SWEET-CORN PRODUCTION IN THE RIOVERDE REGION, SAN LUIS POTOSI, MEXICO

PRODUCCIÓN DE MAÍZ, PARA ELOTE EN LA REGIÓN DE RÍOVERDE, SAN LUIS POTOSÍ, MÉXICO

PRODUÇÃO DE MILHO PARA CONSERVA EM NA REGIÃO DE RIOVERDE, SAN LUIS POTOSÍ, MÉXICO

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SUMMARY

In the state of San Luis Potosi Mexico, a land extent of 29022 hectares to produce maize, *Zea mays* L., under irrigation management are cultivated every year; from these 21 079 hectares (72.6%) are used for grain production, and 7 943 (27.4%) for sweet-corn. 99.7% of the surface used for sweet-corn is located in the Rioverde region, in communal plots of 3 hectares in average, where the corn is planted in crop rotation with chili, *Capsicum annum* L., tomato, *Licopersicum esculentum* Mill., tree tomato, *Physalis philadelphica* Lam., and squash, *Cucurbita* spp. Sweet-corn production is obtained with cultivars and traditional culture techniques; however, the productivity and profitability is lower than in other regions of the country. The objective of this work was to analyze the production system of sweet-corn and to know its limitative factors. To collect the information, farmers from the region were interviewed to summarize the cultural practices: the data was sorted and classified through multivariate analysis. The results shown that sweetcorn production system is under a process of transition from traditional to intensive. Also we found that the farmers with the best results, normally use low plant density, apply nitrogen fertilizers opportunely and adequately, and sell the harvest before or after the majority of producers.

Key Words: Development of agriculture; traditional agriculture; cropping systems; traditional agricultural systems; *Zea mays* L.

RESUMEN

En el estado de San Luis Potosí, México, anualmente se cultivan 29022 ha de maíz, *Zea mayz* L., bajo riego, de las cuales 21079 (72,6%) se destinan para la producción de grano y 7943 (27,4%) para elote. El 99,7% de la superficie para elote se localiza en la región de Ríoverde, en parcelas ejidales de 3 ha en promedio, en rotación con chile, *Capsicum annum* L., jitomate, *Licopersicum esculentum* Mill., tomate, *Physalis ixocarpa* Brot y calabacita, *Cucurbita* spp. La producción de elote se obtiene con cultivares criollos y técnicas tradicionales de cultivo, con niveles de productividad y rentabilidad inferiores a los de otras regiones del país. El objetivo del trabajo fue analizar el sistema de producción de maíz para elote, y reconocer sus factores limitativos. El estudio consistió en una encuesta entre los agricultores de la región. La información sintetiza las prácticas de cultivo; luego se ordenan y clasifican mediante análisis multivariable. Los resultados indican que la producción de elote se encuentra en un proceso de transición de tradicional a intensiva. Los productores con mejores resultados usan densidades de población bajas, aplican oportuna y moderadamente fertilizantes nitrogenados y venden el elote antes o después del resto de los productores.

Palabras Clave: Evolución de la agricultura; agricultura tradicional; sistemas de cultivo; sistemas agrícolas tradicionales; *Zea mays* L.

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RESUMO

No estado de San Luis Potosí, México, anualmente se cultivam 29022 ha de milho (*Zea mayz* L.) com baixa irrigação, das quais 21079 (72,6%) se destinam para a produção de grãos e 7949 (27,74%) para milho verde. Em 99,7% da área determinada a milho verde se localiza na região de Rioverde, em parcelas ejidales com média de 3 ha, em rotação com pimenta, *Capsicum annum* L., tomates, *Licopersicum esculentum* Mill. e *Physalis philadelphica* Lam. e abóbora, *Cucurbita* spp. A produção de milho verde se obtém a través de cultivos nativos e técnicas tradicionais, com níveis de productividade e rentabilidade inferiores a de outras regiões do país. O objetivo do trabalho foi analizar o sistema de produção de milho verde e reconhecer seus fatores limitantes. O estudo foi desenvolvido a través de uma entrevista entre os agricultores da região. A informação, primeiramente, se apresenta em quadros que sintetizam as técnicas de cultivo; logo, se ordena e classifica mediante analise multivariável. Os resultados indicam que a produção de milho verde se encontra em um processo de transição de tradicional a intensiva. Os produtores com melhores resultados usam densidades de população baixas, aplicam fertilizantes nitrogenados, e vendem o milho verde antes ou depois do restante dos produtores.

Palavras Chave: Evolução da agricultura; agricultura tradicional; sistema de cultivo; sistemas agrícolas tradicionais; *Zea mays* L.

