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The action groups and the application of high productivity technology for temporary corn in locations of the Puebla Plan, Mexico

Los grupos de acción y la aplicación de tecnología de alta productividad para maíz de secano en localidades del Plan Puebla, México

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Abstract

The aim of this study is to show the importance of action groups and the application of technology, not only in maize production but also in the economic income of farmers. Action groups are the means to make consolidated purchases of inputs, manage financial resources and promote better marketing of the product. The methodology consisted of systematizing information from the follow-up of an action group made up of ten producers who applied improved technology to produce maize; this information was complemented with a socioeconomic survey of 30 farmers from three municipalities. The results indicate that the integration of action groups allows to increase the yields by almost 50% more with respect to the control group and a b/c ratio of 2.44 is obtained. In conclusion, a sufficient volume of maize production is produced to satisfy the families' self-consumption needs and surpluses for sale. These production levels favor the reproduction of rural families. This article provides information for decision-making in the implementation of maize production programs in other locations.

Keywords: Action group, technology, corn production, Puebla.

Resumen

El objetivo del artículo es evidenciar la importancia que tienen los grupos de acción y la aplicación de tecnología no solo en la producción de maíz sino también en los ingresos económicos de los agricultores. Los grupos de acción constituyen el medio para hacer compras consolidadas de insumos, gestionar recursos financieros y favorecer una mejor comercialización del producto. La metodología consistió en sistematizar información del seguimiento de un grupo de acción constituido por diez productores que aplicaron tecnología mejorada para producir maíz; esta información se complementó con una encuesta socioeconómica de 30 agricultores de tres municipios. Los resultados indican que la integración de grupos de acción permite incrementar los rendimientos en casi un 50 % más respecto al grupo testigo, obteniendo una relación b/c de 2,44 en promedio. En conclusión, se produce un volumen de producción de maíz suficiente para satisfacer las necesidades de autoconsumo de las familias y excedentes para la venta; estos niveles de producción favorecen la reproducción de las familias rurales. Este artículo aporta información para la toma de decisiones en la implementación de programas de producción de maíz en otras localidades.

Palabras clave: Grupo de acción, tecnología, producción de maíz, Puebla.

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1 Introduction

Even though corn is native from Mexico, the country has production problems. According to ASERCA (2019), currently 16.2 million of maize is imported, because the federal government for many years guided its policy to the import of maize and abandoned local production, considering that it was cheaper to import the grain than to produce it, having consequences on food security and sovereignty. However, most small producers of family farming continued to produce maize without government support, even though maize is a staple grain for family consumption and animal feed. On the other hand, in the face of this limited government support for local maize production, some institutions such as the Graduate School continued to do technology generation and dissemination activities for smallholder farmers, specifically in maize production.

There is now a more favorable policy for producing domestic maize, and the experience obtained by the Graduate School and other institutions in the process of generating, disseminating and applying technology must be leveraged to boost local maize production and reduce the import of this grain.

Technology is a combined process of thought and action whose purpose is to create useful solutions. Likewise, Aguilar (2011) mentions that technology is conceived as the set of knowledge, skills and means needed to reach a foredetermined end. For its part, the Graduate School implemented this technological development process in farmers' land and considered traditional knowledge to generate high productivity technology that is appropriate to the conditions of producers and to solve a low food production. The generation of technology also involved dissemination and escalation, since these processes were carried out by an integrated scientific-technical team that was in constant communication.

One of the strategies of the Graduate School to carry out the dissemination and escalation of technology was to associate with farmers to integrate action groups; social learning was promoted in this environment thanks to the interaction between different actors, i.e., participants in the action group learned through observation, technological demonstrations, and the components and processes that integrated the dissemination and escalation strategy.

With regard to action groups, Friedmann (2001) points out that the central axis in social learning is the action group that is composed by twelve people (or less) who are oriented towards a specific task; in this approach the action group learns from its own practice. The same author mentions that the correct method of bringing such change is social experimentation, careful observation of results and willingness to admit and learn from mistakes.

