

## DEVELOPMENT MODEL FOR NOPAL EXPLOITATION IN MILPA ALTA, MEXICO CITY

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### ABSTRACT

At the present time, three times more food than required to feed all humanity is produced, however a third of this production is wasted due to current shrinkage between production and the final marketing stage. In Mexico, 88 million tons of food are wasted annually. Regarding the nopal vegetable (*Opuntia ficus-indica* (L.) Mill), it is estimated that 63.3% of total production is discarded because of excess production. The aim of this research was to design a Community Development Model, for the industrialization and trade of nopal, by applying an integrating and organizational process, based on a cooperative for the production, dehydration and trade of organic nopal, in order to promote local participation, taking into account the well-being of producers and the sustainability of this process. This proposal was based on the three aspects of sustainable rural development: economy, environment and society; and was evaluated at the five stages that comprise the integral development model. The result of this evaluation suggests that it is viable to implement this development model in the Milpa Alta municipality, as here we find the necessary environmental, social and economic conditions.

**Keywords:** environmental actions, economic actions, social actions, cooperative, *Opuntia ficus-indica* (L.) Mill.

### INTRODUCTION

One of the main problems that results in insufficient food production derives from the fact that around a third of world production is wasted, due to the existing losses between production and the final marketing stage; related to the quality standards required by the market and poor distribution (FAO, 2019); as well as production surpluses.

In Mexico, 34.7 percent of the food produced is wasted each year (CEDRSSA, 2019), so that procedures are required to ensure these foods contribute to sustenance, instead of being discarded. In the case of the nopal vegetable, it is estimated that 63.3% of total production is discarded (SEDESOL, 2018) due to the fact that there is excess production, resulting in low prices for producers.

In recent years, the Milpa Alta municipality has experienced a strong boom in the agricultural context, mainly due to the exploitation of nopal vegetables, as a renewable natural resource of great economic potential, occupying second place nationwide, representing 48.02 percent of total production, as 194,751.07 tons/year are produced annually (SIAP, 2021).

Although it is true that the production of nopal in Milpa Alta is remarkable, what is truly important is to understand why around a third is not commercialized. One of the main

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reasons is that, of the 10 thousand producers in the municipality (Delgadillo, 2019), 5,560 of them sell their product at the Nopal Collection Center in Milpa Alta, resulting in excess supply of this product. When there is strong competition, prices decrease, which together with the fact that producers do not have a market for their product, causes them to decide to discard nopal, sometimes even throwing away the entire production. Another important reason that nopal is discarded refers to its presentation in the market (fresh and with thorns) because it is a highly perishable product and if not sold the same day, it will not be used.

Currently, trade in dehydrated cactus has acquired great importance worldwide due to the diversity of sectors in which it can be used; for example, in the food industry, medicine, biotechnological management, and particularly in the cosmetic industry, for which markets such as Japan and Korea demand this product (SAGARPA, 2017).

The aim of this research was to design an integral development model in Milpa Alta, Mexico City for the industrialization and trade of nopal vegetables, based on the three essentials of sustainable rural development: economy, environment, and society, in order to take advantage of all production and avoid waste. This would employ a cooperative as an organization for the production, dehydration and trade of organic nopal, promoting the well-being of producers and the sustainability of this process.

The hypothesis maintained in this work indicates that the implementation of the development model in Milpa Alta is possible, because the municipality manifests social, environmental and economic factors, that will ensure the exploitation of all nopal that is produced.

## **THEORETICAL DISCUSSION**

### **Sustainable rural development**

Sustainable rural development brings together three interdependent factors: economy, environment and society; a relationship that translates into economic and social development, while respecting the environment, so that this development is ecologically sustainable, economically viable and socially equitable. The goal pursued by this trilogy is long-term growth without damaging the environment or ecosystems, while avoiding indiscriminate consumption of resources; that is achieving balanced development, while making efficient use of natural, renewable and non-renewable resources (SEMARNAT, 2018). In Mexico, the definition of what is sustainable was taken up by national institutions that became aware of the concept of sustainability, so that multiple organizations and public policies institutionalized this term. Economic productivity is a factor that is not differentiated from peasant activity within rural development. Rigor is directed towards the production practices of peasants or small producers in communities, whereas there is no clear and specific proposal concerning the role of multinational companies that pollute, as it is these large industrial and service corporations that are most detrimental to sustainable development (Herrera, 2013).