INTRODUCTION

In Mexico, the governmental policies in the eighties were focused to regulate the cultivation and supply of maize, *Zea Mays* L.; however, these policies influenced the production and profitability of the crop in a negative way (Aburto, 1979; CDIA, 1980; Montañez & Warman, 1985). As a consequence of the low profitability level of the crop and the increasing demand of horticultural products, the farmers in some regions of the country re-directed maize cultivation to silage and sweet-corn production, this practice has permitted them to lower production costs, obtain better prices for harvest, and increase their profitability to a reasonable level (Charcas *et al*., 2000).

In San Luis Potosi state, every year, 29022 hectares of maize are cultivated under irrigation from these 21079 (72.6%) are used for grain production, and 7943 (27.4%) for sweet-corn. A 99.7% of the state surface employed for sweet-corn production is located in the Rioverde region, in communal plots of 3 ha average. Fields are planted in crop rotation; the crop is alternated with chili, *Capsicum annum* L., tomato, *Licopersicum esculentum* Mill., tree tomato, *Physalis ixocarpa Brot*., and squash, *Cucurbita* spp.

The production of sweet-corn is basically obtained with cultivars and traditional culture techniques, these include direct sowing in plants, low population density, inefficient fertilization (quantity and opportunity); the levels of productivity and profitability, in the Rioverde region, are lower than they are in other areas of the country; nevertheless, they are prone to be improved, and this is shown by the results obtained by outstanding local farmers (Charcas *et al*., 2000).

So far in Mexico and especially in the region there is a lack of appropriate technology to produce sweet-corn. This is due to the fact that the National Institute for Research in Agriculture, Forestry, and Husbandry, (INIFAP) has directed the research of maize toward the increment in yield especially in grain production (Hernández, 1983; Hernández *et al*., 1988).

The objective of this work was to analyze and describe the production system of sweet-corn for the Rioverde region in San Luis Potosi Mexico, and to identify and evaluate the factors that limit its production.

MATERIAL AND METHODS

The first step in the procedure was to define the areas of study and then to survey the farmers of the region.

Areas of study: Based on the geographical location (99º 50' & 100º 10' meridians west of Greenwich, 21º 45' & 22º 10' parallels north latitude) and the availability of water for irrigation, the area was divided into two zones: a) Zone of “Manantial de la Media Luna” this area includes the 049 irrigation district, which is located in the center of the valley of Rioverde, and the valley of S. J. del Tapanco, the latter is located in the south border; within this zone four localities were chosen: S. J. del Tapanco, Plazuela, El Huizachal and El Capulin. b) Zone of irrigation by deep well pumping; the area includes the communities El Refugio and 20 de Noviembre, these are located to the southwest and west of the valley, in this area four localities were also selected: San Diego, El Refugio, El Jabali, and 20 de Noviembre (Figure 1).

The survey: it was elaborated based on the proposals of various researches (Byerlee & Collins, 1980; Byerlee *et al*., 1980; Martínez, 1981; Doorman, 1991; Perales, 1998). The survey covered the following topics: a) tenure and usufruct of the production sources (land, water, well, machinery, etc.), b) funding, c) activities outside the production unit, d) water and land management, and e) processing of agricultural work (activities needed to produce sweet-corn, maize grain and silage).

A total of 449 farmers, (women/men), heads of a family, were interviewed. To carry out the interview 270 students and 18 professors from the University of Chapingo were previously trained.