Plan-Puebla program was an agricultural development strategy that operated in the Puebla Valley. This strategy was implemented in three sectors: producers, industry institutions and a technical team of the Graduate School. The technical team was responsible for generating, disseminating and applying technology. Through this agricultural development program, social change was achieved through increased maize production with the generation and application of technology and the formation of solidarity groups. In another Mexican context, in Tehuantepec Regalado et al. (2005) used a strategy to carry out social experimentation in projects conducted with producer associations, mainly with the indigenous population; the variables that make up the strategy are: 1) information, 2) participation of the actors involved, 3) generation of initiatives, 4) action and 5) development.

On the other hand, Cazorla et al. (2013) and Cazorla et al. (2018), developed the model called "working with people", which is understood as a professional practice that seeks to connect knowledge and action through joint projects that integrate learning and values into people (action groups) involved in joint work. This model has had a wide application with favorable results in Europe and other countries.

The experiences mentioned demonstrate the importance of action groups and the process of social experimentation in the agricultural field. A proof of the scope of the Plan-Puebla development program with these groups and social learning was observed in the town of Tlaltenango, where farmers produced yields between 600 to 800 kg/ha at the beginning of the program and at the end of the program reached production levels of 7000 kg/ha; with these maize yields they solved grain needs for the family and the surplus was earmarked for livestock feed and sale, and families improved their income and well-being. With these achievements, producers do not need to complement their income with off-farm activities, contrary to what happens in other areas (Chapman and Tripp (2004); cited in Maziya et al. (2017)).

In this context, the following questions arise: what was the social experimentation process in Plan-Puebla development program? What was the role played by beneficiaries and action groups in bringing about favorable changes in maize production?

The topic studied in this article is important as there is a significant deficit in maize production in Mexico, thus actions to reduce maize production need to be taken. Action groups, with support for the dissemination and application of technology, are also relevant as they are an alternative to improving farmers' production, income and well-being; however, this knowledge had been little explored given the existence of an unfavorable policy for domestic production. In the current scenario of a more self-sufficient policy, this knowledge can contribute to maize production. The objective of this study was to analyze a case study in three municipalities of Puebla to show the importance of action groups and the application of technology, not only in increasing maize yields but also in improving the income and well-being of farmers.

2 Methodology

This research was based on a case study that, according to Yin (1994) cited by Arzaluz (2005), is a research strategy that allows to organize social data without losing sight of all the relationships of the phenomenon being studied; it also uses some qualitative and quantitative elements (Hernández et al., 2014). The research stages were: participatory workshops with key informants with extensive experience in maize production; integration of action groups with outstanding producers; establishment of demonstration plots on farmers' land and escalation of experience to other producers; these activities were monitored and yields were estimated at the end of the agricultural cycles.

To characterize the socioeconomic context, 30 producers from Tlaltenango, Santa Ana Xalmimilulco and Calpan were interviewed. The instrument used was a questionnaire that included questions based on the producers and their families.

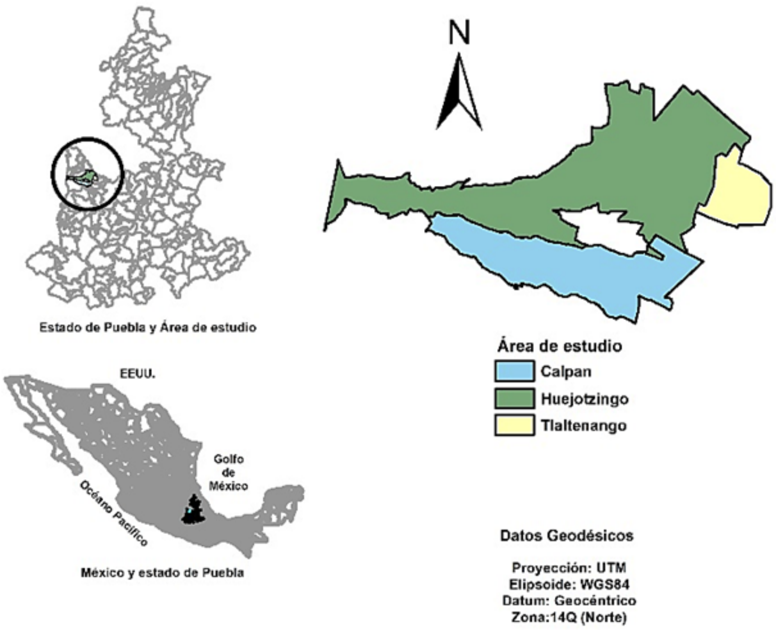
Information from the different stages of the research was systematized and the survey data were included in Excel to estimate basic parameters of the dataset.