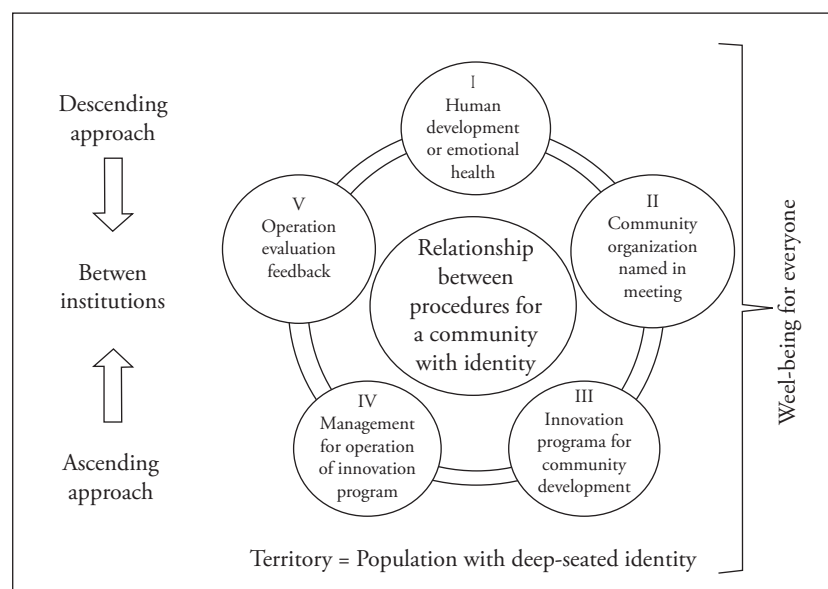
### Comprehensive development model

In the 60's, the concept of Comprehensive Rural Development (CRD) emerged in an attempt to find a balance between the variables involved in rural development processes. CRD appeared as an eclectic development style with widespread institutional participation for the sectoral harmonization of the economy, attempting to address agricultural productivity with the purpose of strengthening agricultural development. In the years 1970-1976, the Federal government created the Public Investment Program for Rural Development (PIPRD), which considers the community to represent a development unit (Herrera, 2013).

### Stages in the comprehensive development model

The model (Figure 1) presents an application methodology delimited by principles of territoriality, an ascending and at the same time descending participatory approach that represents social actors from each of the localities in the territory; a close relationship between development actions, whether in the productive, emotional, physical and judicial contexts, as well as the proposal and operation of innovative and multisectoral procedures (De los Ríos *et al.*, 2011). The model consists of 5 stages.

**Stage I.** Above all, man is a social being; this depends on his social and physical environment, not only to survive physically, but also for his mental and spiritual development. Cultural heritage, which cannot be conceived outside society, provides human beings with content and form for their existence. The ongoing process in human history implies cultural continuity based on interaction, or “getting along with others”. It is concerning this aspect,



Source: self elaborated based on De los Ríos, C. *et al.*, 2011

**Figure 1.** Stages of the sustainable development model in the community.

where emotional development embraces elements from the external world, in order to differentiate itself in its own terms and to promote human development (Papalia, 2010). In this way, human development considers people as a principal focus of attention to whom concrete opportunities must be granted to achieve balanced and integral development.

**Stage II.** This enables territories to form a horizontal cooperative organization that represents the population of the territory in a real and true way. Local agents and institutions are brought together in the local action group. A team of technicians will be one of the fundamental supporting agents, as the function of the representative group will be to carry out the management of resources for established developmental procedures, with participation from locals.

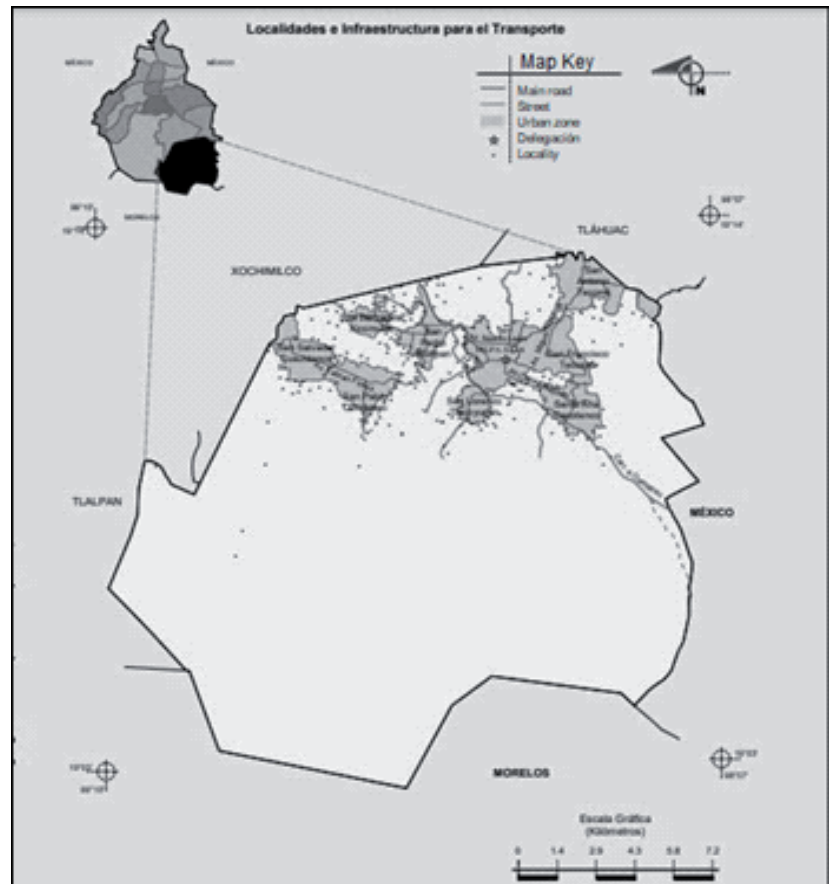
**Stage III.** This refers to establishing and operating sustainable rural development procedures in the territories, based on rural innovation programs. These programs function with territorial logic, multisectoral diversification and public financing. For example, some of these programs consist of LEADER (links between rural economic development programs links between rural economy development actions, PRODER (Program for Diversification in rural areas) and Territorial Pacts. Likewise, there are the more traditional institutions that have contributed to the development of agriculture in many European regions: agricultural cooperatives and irrigation associations. Both innovative mechanisms and these more conventional institutions have promoted the competitiveness of small and medium-sized enterprises, and in this way have furthered growth with equity (FAO, 2018).