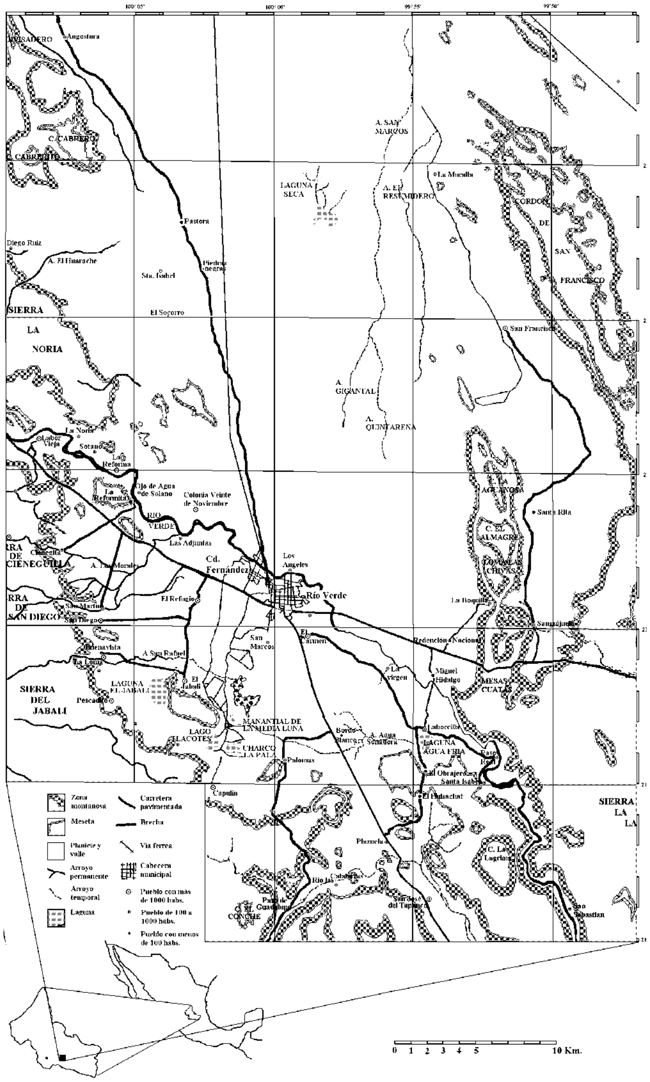

FIGURE 1. Location the Rioverde region, San Luis

Analysis of the Information: the information was processed in Microsoft Excel using Windows 98. The crop practices are summarized in tables completed with average values and percentages. Subsequently, 85 questionnaires were chosen because these included the data of 15 variables related to management practices and production costs, then the information included in these was multivariable analyzed; this analysis was done using the software PC-ORD (McCune & Mefford, 1999), the information was later arranged and classified.

The sorting or arrangement of information was done using the software DECORANA (Hill, 1979a; Ter Braak, 1988).

The sorting graph is interpreted as it follows: production variables (species in the software format) as well as the interviewed farmers (samples) that occupy marginal positions represent mistakes, false information, or extreme conditions. On the other hand, the entities located between the center and the margin of the graph show a clearer relation with the axes or gradients. At the same time the position of the variables represent centers around which are placed the farmers that are better related with these. The software TWINSPAN (Hill, 1979b) was used to classify the information. In the classification diagram, the hierarchic order of variables and the interviewed farmers are respectively represented in binary notation along the inferior right margins; at the same time, the names or numbers of the variables and the interviewed farmers appear along the superior left margins.

RESULTS AND DISCUSSION

From the 449 heads of the family interviewed, 325 of them (72.4%) mentioned that they included sweet-corn or maize in their crop rotation.

Process of the agricultural work

Farm activities before planting: These usually start with a plowing operation; followed by a harrowing pass, the furrows are then made and finally irrigation channels are constructed. Once the former steps have been completed and prior planting, the field is irrigated. These operations are the same as those recommended by research institutions and extension service stations (INIA, 1965; SARH, 1978; Hernández, 1983). Opening of irrigation channels to moisten the field is necessary from January to March, yet, irrigation is not necessary in the interlude from June to August because the rainfall season takes place during those months.

The majority of the farmers employ the tractor to plow and harrow (higher energy demanding tasks); however, they use harnessed mules or bulls to furrow and open the channels (Table 1). This combination of motor and animal traction is partly explained by the low number of tractors and implements and the lack of skill of the operator to maneuver the equipment (Durán *et al*., 2002; Michico *et al*., 2007).

TABLE 1. Percentage of farmers that use tractors to prepare the seedbed in Rioverde, S.L.P. México.

Zone/ community	Plowing	Harrowing	Furrows	Irrigation channels
Manantial de la Media Luna				
El Capulín	91.3	100	65.2	27.8
El Huizachal	90.9	100	27.3	0.0
Plazuela	72.7	100	33.3	20.0
S. J. del Tapanco	84.7	100	16.0	4.5
Deep well pumping				
El Refugio	74.7	100	47.8	34.5
El Jabalí	88.5	100	59.3	25.0
San Diego	90.0	100	37.5	12.5
20 de Noviembre	90.0	100	66.7	50.0

In 1994, due to the former conditions there were 426 tractors and 2512 harnesses of mules or bulls being used in the region. These resources were used to cultivate a surface of 49495 hectares, from these hectares 15132 were under irrigation (INEGI, 1994). Based on general calculations these tractors could be used to take care only of the irrigation area, and the rainfed lands would remain unattended.

Sowing: The sowing is arranged in furrows every 0.8 meters apart, it is dibble-planted and the spacing between each dibble ranges from 0.43 to 0.71 m. Two or three seeds are planted in the bottom of 10 cm deep furrows (Table 2).

TABLE 2. Sowing spacing, plant density distribution and percentage of farmers that use machines to sow maize in Rioverde, S.L.P. México.

Zone/ community	Distance (m) Rows	Distance (m) Plants	Maize grain planted	Motorized traction (%)
Manantial de la Media Luna				
El Capulín	0.8	0.71	2	33.3
El Huizachal	0.8	0.53	2	15.4
Plazuela	0.8	0.51	2	16.7
S. J. del Tapanco	0.8	0.46	2	20.0
Deep well pumping				
El Refugio	0.8	0.48	2	19.6
El Jabalí	0.8	0.54	3	19.3
San Diego	0.8	0.43	3	19.3
20 de Noviembre	0.8	0.46	2	38.5

The average plant density of maize was calculated by direct observation and it was estimated in 34,000 plants ha^{-1}. According to Laird *et al*. (1955) this density is optimal for: traditional cultivars (native), grain production, and the average conditions of soil fertility in the region. It is recommended to use 60000 plants ha^{-1} (Hernández *et al*., 1988; Smith *et al*., 1994) for grain production by nitrogen and phosphorus fertilization. Nevertheless, until now there is no information on adequate density and fertilization for sweet-corn production in Mexico.