2.1 Study area

The study area included three municipalities in the state of Puebla, and these are part of the Huejotzingo Priority Care Microregion (MAP) (Figure 1). The study took place in the municipality of Tlaltenango, in Huejotzingo, and the municipality of Calpan was considered the witness to compare the results. According to the Graduate School **?**, the MAP is conceptualized as a geographical space with productive, environmental or social nature problems, and where the COLPOS Campuses, through their academics, define areas to carry out activities of linkage and technological transfer in an organized and systematized way, providing feedback of education and research activities.

Agricultural activities represent the main sources of income for the population. According to INEGI (2007), there were 12 949 units in the area, of which 3 239 units were productive and 9 710 were not. On an area of 33616.7 ha, units showed temporary agriculture, and based on the knowledge and resources available producers were able to employ strategies that allow them to guarantee the internal needs of the units and more participation in the local market. Strategies consist of two production systems: 1) a system based on maize production combined with milk and meat production, and 2) traditional maize system interspersed in fruit trees; the first is more common in the municipality of Tlaltenango and in Santa Ana Xalmimilulco and the second in Calpan.

Figure 1. Municipalities that are part of the study area.



Georeferenced spatial data from INEGI, 2012.

2.2 Action groups

The action group in San Pedro Tlaltenango consisted on maize producers who combine grain production with livestock. The group in San Ana Xalmimilulco was formed as a Rural Production Company (SPR by its acronyms in Spanish), a legal company created to carry out production, marketing, among other activities. While in San Andrés Calpan 7 individual producers were identified, and whose plot's performance estimates were made to know their levels of maize production.

These groups practice two production systems related to maize production. The first consists of a system based on the production of maize under dry conditions that is combined with milk and meat production; and the second of a traditional maize system interspersed in fruit trees. The first is more common in the municipality of Tlaltenango and in Santa Ana Xalmimilulco, and the second is more used in the municipality of Calpan. Key producers were identified in both locations to streamline processes for the formation of action groups; one of the leaders of in Tlaltenango played this role, and the representative of the Rural Production Society was the representative of the group in Santa Ana Xalmimiluco; each of these producers were responsible in their localities. In Tlaltenango, the responsible was the head of the Decision Committee of the Intensive Program for Maize Production, and in Santa Ana Xalmimilulco the person in charge was the group manager.

3 Results and Discussion

The process of social experimentation provided evidence in variables on: information on the technology used (fertilization dose), integration and behavior of action group producers and institutional factors.

Technology used

The technology that caused changes in maize production was generated under the approach designed by Laird (1977) to develop experimental field work of the producers, using the components of the scientific method, which was introduced in the Puebla Plan (CIMMYT (1974)).
This approach presented an advantage at the dissemination stage because it maintained agricultural practices carried out by producers. The components

of the technology were 130 kilograms of nitrogen, 40 kilograms of phosphorus for a population density of 50 000 plants ha^{-1}. Subsequently, nitrogen, phosphorus and potassium levels were increased, using improved seeds and a population density of 60 000 plants ha^{-1} to obtain higher grain volume and fodder. During the period 1967 to 1992, there were changes in maize production (Díaz et al., 1999), and it was observed the presence of Tlaltenango producers with production levels higher than 6 ton/ha (Regalado et al., 1996). Technological information in the diagnosis is set out in the following paragraphs.

Fertilization: Based on Table 1, the relationship between fertilizer application levels, use of hybrid seeds and yields per hectare is noted. In some cases, the data show a difference of more than 50% between the volume of grain produced with improved materials and the native materials.

Table 1. Fertilization dosages and production levels with the use of improved and creole seed.