**Stage IV.** This contemplates the fact that the global financing or operational program must entail a multi-year period and affect the flexibility of the program throughout the entire period, in terms of the type of projects that can be financed to strengthen the family economy and generate permanent jobs in the community or territory.

**Stage V.** The territories will establish mechanisms for the formation of a strategy for the exchange of experiences and feed back of knowledge, in order to optimize their behavior and experiences, forming support networks between localities and territories. This will involve a bottom-up approach that consists of actively participating with local agents, while taking into account the realities of each territory; and a top-down approach, which will allow government and public institutions to participate in the process of planning and management of development procedures in the territories.

## METHODOLOGY

This research was carried out in the municipalality of Milpa Alta (Figure 2), located to the south-east of Mexico City, in an area of 228.41 km<sup>2</sup>. Its geographic coordinates are between parallels 19° 03' and 19° 14' north latitude; the meridians 98° 57' and 99° 10' west longitude; at an altitude between 2,200 and 3,600 meters above sea level (INEGI, 2019). Twelve towns are located within these boundaries: Villa Milpa Alta (the capital of the delegation), San Antonio Tecómitl, San Francisco Tecoxpa, San Jerónimo Miacatlán, San Agustín Ohtenco, San Pedro Atocpan, San Pablo Oztotepec, San Bartolomé Xicomulco,



Source: INEGI, 2010.

**Figure 2.** Location of the Municipality of Milpa Alta, Mexico City.

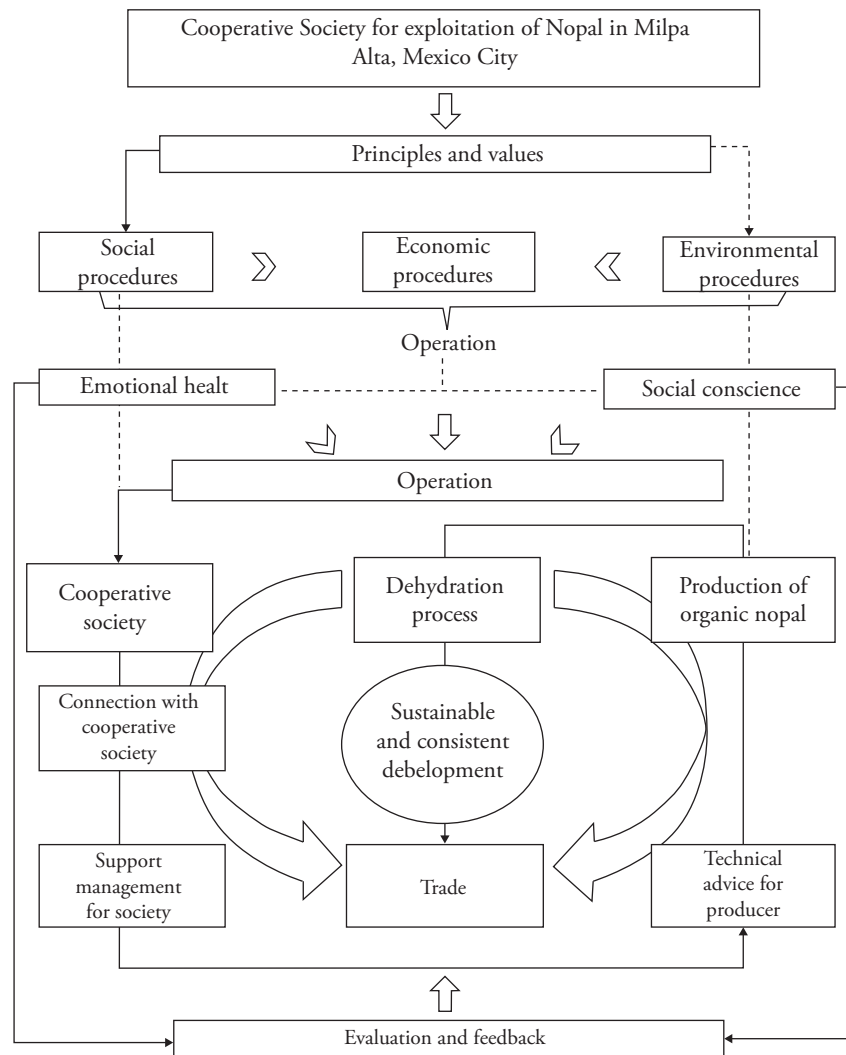
San Salvador Cuauhtenco, San Lorenzo Tlacoyucan, Santa Ana Tlacotenco and San Juan Tepenahuac. The population consists of 137,927 inhabitants, of whom 67,151 (48.7%) are men and 70,766 (51.3%) are women (Municipality of Milpa Alta, 2019).