The majority of the farmers employ animal traction. Some farmers who own tractors have a planter type Lister, this places the seed to the base of the furrow; however, they do not usually use the equipment because this arrangement difficult the first irrigation and delays the first weed out, this is owed to the plant size which does not outreach the furrow border. At the same time, seed size and shape are uneven in traditional cultivars, this causes that the seed breaks or obstructs the outlets of the planter; furthermore, the operators of the tractors lack the skill to handle the planter appropriately, this inconvenience causes either bare patches or patches with excessive seed density. For this reason some farmers that employ tractors to sow substitute the planter for furrows over the bar, in this a scaffold of wood is adapted as a seat for people who sow by hand, at the same time a rail or wood beam is tied to it, and when dragged perpendicularly to the furrows covers the seed with the soil of the borders.

Irrigation: The availability and cost of water in the Zone of “Manantial de la Media Luna”, in communal lands water is distributed in different tandeo ways and the cost to irrigate an hectare is US$1.0; nevertheless, in the 049 irrigation district, there is an irrigation program for each canal and each farmer pays a yearly fee of US$25.00 (about US$3.0 per hectare). Farmers in the zone of irrigation by deep well pumping, who own one or more wells, have water at their disposal when they need it; the cost of water depends on the type of energy used to obtain it, thus with an internal-combustion engine the cost of irrigation per hectare is US$6.0. The farmers who do not have wells buy the water and pay from US$16.00 to 24.00 to irrigate each hectare.

In both zones the number of irrigations depends on the season; therefore, in winter-spring four irrigations are necessary for sweet-corn production and five for grain production; in summer-fall two irrigations are enough for both types of crops.

Pests: Farmers indicated that the pests that attack the crops include fall armyworm, *Spodoptera frugiperda* J.E. Smith, corn earworm, *Heliopthis zea* Boddie, cutworms, *Agrotis* spp, *Euxoa* spp, *Peridroma* spp, *Feltia* spp *y Prodenia* spp., and southwestern corn borer, *Zeadiatraea grandiosella* Dyar, as well as the diabroticas, *Diabrotica* spp. Hernández *et al*. (1988) points out that the maize field is mainly attacked by armyworm and southwestern corn borer. To fight the mentioned pests diverse pesticides are applied once or twice a year.

Seedbed Preparation: When farmers use only animal traction, two weeds out are performed by moldboard plow, these are supplemented by others performed by using a hoe. With mechanized traction two weeds out by rototiller are recommended, supplemented by two more manually performed (Hernández *et al*., 1988). The problem to control the arable weed is minimal if the crop rotation includes vegetables; the same situation occurs when the sowing is done in winter-spring because the arable weed community is characteristic of the rainy summer. Animal traction is preferred over the tractor because the latter damages a bigger number of crops. Herbicides are not used very often because in the vicinity there might be vegetable crops planted and the residual effect could affect them.

Fertilization: The majority of the farmers apply fertilizers approximately forty days after the sowing, it is done at the same time that the first weed control is performed; in all studied communities except “El Refugio” nitrogen fertilizers are applied. The bigger amount of fertilizers is applied in the deep well pumping zone (Table 3). Few people apply fertilizers twice; however, when a second application is performed it coincides with the second weed control or it is done just before the last irrigation to forward the development of the plants. The fertilizers that are used the most are: ammonium sulphate, urea, and ammonium nitrate. The most common fertilizer formulation (N:P:K) are: 17-17-17 and 18-46-00. The INIFAP (Hernández *et al*., 1988; Ma *et al*., 2007) recommends applying 160 kg of nitrogen and 60 kg of phosphorus per hectare respectively, and split it into two doses; a half of nitrogen and the whole phosphorus need to be applied at planting time, and the remaining nitrogen should be applied on the second weed control. However, nobody follows the recommendations because with vegetable crops big amounts of nitrogen, phosphorus, and potassium are applied and when maize is planted in the succeeding sowing season the residual of the fertilizers is taken advantage of.

Harvest: Approximately three months after the sowing, the sweet-corn is harvested; the grain is harvested a month later than the sweet-corn. The average yields in the region are 6 tons per hectare of sweet-corn, 2.4 tons of grain and 827 lots of straw or stubble (Table 4).

TABLE 3. Proportion of farmers, fertilization time (days after planting), formulations applied to the crop in Rioverde, S.L.P. México.