Producer	Dose kg ha^{-1}			Yield t ha^{-1} with seed:	
	N	P	K	Hybrid	Creole
Producer I	174	46	—	8.2	4.0
Producer II	150	57	—	8.0	5.0
Producer III	128	46	30	4.5	4.0
Producer IV	165	69	—	7.5	3.5
Producer V	142	69	—	6.2	4.0

Source: Workshop on "Recognition of Local Production Technology"

Public workers believe that the income of maize producers is very low, and sometimes they even lose money; however, cost-benefit calculations proved otherwise, as shown in Table 2. This calculation was made considering the cost of $4.0 per kilogram of corn. The cost benefit ratio was positive even with a yield of 4.5 t/ha. This income is obtained only from the grain without considering the fodder; however, if both products are considered to be intended for the feeding of livestock to obtain meat and milk, then profits are higher.

This analysis shows that maize production is cost-effective. In the social field, the introduction of technological components contributed to the development of conditions to strengthen such initiatives at the Community level, taking into consideration experiences to improve production processes and bring about changes in the institutional components. From the environmental perspective, Turrent (2019) notes that the results of studies carried out in wheat with NPK agronomic doses every year, with and without soil acidity correction, with and without crop rotation, with and without incorporation of manure show that the use of agronomic doses of fertilizers acts as a long-term soil degrader. However, more specific studies related to the impact of technological components on water are needed.

Tlaltenango Action Group

The experience of these producers led to the following questions: how to visualize the use of technology for maize production that allows producers to improve their income and stay without migrating? The answer was to select the top 10 producers in this municipality to form an action group that would allow to transfer this knowledge to other producers both locally and beyond, as well as managers of local, state and federal institutions, seeking to incorporate public policy expertise for maize production. The strategy of selecting the best maize producers coincided with Manrrubio and H. (2010), which considered the principle of building on what the experts know. Based on these elements, the group established 10 ha of demonstrative lots to expose the application of high productivity technology and obtain high maize yields; Table 3 shows the sources and volume of fertilizer used.

The Graduate School (CP)-Campus Puebla financed the planting of the 10 hectares in this first year. Each producer worked on one hectare with this resource for demonstration purposes and the rest of the area was financed by themselves; in terms of percentage, the amount contributed by the CP accounted for 30% of production costs per hectare, and the remaining 70% was provided by each of the group members. In terms of financing and as a result of the first year, a scheme was created for maize production which was operated in the following years and consisted on the contribution of 50% of the municipality and 50% of the action group. In the second year, the surface was expanded to approximately 147 ha and the group bought a precision seed drill. In the third year, the program was extended to more producers, mostly young people who after their migration experience re-started agricultural activities. It was very interesting to note that the group of first participants stablished a minimum yield of 6.0 t ha^{-1} as a requirement for new income producers to receive funding from the municipality. In terms of yields and based on Table 4, it was noted that in maize production levels during the first year (2011), the initiators of the project recorded an average production volume of 7.24 t ha^{-1}, a production level that is sustained during the period 2013-2014; additionally, there were cases in which some members of the group obtained yields higher than 10 t ha^{-1}. These yield levels exceeded production levels from 2.2 to 3.7 t ha^{-1} raised by the Mas Agro strategy, which is a national program aimed at standardizing the level of maize production on temporary terms among small producers (Turrent et al., 2017).

Table 2. Production costs ($), yield (t/ha) and b/c ratio in maize cultivation in Tlaltenango