In order that information analysis should be reliable, the research was both qualitative and quantitative (Sarduy, 2007). Methodology was divided into three stages.

### **First stage, Development Model Proposal**

We designed a development Model for the Industrialization and trade of nopal in Milpa Alta, in order to exploit all nopal vegetable production. This model (Figure 3), is based on the objectives and principles of the conceptual and ideological bases and the implementation phases of the comprehensive development model. The model consists of Integral Community Development.

In the following, we describe the phases that constitute the development model. The development model entitled: Cooperative Society for making use of nopal vegetable in



Source: self elaborated.

**Figure 3.** Development Model for exploiting nopal vegetable in Milpa Alta, Mexico City.

Milpa Alta, Mexico City, is a system that comprises several activities and processes. The basis of the proposed model is based on values and principles, and consists of five stages.

**Values and principles.** Concerning community organizations, whose purpose is the economic and social development of communities, Kliksberg itemizes the following values for social development: solidarity, equity and sustainability (Kliksberg, 1999).

**II. Functionality.** The structure of the model proceeds based on the three supports for integrative development, a) social actions, which include the creation and functional aspect of the cooperative; b) economic procedures, aimed towards activities for the industrialization and trade of nopal and c) environmental projects involving the organic

production of nopal. In order to integrate all these variables, the model must take into account two important points: social conscience and emotional health. Social conscience, for its part, is the knowledge that a person has concerning the state of other members in their community. The individual with a social conscience is acutely aware of how the environment can favor or impede people's progress, hence the importance of this for the cooperative to maintain beneficial development of productive activities and especially in terms of relationships between participating members. These relationships will be based on ethics and morals, ideas, political theories and other forms of consciousness that represent the social reflection of men in their spiritual life. Marx and Engels comment "...men, by developing their productivity and material exchange (that is, the relations of production), also modify, along with this reality, their thoughts and the products of their thoughts" (Rosental & Iudin, 2017). According to Maslow (1999), emotional health derives from heritage and the context in which this develops, that is the environment where this develops. The articulation between both these aspects; person-environment is vital to generate spaces that facilitate good emotional development, which in turn will lead the person to become aware of his situation, developing skills that will enable him to face the environment in a contemporary manner; dynamic, evolving, competitive and globalizing (Maslow, 1999).

This organizational model, based on shared strategies, principles, emotional health, social awareness, norms, and ethical values will strengthen autonomy, belonging, integration, equality, and solidarity among members.

**III. Operability.** Once the bases that will keep the model working adequately have been established, the operation continues, and will be highlighted as a strategy for the cooperative society to achieve sustainable local development considering.

**Social actions.** Model implementation begins with the integration of the members of the cooperative society, which takes place in accordance with that established in the General Law for Cooperative Societies in Mexico, as well as the Commercial Company Law; once the cooperative is registered and functioning, it will be linked through INAES (National Institute of Social Economy) and PRONAES (National Promoter of Unified Economy), in order to attract more customers and participate in fairs. The management of support and technical advice will be made through the Fund for the Social Development of Mexico City (FONDESOC), the FND (National Financial Development for Agriculture, Rural, Forestry and Fisheries) and through support programs for cooperative societies in Mexico City.

**Environmental programs.** Environmental programs will be undertaken in an ongoing and sustainable way. Sustainable actions are intended to preserve, conserve and protect the region's natural resources and contribute to protecting the planet for the benefit of current and future generations. Sustainable actions will comprise healthy processes to try to satisfy the social and economic needs of society. Similarly, this action will address cultural and environmental factors so as not to jeopardize their implementation. It is with this philosophy that nopal production will be undertaken organically, avoiding the

indiscriminate use of chemical fertilizers and pesticides, so as to offer a quality product that will be healthy for consumers. According to the Food and Agriculture Organization of the United Nations (FAO), the objective of this production system is to promote food security, rural development, sustainable livelihoods and environmental integrity (FAO, 2018). At this point, technical advice will be available from a group of professionals in the field. Likewise, to obtain organic product certification, the producer must comply with the norms of the Organic Products Law published in the Official Gazette of the Federation on October 25, 2013.