Zone/community	Farmers %	Days after planting	Fertilizer formulation applied
Manantial de la Media Luna			
El Capulín	84	36	57-00-00
El Huizachal	86	28	71-00-00
Plazuela (13)	85	24	39-00-00
S. J. del Tapanco	83	40	124-00-00
Deep well pumping			
El Refugio	96	39	109-83-91
El Jabalí	66	40	97-00-00
San Diego	84	35	85-00-00
20 de Noviembre	73	46	106-00-00

TABLE 4. Average crop yield in Rioverde, S.L.P. México.

Zone/ community	Average yield		
	Sweet-corn (t per hectare)	**Maize grain (t per hectare)**	**Lots of straw or stubble**
Manantial de la Media Luna			
El Capulín	5.0	2.0	807
El Huizachal	3.0	1.0	622
Plazuela	-----	2.0	917
S. J. del Tapanco	5.0	2.0	749
Deep well pumping			
El Refugio	9.2	3.4	1097
El Jabalí	7.0	3.0	938
San Diego	6.0	3.0	------
20 de Noviembre	8.0	3.0	975

The communities that obtain the best crop yields of sweet-corn are: El Refugio, 20 de Noviembre and El Jabali. In these places, the seed of traditional cultivars is conserved, produced, and distributed, reason for which they are well-known communities. This seems paradoxical because the farmers from these communities are the most receptive to use improved cultivars and farm inputs; furthermore, they have the best quality water of region at their disposal, to irrigation. However, the sweet-corn and grain yields are very low compared with other producing regions of the country; in El Bajio region, for instance, 20 and up to 15 tons of sweet-corn and grain, respectively, are produced per hectare (Charcas *et al*., 2002).

Commercialization: The price to sell the harvest varies a lot; this variation is caused by brokers and hoarders. Nowadays, the owners of big supply markets employ people who are in charge of spotting the sweet-corn fields and barter their price. These people for a small commission can get an advantageous deal for the buyer; this causes that the farmer hardly recuperates the costs of producing the crop.

Profitability of the crop: In the region, the average profitability of the sweet-corn is of 96.6% and the grain averages a 31.7% of profitability (Table 5). The community El Refugio has attained the highest average profitability of sweet-corn (170.4%) and 20 de Noviembre has obtained the highest in grain (86%). Nevertheless, the profit obtained does not only depend on high yields but also on the opportunity to sell the harvest.

Sorting out of the information

The results of arranging (DECORANA) 10 variables, which are related to practices and costs of maize production for 85 of the interviewed farmers, indicate that the percentages of the total variation that explain the first four axes are: 21.7, 17.3, 12.4, and 9.7, respectively. In the first axis of the Figure 2, to the right, the extreme positions are occupied by the variables that define the plant density of the crop (Dima, Disu), while the variables situated to the left extreme are the ones related to the costs of the agro-chemical products (Plag and Fert). It seems that this axis corresponds to a gradient of intensity of cultivation. In the second axis at the top extreme, the variables related to arable weeds and pests (Esca) are ordered. In the bottom side, the variables of costs of fertilization, irrigation (Fert and Rieg) and crop yield (Rend) are ordered. This arrangement of variables indicates that it is a gradient of forms and strategies of crop production.

The farmers (Num. 1, 12, 36, 44, 83) that use low population density and invest a small amount on pesticides and fertilizer are ordered on the right extreme of the first axis, -already acknowledged as gradient of intensity of cultivation. The farmers that utilize a higher plant density and spend more on pesticides and fertilizers are located to left extreme (Num. 35, 37, 63, 65 and 85). Thus, as the plant density increases, the investment on agro-chemical products needs to be increased.

TABLE 5. Profitability of the maize crop in Rioverde, S.L.P. México (US$/ha).

Zone/community	Sweet-corn	Maize grain
Manantial de la Media Luna		
S. J. del Tapanco	4.36	-1.47
Deep well pumping		
El Refugio	17.04	3.66
El Jabalí	9.05	2.97
San Diego	9.32	2.11
20 de Noviembre	8.46	8.6