Concept	Participating producers				
	Benito Cordero	Ignacio Pérez	Crescencio Lima	Heliodoro Lima	Aron Lima
Preparing the land and planting					
Harrow	(3) 900	(2) 600	(2) 600	(2) 600	(2) 600
Fallow	(1) 600	(1) 600	(1) 600	(1) 600	(1) 600
Disc harrow	(1) 250	(1) 250	(1) 250	(1) 250	—
Furrow	—	(1) 250	(1)250	(1) 250	—
	Seed drill	Use of animal	Use of animal	Use of animal	Seed drill
Machine and worker	600	500	500	500	600
Seed cost	1200	1 200	1 200	1 200	1200
Fertilization costs					
18-46-00	1 520	950	1 140	1 140	760
Urea	1 380	1 265	1 380	1 150	920
Potassium	—	—	—	—	400
1 application	250	250	300	300	300
Tilled	300	300	300	300	300
2 applications	300	300	300	300	300
Cost of weed control					
Agrochemicals	270	280	270	130	330
Application	200	200	200	200	200
Pest control costs (does not apply)					
Mowing costs					
$14/ Furrows	1 300	1 300	1 300	1 300	1 300
Harvest costs					
Wages	2 000	2 000	1 500	1 200	1 000
Shelling costs					
Wages	420	420	200	350	300
Sheller	350	350	250	250	250
Hauling	500	500	500	500	500
Yield, total cost and b/c ratio					
Tons/ha	8.2	8.0	7.5	6.0	4.50
Total cost/ha	12 340	11 515	11 040	10 520	9 860
Ratio b/c	2.65	2.77	2.71	2.28	1.80

The numbers in parentheses in the soil preparation and planting area indicate how often producers performed these activities.

Table 3. Yields (t ha^{-1}) obtained by the first and second participants in Tlaltenango

Producers	First participants			
	2011	**2012**	**2013**	**2014**
Producer I	7.8	10.4	7.2*	9.76
Producer II	7.9	10.6	9.1**	10.94
Producer III	5.8	5.1	8.2***	9.44
Producer IV	6.8	8.8	8.8**	8.00
Producer V	9.2	10.9	8.5**	9.7
Producer VI	7.3	9.2	10.8**	9.1
Producer VII	6.2	12.3	10.7**	10.5
Producer VIII	5.0	9.1	8.8*	9.4
Producer IX	9.4	9.6	10.6**	8.3
Producer X	6.9	7.9	6.0*	—
Average	7.2	9.4	8.9	9.5
Producers	Second participants			
	2011	**2012**	**2013**	**2014**
Producer XI	—	—	10.7***	7.5
Producer XII	—	—	7.9*	6.8
Producer XIII	—	—	8.8***	6.4
Producer XIV	—	—	9.4*	11.4*
Producer XV	—	—	10.8*	1.1
Producer XVI	—	—	9.7***	9.7
Producer XVII	—	—	7.6*	8.5
Average	—	—	9.3	8.8

Data from 2012-2015 campaigns; Note (*) HS-2 Seed of the Graduate School, (**) Mist Seed, (***) ASPROS Seed.

The use of improved seed extended among the members of the action group; however, at the local level this use is low. According to Espinosa et al. (2003) this type of behavior is similar to the use of improved seeds at the national level.

Escalation in other locations

Based on the results obtained and by the effort to produce HS-2 seed, belonging to the Postgraduate School through a collaboration agreement and by the interest of an action group represented by Rural Production Society (SPR) to use this seed, the municipality of Huejotzingodesigned and operated a similar funding scheme used by the Tlaltenango action group.

Santa Ana Xalmimilulco

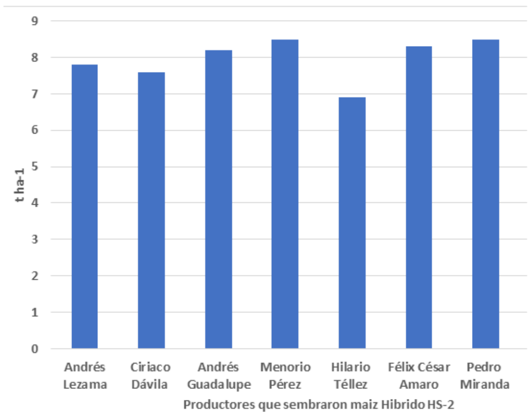
The factors that determined the training and participation of the action group in the HS-2 maize project were: 1) the participation of the head of the Santa Ana Xalmimilulco group in the Municipal Council for Sustainable Rural Development of San Miguel Huejotzingo, 2) feedback of experience on the use of hybrid seeds with San Pedro Tlaltenango producers, and 3) participation of some members of the group in a pilot project to introduce HS-2 hybrid maize among producers. These actions allowed the producers to participate in the planting of 100 ha of HS-2 hybrid maize (Regalado et al., 2010).