**Economic activities.** The economic actions of the development model will focus on an economy for solidarity and sustainable development; these will firstly be associative, family oriented and individual, as much concerning the level of production, but also distribution and consumption. A unique economic rational unfolds from the solidarity economy, derived from the fact that for this the main economic factors are work and cooperation. In this sense, great cultural effort is required, recognizing the value of work well done, “work accomplished in goodwill”, while also discovering and promoting a sense of solidarity. These actions will serve to identify forms of ownership, distribution of benefits, work organization, decision-making, commercial relationship for buying and selling, enabling us to take advantage of and promote and develop the values and strategies that form part of the popular and unified economy. And secondly, alluding to the configuration of a comprehensive and multidimensional process, which combines: 1) functioning of the economic system, 2) population and structure of society, 3) environment and territory and, 4) the political will implemented by the centers of power to install management of sustainability, as a way of achieving equitable distribution of income and generating collective well-being (CESOP, 2017).

**IV. Trade.** The problem faced by nopal producers is the excess supply of their product, hence the proposal is to accrue added value by dehydrating the nopal. This way of industrializing the product will make it more attractive and seek to obtain more or different consumers, improving the price-value. Regarding trade, this will first be carried out regionally and little by little the market will expand, finally achieving exportation by combining with opportunities offered by the federal government.

**V. Evaluation and feedback.** This model represents a long-term process because social, economic, cultural, and environmental aspects are interrelated, together with individual and group problems and needs, which is why these aspects in the model have to be constantly evaluated for it to function properly. This feedback will help improve both personal and work results, as it is vitally important that there is communication between the members of the cooperative, enabling an exchange of experiences with the aim of coping with social and work relationships, in order to learn from each other, thus improving results. When applying the model, the proposed strategy must demonstrate its potential for becoming integrated into networks, to promote the interchange of experiences through relationships at the local level, by means of flows and mechanisms of information and knowledge and innovations between actors, who have needs and resources in common.

### Second stage, obtaining information

The study unit consists of producers who sell nopal in the collection center in the municipality of Milpa Alta, so the reference indicating the number of producers was obtained from the PIAPRON program database (Integral Support Program for Producers of Nopal). A total of 5,560 producers were registered in the program (Table 1) pertaining to the twelve towns that make up the municipality.

The register includes data, such as: the name of the producer, address, town, telephone number, gender and age.

Because the population is elevated, a sample size was determined, surmising an accuracy for general reliability of 95 percent and an absolute maximum error of “d=0.1”. Sample size was calculated by applying a maximum variance formula (Equation 1) (Infante & Zárate, 2010).

$$n = \frac{NZ_{\alpha}^2 pq}{d^2 N + Z_{\alpha}^2 pq} \tag{1}$$

where *n*: sample size; *N*: size of population; *p*: proportion of binomial type population (0.5); *q*=1-*p* (0.5); *Z<sub>α</sub>*: normal distribution table value *Z* (95%), 1.96; *d*: predicted error 0.1.

$$n = \frac{(5560)(1.96^2)(0.5)(0.5)}{(0.1^2)(5560) + (1.96)^2(0.5)(0.5)} = 94.1923 = 94 \text{ interviews}$$

Once a sample size of n=94 producers was obtained, the Excel program was used to randomize the list in order to define the number of producers to be interviewed.

**Table 1.** Register of producers in the PIAPRON program.

No.	Location	No. of producers
1	Villa Milpa Alta	2,063
2	San Lorenzo Tlacoyucan	1,357
3	San Francisco Tecoxpa	743
4	Santa Ana Tlacotenco	475
5	San Jerónimo Miacatlán	396
6	San Agustin Ohtenco	201
7	San Juan Tepenahuác	130
8	San Pedro Atocpan	88
9	San Antonio Tecómitl	64
10	San Pablo Oztotepec	33
11	San Bartolomé Xicomulco	5
12	San Salvador Cuauhtenco	5
Total		5,560

Source: prepared with data from the nopal producer register in the municipality of Milpa Alta.

A survey was designed that consisted of dichotomous and open questions, the structure of the survey consisted of three sections; the first focused on the social situation of the interviewee, the second was directed to the production and trade of nopal and the third, focussed on the organizational situation of the producers; the data provided by the producer included the following variables: production, yields, harvested area, income, amount of nopal discarded; and qualitative variables. The qualitative variable of interest referred to the number of producers who would participate or be part of the proposed development model, for the purpose of exploiting their nopal production. Surveys were carried out either at the producers' plots; at the Milpa Alta nopal vegetable collection center, or where the producers sell their product and the rest of the surveys were applied at the producers' homes.

### Third stage

During this stage, the quantitative and qualitative variables were analyzed using the RStudio program.

## RESULTS AND DISCUSSION

Of the 94 interviews carried out, 53% were for women and 47% were for men; the average age of men was 45 years old, the oldest being 70 years old and the youngest 20 years old; the average age for women was 46 years old, with the oldest being 76 and the youngest 20 years old.