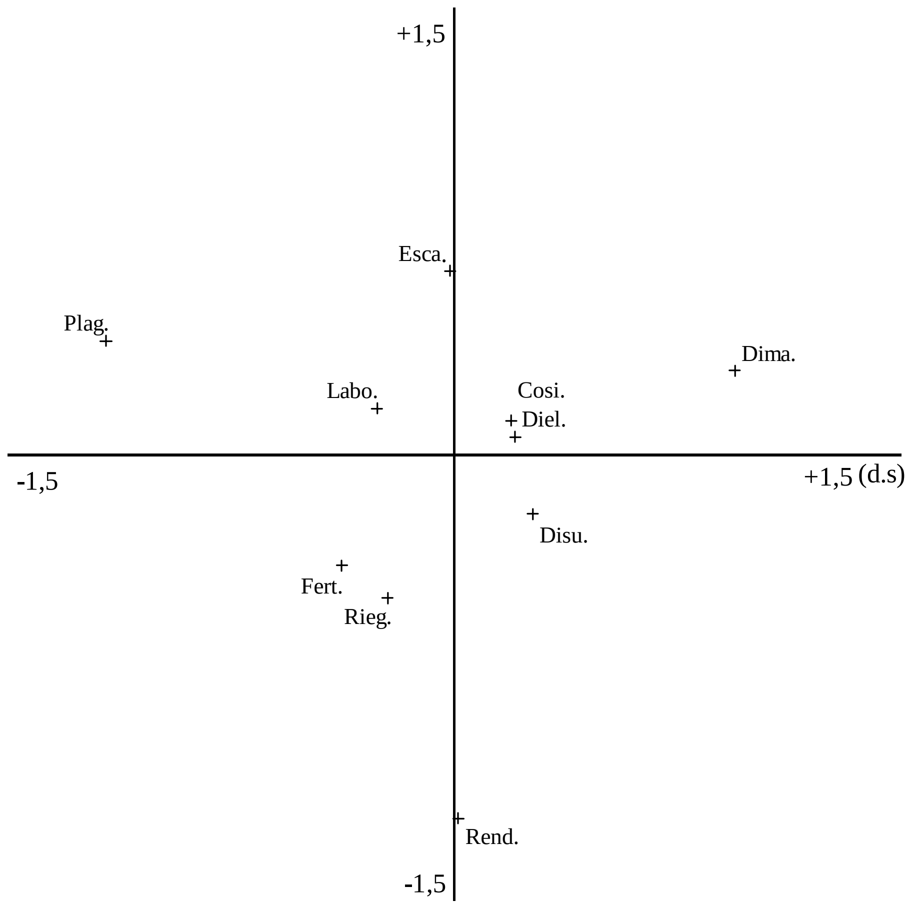

FIGURE 2. Sorting out of the farming practices and costs of sweet-corn production for 85 farmers from Rioverde, Mexico, using DECORANA; scale in units of standard deviation (d.s), (first gradient: crop intensity, second: strategies of production systems). Variables: seedbed preparation, spacing between harrows, spacing between plants, fertilization, and yield.

On the second axis, (gradient of forms and strategies of crop production), the farmers that invest more on weeds out and control of pests are located on the top extreme; these farmers, at the same time, spend less in irrigation and fertilizers application, this results in lower crop yields (Num. 54, 62, 73, 81, 84). This strategy is mainly focused to take advantage of residual effects of fertilizers previously applied on vegetables crops. In the low extreme of the gradient are placed the farmers that obtain the best yield; they invest more resources on irrigation and fertilization, nevertheless, they invest small amounts on weeds out and pest controls (Num. 21, 23, 32, 38, 42); this way of production is focused to obtain high yields by applying fertilizers and higher number of irrigations.

In general, the sorting out of results show that sweet-corn production is characterized by a variety of crop cultivation that ranges from extreme traditional to an intensive extreme; the former characterized by crop practices and plant density dependent on soil fertility and residual effects of fertilizers and, the latter exemplified by practices and plant density adjusted to abundant materials for production (Figure 3).

Classification of the information

The classification of the information (Figure 4) was done by TWISPAN. The variables are classified in four groups; these are arranged into two sets.

a) The first set includes only the group one, this is made up of two variables 11 Fosf (phosphorus) and 12 Pota (potassium). It was defined in level one of classification and includes methods of intensive production; even though, nitrogen is applied in this method, potassium and phosphorus fertilizers are also used.