The results of this first experience in Santa Ana Xalmimilulco corroborated the possibility of increasing the levels of yields of the grain and fodder through the most accurate application of technological components, including the use of this seed. Based on the yield data of the first members who used this seed as shown in Figure 2, it was determined that the use of this material would be an alternative to obtain a higher volume of grain to supply the production and fodder unit for green and dry silage that is used throughout the year in significant quantity and quality to support livestock activity with the aim of maintaining or increasing milk production which, according to the producers, is estimated at a volume of 90 thousand liters per day.

San Andrés Calpan (witness producers)

During the first three years of the maize production project using high-productivity technology, yield estimates were carried out on the lands of the members of the action groups; however, in order to understand the differences in carrying out maize production in the form of an action group, in 2014, in addition to making estimates of yields in lots of producers belonging to two action groups, a group of Calpan producers who cultivated maize during the spring-summer 2014 was included, without having participated in programs implemented in Tllatenango and Santa Ana Xalmimilulco.

Figure 2. Yields in t ha^{-1} obtained in the maize project HS-2.



Comparison of technological variables and personal characteristics of producers with and without action groups

This analysis is based on the information obtained through the application of a questionnaire that included variables related to the levels of maize yields, technological components used, and other personal factors of the members of the action groups, as well as witness producers.

Maize yields

Based on the data on Table 5, a relationship between action groups and maize yields can be observed, especially with regard to average and maximum yields. Such behavior can be considered to mention that the use of technology is applied more precisely when producers are part of an action group, since it is possible to achieve financial resources for obtaining inputs through this partnership.

The relationship between the use technology on maize yield is mentioned in different studies (Regalado et al., 1996; Díaz et al., 1999; Damián et al., 2007), coinciding with the results obtained in Tlaltenango. Likewise, Gürel (2019) agrees that advances in agriculture have often been the result of innovations in individual components (such as improvement, chemical inputs, irrigation technologies); however, changes occurred in Tllatenango and in Santa Xalmimilulco when considering the application of technological knowledge through action groups as a variable. Noriega et al. (2019) relate the training and dissemination of technological innovations under the field school model with maize productivity; additionally, Velázquez et al. (2019) found that the use of technologies determines the productivity and competitiveness of maize production. These changes in maize production generate a surplus of grain and fodder, which is mentioned by Lutz and Herrera (2007) as a positive impact on families and communities. While the producers of Tlaltenango and Santa Ana Xalmimilulco included the technological components to produce high levels of maize yields, the achievement of the resources to acquire the inputs for their application becomes effective as long as the producers conduct this practice as action groups, as in Tlaltenango and in Santa Ana Xalmimilulco. A questionnaire was used as an instrument for gathering field information from action group members as well as witness producers. Table 6 shows the technological components that producers used during the 2014 agricultural cycle to produce changes in maize production. Based on this information, it was observed that in the locations where the activities were carried out as action groups, the producers more accurately applied the technological components generated by the agronomic research of the Puebla Plan, used improved seed and carried out more moisture conservation practices, which allowed them to sow in April and achieve a more homogeneous germination of the seed.

Characteristics of the producers who were part of the Action Groups

Based on information collected in questionnaires, it was noted that 80% of the heads of families in the localities are men, and few women make decisions in agricultural production, rather, their participation is to support other activities at home such as the care of family members and the preparation of food for workers during harvest.

With regard to age, a larger adult population was observed in Calpan and with fewer years of study, while in the two action groups, a larger young population was noticed; in this sense, there was a case of a member who migrated to the United States of America and once he returned to Tlaltenango he started agricultural activities. Currently the families of the members of the three localities remain in the community, carrying out activities inside and outside the family unit.

Table 4. Yields obtained with and without action group

Action group	Members by group	Yield t ha^{-1}		
		Average	Minimum	Maximum
Tlaltenango	16	8.9	4.3	11.4
Santa Ana Xalmimilulco	7	7.8	6.5	12.3
Calpan (Witness)	7	4.4	2.4	6.4

Elaboration with field data, 2015.