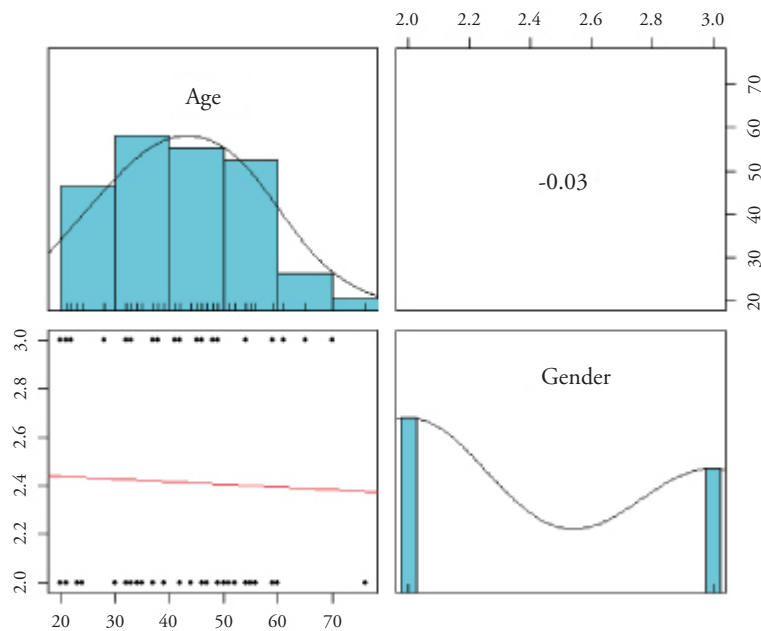
The variable of greatest interest was the qualitative variable with data concerning the number of producers who were willing to participate in the cooperative society for the industrialization of nopal, 56.38% of producers chose to participate, whereas 43.62% decided not to take part in the cooperative, that is, 53 and 41 producers respectively.

Of the producers who decided to participate in the cooperative, 31 were women and 22 were men. The average age of men was 42.45, while for women it was 43.25. The existing correlation between gender and age of the producers is low (Figure 4), in fact, it is apparent that neither age nor gender influence the decision to participate in the cooperative.

Although it is true that the development model represents a proposal, some of the stages can be verified in the light of the answers obtained from the surveys applied to producers. Validation of the proposed model, will require the answers to three questions: is it possible to apply this model in the Milpa Alta community? What contributions and benefits will the model provide for the community? And most importantly, how will this model be implemented?

For the model to be successful, all the parts must be integrated and work in harmony because the model works as a system, made up of stages which will be implemented in the short, medium and long term. The producers who were interested (56.38%) in being part of the cooperative agreed to participate in all the processes of the proposed model. The model is presented in 8 points, which are described below.

**1. Meetings held.** These will be held at the House of Culture in San Antonio Técomitl, located at Dr. Gastón Melo No. 40, for which the authorities were contacted to gain



Source: self elaborated.

**Figure 4.** Correlation analysis.

access to the facilities. In these meetings, the cooperative society will be integrated into an association, as a way of combining efforts and sharing ideals to produce collective responses.

**2. Delivery of value workshops, and modules for ethics and well-being.** This represents one of the most important workshops and consists of conceiving the Earth as a mother and as a territory, with a group consensus that decision-making and collective work should be treated as recreational (Torres & Ramírez, 2019).

**3. Description of innovation activities for producers.** Although it is true that organic production in Mexico has been present since the 1960s, in Milpa Alta it presents some peculiarities: there are only a few producers that avoid the use of agrochemicals, they are not certified as organic producers, and there is no regional market for organic products. This modification of activities will benefit the environment and producers, as it will enable them to initiate the certification process as organic producers, meaning that the product can attain a higher price. Organic products cost between 11 to 337 percent more than conventional products (PROFECO, 2018). Besides this, technical advice will be provided by professionals who will form part of the cooperative, on the subjects of plant breeding, agricultural parasitology, agroindustry and agricultural economy. The technicians will implement procedures and actions in order to certify the nopal as an organic product, following the guidelines defined by the Mexican Organic Institution, published in the Federation's Official Gazette on October 29, 2013. This agreement, establishes the organic practices and requirements to produce, certify and market products as organic, citing

article 7 of the Diario Oficial de la Federación (DOF, 2013), the technicians will be in charge of: a) Drafting a management history, which must include the inputs used in the agricultural production unit over the last three years; b) A description of the activities that are currently undertaken in the unit or that prevail in this process: for plant production such as fertilizer or plant nutrition, pest management; c) A program of activities that includes aspects requiring modification during the reorganization process, for example: crop rotation, manure management, livestock management, fodder production plan, pest and disease management, environmental conditions, soil conservation, water management, while ensuring that d) Tools and machinery used in the organic operation must be distinct from those used in agricultural activity.

