRODETER APPROACH AND TECHNICAL SUPPORT

Based on the genesis of the program that rural producers should be decision-makers and not beneficiaries of actions, in 2019, 2020 and 2021, they were implemented at the request of the Ministry of Agriculture and Rural Development in collaboration with INIFAP, both programs, the first sought, in addition to generating territorial development,

an organizational figure that would allow subjects greater profits from direct support, technical support and technology transfer, for which 410 PRODETERs were established, of which 128 were executed directly by INIFAP, and in contracting as services in each state of the republic 110 more PRODETER, which represented more than 50% of the strategy and supported this activity by about 300 researchers. The PRODETER consisted of three large sections: 1. Technical-productive diagnosis of the Family Production Units; 2. Technology Transfer Proposal, and 3. Technical Support Strategy. (Avalos, *et al.*, 2021).

In the first case, 5,734 Family Production Units (UPF) were characterized. The problem was detected and the appropriate technological model was defined for its solution or its contribution to reduce it. Subsequently, demonstrative modules were established (in producer lands) and demonstration events were held; b). Execution of a technical capacity development program for extension agents and producers; c). Experience and knowledge exchange sessions between producers. The objective was to provide feedback to producers and extension agents in the application of technological components, which allowed direct interrelation in the field between extension agents, producers and the researcher. The technical support was carried out in the plots and/or ranches of the producers and ranchers. The researcher designed a program of visits to the territory, considering: the phenological stages of the crop, the physiological stages in the animals, the recommended technological components and other specific aspects. For the development of these activities, INIFAP assigned 256 researchers, of whom 128 were responsible, and 128 co-responsible. 1,740 training events were held in 128 PRODETER, with an attendance of 34,941 people.

In the case of the Technical Support Strategy between the Ministry of Agriculture and INIFAP to work directly in 27 states of the republic, 450 municipalities and with 1,139 Professionals, with a work scheme based on four areas: agroecological transition plan, organization and territory, education and training and public policy. To this end, the Production Program for Well-being (PpB) of the Mexican Ministry of Agriculture provides direct support to producers of corn, beans, rice, wheat, chios, amaranth, coffee and sugar cane, cocoa, milk and honey. , and INIFAP provides technical support. 174 researchers participate in direct accompaniment and as many in local training in each territory. The difference between the extension method and the accompaniment method is the permanence of the technicians or service providers in the vicinity of the localities

where they are going to work, while in the former it is based on the method of training and visits widely described by (Swanson 1987; Cadena, *et al.*, 2018).

10 INTEGRATED MANAGEMENT SYSTEM (SIMANIN) AS A MODEL FOREST

SIMANIN is an integrated management system for forest resources, which was used as a model forest in the 1980s and continues to operate in the pine forests of the Tapalpa plateau, as an example of how forest management can be carried out. This model seeks sustainable productive, ecological and social development. It involves a set of administrative, scientific and technical actions aimed at organizing in time and space the rational use and sustainable use of the production systems of the forest ecosystems of a given area, in order to obtain the optimum benefit from them, without detriment to the environment and considering the needs of society. The System begins with a diagnostic scheme that includes the frameworks: Legal (location, belonging, limits, land tenure), Natural Physical (Orography, Hydrology, Geology and soil, climatology), Natural Biological (Types of vegetation, Areas of exploitation, Fauna, Areas with potential for timber, non-timber, protection areas), Socioeconomic (Population, jobs, markets, economy), and Forest exploitation (Forest management, productive organization, evaluation and control systems, felling system, planning of harvest, industry supply, regeneration systems, forest fires, forest health).

The planning of the activities and the understanding of the natural and social environment made it possible to detect and define the planning of the activities, answering the questions of how, where, how much and when to carry out timber and non-timber harvesting. The study of the environment and the activities was carried out mainly with INIFAP researchers, forest technicians, forest owners and field personnel. Under this scheme, important contributions were made to the knowledge of soils, botany, livestock, growth and increase of trees, mortality of trees, forest management, fauna of the area, knowledge of the hydrological behavior of the forest, pests and diseases, use of resin, management of forest fires, among others.

The knowledge generated made it possible to integrate the natural and dynamic environment of the forests with the needs of the industry and the social environment to develop the management system, which allowed the development of specific plans for the use of wood, resins, soil protection, water and the same vegetation, to improve roads, find uses for crop waste and improve management techniques among many others.

The system started from an intensive field sampling design, in which data on trees, herbaceous and shrubby vegetation and the physical environment were taken. In turn, the sites were located and delimited for later geolocation and corroboration of data if necessary and established in some permanent way.

For decision making, a large amount of data had to be analyzed, which allowed the generation of new information and investigations that were not available, therefore, statistics and mathematical modeling were used to generate volume models of the most representative species, growth and increase models, mortality models, cutting simulation models, resin utilization models, pest irrigation models. Additionally, an analysis was made of the conditions of fire irrigation, situation of the forest roads. (Baker, *et al.*, 1994, Benavides, 1987; Benavides, 1993, Benavides, 1994).

Having defined the management plan and its long-term action, a strategy was implemented for the control and monitoring of all planned activities, which would allow correcting the guidelines and providing feedback to the processes. Although there are examples of this management such as the joint towns of Oaxaca and Ciudad Madera in the northern state of Chihuahua, the truth is that due to the very nature of forest management and the needs of exploitation, it has not had the impact that is required and there are no data that can support the four areas described in the Model.

11 THE VISION OF TRANSFER IN THE FRAMEWORK OF SOCIAL NETWORKS

The evolution of social networks and the use of computer tools allows INIFAP to take advantage of these to transfer knowledge or prepare newsletters that account for the fulfillment of institutional objectives, therefore the use of social networks allows reaching a specialized public and population in general through capsules such as ... did you know what?, the WEB sites destined and anchored by the Ministry of Agriculture where outstanding results are published, the virtual platforms for videoconferences, the sites to investigate and update meteorological data through the National Laboratory of Modeling and Remote Sensors, the repositories of the technological heritage and processes framed in the three magazines called: Mexican Magazine of Agricultural Sciences, Livestock Sciences and Forestry Sciences.

With these technology transfer actions, INIFAP seeks to contribute to improving the living conditions of rural families through technical support, the technological offer resulting from research to achieve food self-sufficiency, reduce poverty in accordance

with conservation of natural resources and making mixtures of resources between producers, government, education and research institutions and professional service providers also called agents of change, or extensionists, to help solve national problems.

In all cases, the work of the INIFAP researcher who participates in a technology transfer, through the methods and models described, is invaluable, and is complemented by the participation of groups or individual producers, a source of financing and the bridge between them. Actors, the technician with a disciplinary approach according to the needs of the sector it serves. The conjunction of these elements has been the trigger for the adoption of technologies that contribute to the solution of the problems of the three sectors, agriculture, livestock and forestry.

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