Table 5. Technological components used by action groups for temporary maize production

Technological practices	Tlaltenango (Action Group)		Sta. Ana Xalmimilulco (Action Group)		Calpan (Witness)	
	Modality	%	Modality	%	Modality	%
Moisture conservation practices	1 a 3	93	1 a 3	66	1 a 3	42
Date to sow	April	56	April	66	April	57
Machine used	Tractor	75	Tractor and worker	66	Tractor and worker	42
Seed type	Improved	100	Improved	100	Creole	100
Color of the grain	white	62	white	77	white	100
Use of fertilizers	Yes	100	Yes	100	Yes	100
Type of fertilizers	Urea 46%	62	Urea and black urea	33	Urea	57
Implementation time (stage)	In 1st and 2nd sow	50	In 1st and 2nd sow	66	In 1st and 2nd sow	85
Application of manure	Yes	81	Yes	100	Yes	57
Type of manure	Several	81	Several	100	Several	57
Amount of manure	100-200 t ha^{-1}	37	40-50 t/ha	55	No data	42
Frequency of application	Once a year	43	Every three years	44	Once a year	57
Harvest time	November	93	November	55	November	57

Elaboration with field data, 2014.

Table 6. Age and years of study of the members of the Action Groups

Action groups	Age			Years of study		
	Average	Min.	Max.	Average	Min.	Max.
Tlaltenango	53	23	82	8	6	17
Santa Ana Xalmimilulco	56	43	77	8	3	15
Calpan (Witness)	70	60	86	3	0	12

Elaboration with field data, 2014.

Action groups and management strategy

Action groups managed a set of components that constituted the strategy to apply the technology and produce high maize yields; these components were: inputs, seeds, financing, technical assistance and marketing process.

Inputs

Tlaltenango's action group argued on topics related to the acquisition of inputs and seed in a consolidated way with the company that offered better product quality and full weights. These decisions were based on the experiences of some group partners, as well as on the advantage of having economic resources that would allow a better negotiation to acquire inputs at a better price and in a timely manner. In the first year of operation of the project, the Tlaltenango group and the Puebla Campus bought their inputs one month before planting.

In the second year, the municipality participated in the project and tried to make the purchase with another company and with the same products, seeking to further lower the price of the inputs; that proposal did not succeed because the group requested an analysis of the product from the supplier to verify that the percentage of active ingredient was the same as that shown on the packaging, but the supplier refused to submit it; hence, the municipality, through the agricultural regulations, bought the inputs with the company suggested by the group.

Financing

Tlaltenango generated a financing scheme called near funding management in rural development program in Europe (Cazorla et al., 2005). This scheme consisted of a mixture of resources of beneficiaries and local authority in the form of a subsidy, avoiding indebtedness which is a factor that limits access to financing (Almeraya et al., 2011). The incorporation of local authorities into this type of project allowed a closer relationship with the groups, especially to plan actions such as: definition of beneficiaries, planted area, needs of inputs, amount to be contributed by the people involved, proposal of possible suppliers, definition of type of fertilizers, solution of problems during the purchase process, field tours, and harvest estimate.

Technical assistance

The study conducted by Afful et al. (2015) showed that maize producers, upon receiving information on the public extension, increased their levels of maize production under dry conditions. These results coincide with the idea developed in Tllatenango, which was underscored with the believe that producers knew about the management of maize cultivation and that the work of the technician should be as a facilitator. Technical assistance consisted of providing technical information and the benefits they had as a group to carry out management processes with other actors.

4 Conclusions

The integration of an action group with the best maize producers in Tlaltenango to convey their experiences by establishing demonstrative lots with the participation of the Graduate School and local authorities was a strategy to bring about changes in maize production.

The social learning process contributed to the creation of action groups that defined: 1) technological components to be implemented in demonstrative modules, 2) strategy for input management, 3) the establishment of relationships with institutional and local actors, and 4) technical assistance to facilitate processes in the technical and financing fields; actions that created the conditions for the group to demonstrate its ability to produce changes in maize production, and the viability of maize production.

It is possible to incorporate the experience generated by the action groups into a broader state maize production program, in areas with more potential for the production of maize, through more business management to integrate this type of agriculture into the value network; however, this requires the political will of decision-making actors at this level.

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