**4. Planning for the Organic Procedure.** Each producer must describe the activities that will be undertaken during the productive process, including cultural practices, source of inputs to be employed for soil nutrition, as well as for the control of pests and diseases. Once organic certification has been achieved, the producer can request authorization to define National Distinction on product labels (SADER, 2019). To ensure that plantations become certified, the State Plant Health Committee of Mexico City will provide support (CESAVEDF), as well as advice on agricultural health and safety issues, through different programs, including: System of Reduction of Contamination Risks (SRCR) so that the product is innocuous, and the Certification of BPA's (Good Agricultural Practices). Likewise, they will support the analysis of these plots, as they have access to protocol for this purpose.

**5. Administration of financial support from federal programs for the cooperative.** One of the programs in which the cooperative will register consists FOCOFESS (Promotion, Constitution and Strengthening of Social and Solidarity Enterprises of Mexico City), which provides support such as: specialized technical assistance in consulting and improvement of the production project, as well as a business plan; with indirect economic support for expenses related to the legal constitution of Social Organizations such as Cooperatives; as well as direct economic support for the acquisition of machinery, equipment or raw materials, related to productive activity in the cooperatives. Another backing that will be sought is that offered by the INAES, with the request for credits through the SLCS (Savings and Loan Cooperative Societies), as these operate without profit, and have the capacity to offer loans, credits, mortgages and other financial benefits (INAES, 2021). The following supports will be provided by FIRA through the Support for Organization of Producers and Structuring of Projects for Financial programs. This supports individuals or legal bodies, who do not have, or whose access to formal financing is limited and may be subject to credit. The cooperative will also be provided with Financial Education, which consists of taking into account the elements related to obtaining, operating and fulfilling financing obligations; the options available to access credit and execute more prosperous strategies, as well as issues related to savings, insurance and to guarantee funds, among other aspects, as well as providing all kinds of advice and consultancy (FIRA, 2017). In addition, FPMARE (Financing Program for Medium-sized Agri-food and Rural Enterprises) will be Applied for, when the dehydration plant is in operation. Another

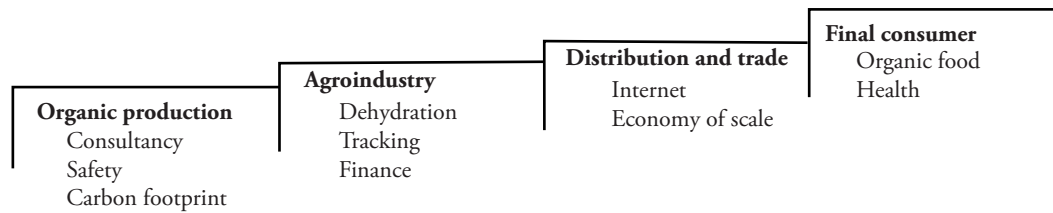
institution that will be solicited is FCSPFCP, 2020 (Financing for Cooperative Society programs and the Financing for trade programs); the latter involves offering services designed to provide spaces for trade, dissemination, and associations; as well as technical advice to link the cooperative with specialist businessmen, who will provide support to improve specific aspects and solve problems within companies.

The programs that will be accessed through the municipality of Milpa Alta include: PRIAPON (Comprehensive Support Program for Nopal Producers), which has the purpose of strengthening the nopal vegetable producing sector through economic support for the production, transformation, industrialization and trade of nopal vegetables, benefiting vulnerable men and women over 18 years of age, residents in the municipality, with the purpose of improving profitability for the production of nopal vegetables and reducing abandonment of agricultural activity within a framework of conservation of natural resources (Official Mexico City Gazette, 2020). And the ALTÉPETL program, which promotes agroecological production (green seal), sustainable livestock, management and exploitation of wildlife, product marketing; promotion and strengthening of community organization; this fosters cooperation to achieve the generation of goods and diversification of income from agricultural activities, promoting community agro-productive development on conservation land in Mexico City. Among the commitments that the beneficiary must make to access this aid, is a commitment to reduce the use of agrochemicals for fumigation and fertilization, and preferably they must incorporate agroecological practices (Official Mexico City Gazette, 2020).

**6. Construction of the nopal dehydration plant.** The dehydration plant will be located in the municipality of Milpa Alta, near the collection center, so that people who require this but are not part of the cooperative can offer their product. If demand is constant, the size of the plant will have a capacity for 150,000 tons per year, which can be increased as producers join the cooperative. The layout of the plant is one of the important factors ensuring maximum benefit from the space available (Díaz, Jarufe, & Noriega, 2008). The plant will be divided into five main areas, which include: I. Raw material reception area, II. Warehouse area, III. Production area in which the process of solar dehydration of the cactus will take place, IV. Quality control area, V. Auxiliary services area.

**7. Marketing and distribution.** Distribution will take place along the route that the product will pursue to reach the final consumer (Figure 5), taking into account that the distribution route will maintain control over marketing and sales.