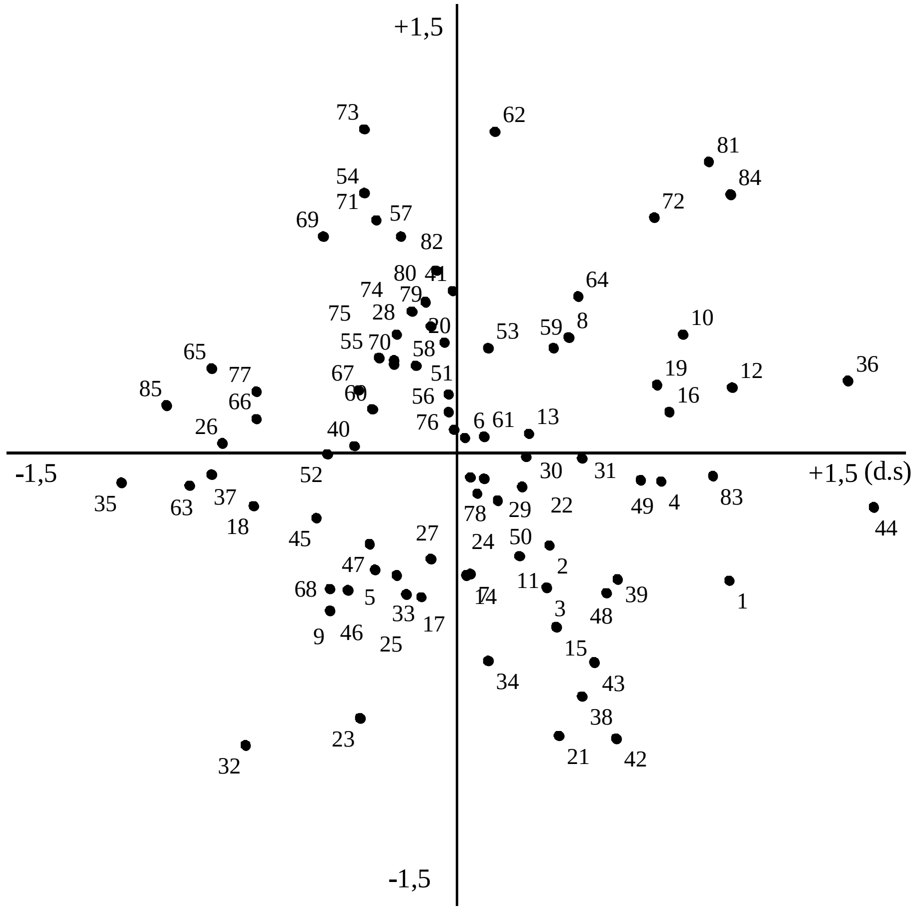

FIGURE 3. Sorting out by DECORANA of 85 farmers from Rioverde, Mexico, according to the production practices and costs (scale in units of standard deviation (d.s), first gradient, crop intensity; second, strategies or production systems).

b) The second set is made up of two sub-sets. The first sub-set includes only the group 2, which is composed of variables 10 Nitr (nitrogen), 13 Fert (fertilization) and 14 Rend (yield); it is specified in level 2 of classification and comprises methods of intensive production that only apply nitrogen fertilizers. The second sub-set is made up of groups 2 and 3; they are defined in level 3 of classification; from these two groups, group 3 covers variables 1 Labo (farm activities before planting), 2 Disu (spacing between furrows), 7 Esca (weed out), 8 Rieg (irrigation), and 15 Prco (harvest price); this group portrays both types of practices intensive and traditional. Finally, group 4 is made up of variables 3 Dima (spacing between plants), 4 Cosi (cost of sowing), 5 Diel (sweet-corn days), 6 Digr (grain days), and 9 Plag (pests); this group covers traditional cultivars, low plant density and deficient application of nitrogen fertilizers. These are the characteristics of traditional methods for grain production, practices that persist even though the intention is to harvest sweet-corn.

The 85 farmers are classified into seven groups (Figure 5), these are divided into two sets, using variable 12 Pota (potassium) as the reference variable to determine the division. The first set embraces all the farmers that apply potassium fertilizers, it is split into two blocks; the first block includes two farmers only (9.85) using variable 13 Fert (fertilization) as a reference, both farmers invest very little on fertilization. The second block, which uses variable 1 Labo (seedbed preparation) as a reference, includes two groupings, the first includes farmers 30 and 31 that invest very little in seedbed preparation; and the second comprises farmers 2, 27, 28 and 61 that spend a lot on this preparation.