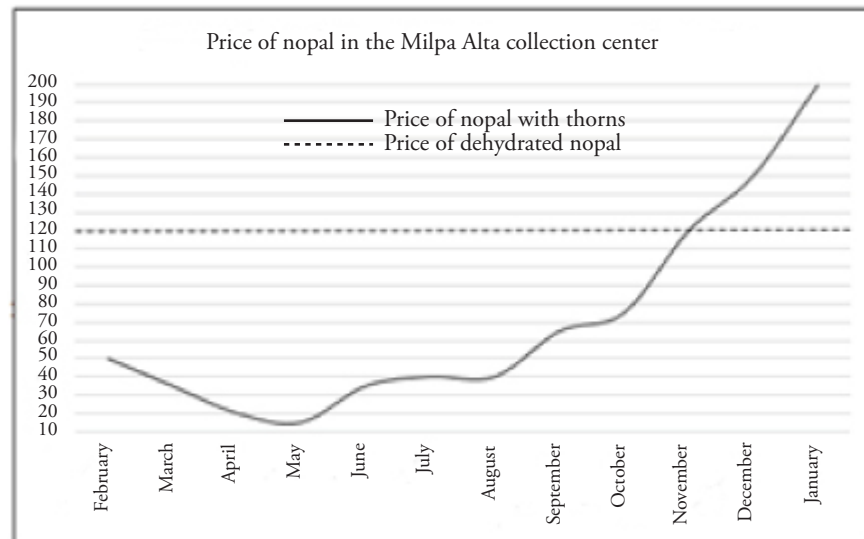
It was decided that the best distribution strategy for the product, would be a short transfer to the local market and indirectly to wholesalers of origin. The main objective of the marketing strategy is to expand demand for this product, principally in the form of dehydrated nopal and bring the characteristics and benefits of the product to the target market. The target market will be the general public but particularly people who suffer from obesity and diabetes in this country. In Mexico, 10.3% of the 20-year-old population suffer from diabetes and 36% of the population suffer from obesity (INEGI, 2021).



Source: self elaborated.

**Figure 5.** Productive production chain and trade of dehydrated nopal.

**8. Citation of Price.** For the producers of nopal vegetable in Milpa Alta, there are two seasons for nopal production, the first that spans from February to August and the second through the months of September to January. During the first season there is an excess in production and supply of nopal; due to this excess the average price of nopal is 33.57 pesos per hundred; during the second season, the price rises as production decreases due to climatic factors such as cold; the average price of nopal at this time is 122 pesos per hundred (data obtained from surveys of producers). The nopal processing strategy is that the proposed price for the product (dehydrated nopal powder) will cost 120 pesos per kilogram, as it will be a 100% organic product. Comparing the prices at which producers offer their product (Figure 6) with the price of dehydrated nopal, evidently profits will be higher, as the average price will be 120 pesos, while the average price that producers obtain throughout the year is only 70.4 pesos. Notably, the nopal will not be wasted or discarded during the season of greatest production, as all production will be dehydrated.



Source: self elaborated with information from producers in Milpa Alta.

**Figure 6.** Average prices for nopal.

In the previous points, we described the way the proposed model would operate, once the five operation stages of the development model and their operability have been described, we provide answers to questions posed at the beginning of this section. Is it possible to apply the model in the community of Milpa Alta? The answer to this question is affirmative, as the environmental conditions exist; namely, the Milpa Alta region is known for occupying the second level nationally for nopal production (SIAP, 2021), in this sense, there would be no shortage of raw material to supply the dehydrator. Another environmental aspect is that the producers want to produce organically. For this purpose, they will receive advice from CESAVIDE (State Committee for Plant Health in the Federal District) and SADER (Ministry of Agriculture and Rural Development), as well as from professionals who will be involved in modifications for organic nopal certification. Regarding social conditions and nopal producers (56.4%), who wish to participate in the cooperative and accrue additional value to their product; regarding economic conditions, this will imply federal government and delegational support to finance this project, as well as contributions from members of the cooperative.

And what contributions and benefits will the model provide for the community? One contribution is the organization of the producers in a cooperative, where all are members have a voice and vote, another positive factor is that the nopal will not end up being discarded, as it will accrue added value; likewise producers will be cultivating and selling all year round. Another benefit is that by producing an organic product, there will be no contamination.

## CONCLUSIONS

The diagnosis and analysis of the operation of the development model proposed for the municipality of Milpa Alta has concluded that this is viable.

By applying the development model to the community, a balance between social, economic and environmental actions will result in harmony for social endeavors in the community. Solidarity, equity and sustainability are values for the social development of community organizations, whose purpose is economic development.

The organic production of nopal will preserve, conserve and protect the natural resources of the region.

By providing additional value to the nopal, producers will receive higher prices.

We anticipate a positive influx of producers concerning the decision to market and collect nopal through a cooperative.

In Mexico, 88 million tons of food are wasted every year, according to data from the study of the Technical Group of the National Crusade against Hunger, released by the Senate of the Republic in May 2016. Much of the food that is wasted consists of fresh agricultural products that, due to problems of low price, size or shape, do not reach the consumer. Dehydration technology makes it possible to take advantage of many of these foods and thereby gain new consumers.

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