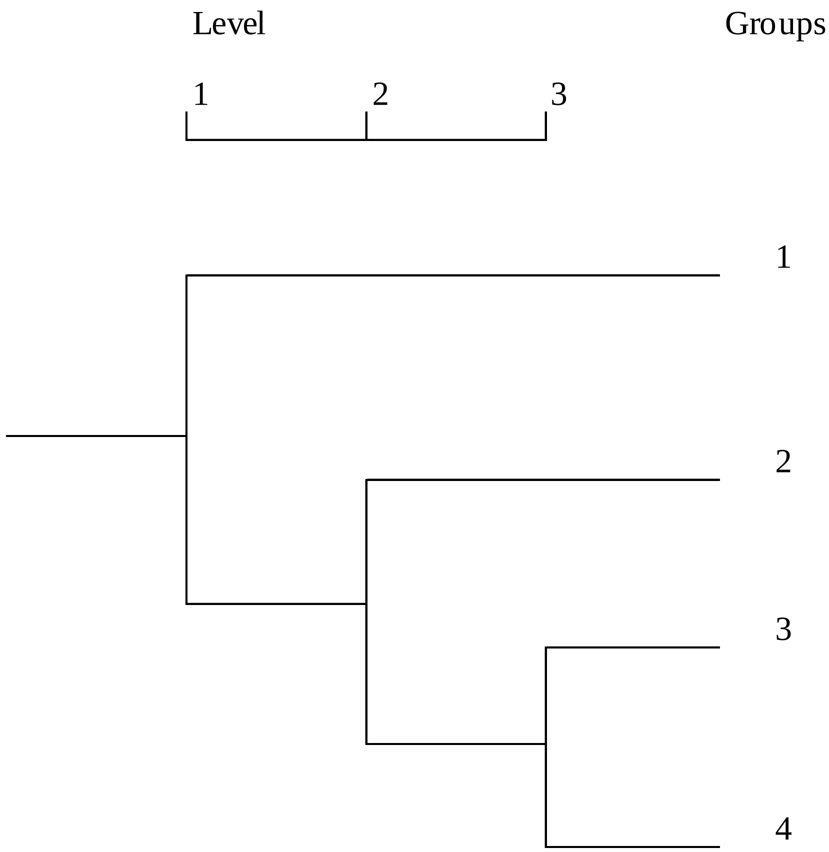

FIGURE 4. Simultaneous classification of 85 maize producers (TWINSPAN) and 15 variables related to farm practices and production costs, in Rioverde, Mexico.

The farmers that comprise the second set do not apply potassium fertilizers; the set is divided into two blocks. The reference variables for the first block are: 3 Dima (spacing between plants), 15 Prco (price for harvest), and 10-Nitr (nitrogen); this block includes two groupings, the first of these (group 4) includes 18 farmers that are characterized by using intermediate plant density, applying nitrogen fertilizers and by getting low prices for harvest. The other grouping (group 5) embraces 7 farmers that are distinguished for using low plant density, applying nitrogen fertilizers in moderate amounts and by obtaining high prices for the harvest.

The second block, which uses 9 Plag (pests), 6 Digr (grain days) and 5 Diel (sweet-corn days) as reference variables, includes two groupings. One of the groupings (group 6) embraces forty-two people that plant precocious cultivars (usually improved), and invest a few amount on pest control. The other grouping (group 7) includes ten individuals that use less precocious maize and invest higher amounts on pest control.

CONCLUSIONS

- The sweet-corn production in the Rioverde region is in a transition phase, from traditional to intensive farming, this transition occurs in two gradients; one of these refers to crop intensity and it is manifested by increments in plant density associated with the increasing of applying materials to produce. The other gradient is associated to strategies or production systems and it is manifested by changes in the farming practices.

- Based on those two rankings, the farmers that produce sweet-corn make up a variety of groups; these different groups are represented by different strategies and production systems.

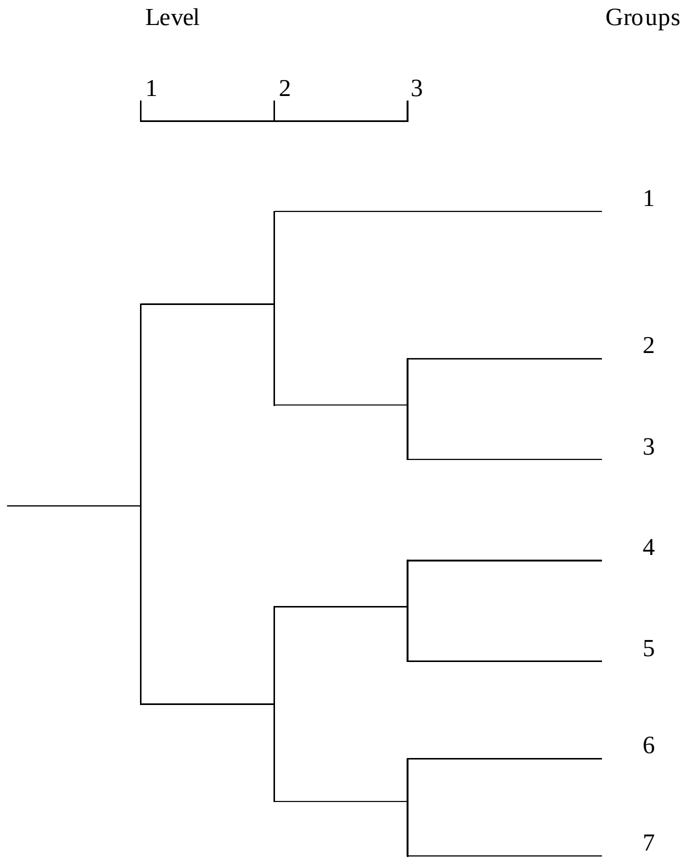

FIGURE 5. Classification by TWINSPAN of sweet-corn producers, in Rioverde, Mexico, classification based on variables that make up the production systems.

- Thus in the traditional production systems, nitrogen fertilizers are applied in low doses and farmers invest high amounts of money on pest controls, and they also plant intermediate maize. In the intensive production systems, high doses of potassium and phosphorus fertilizers are applied and higher amounts are invested in seedbed preparation.

- The group of farmers who have obtained better results is the one that uses low plant density, apply nitrogen fertilizers in moderate amounts, and sell the harvest at high prices.

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