Backyard Agricultural Production as a Strategy for Strengthening Local Economy: The Case of Chontla and Tempoal, Mexico

Fabiola Sánchez-Galván 1,2,*, Horacio Bautista-Santos 1,3, José Luis Martínez-Flores 2, Diana Sánchez-Partida 2, Arely del Rocio Ireta-Paredes 4 and Gregorio Fernández-Lambert 5

1 Postgraduate and Research Department, Tecnológico Nacional de México, Instituto Tecnológico Superior de Tantoyuca, Desviación Lindero Tametate S/N, Colonia La Morita, C.P. Tantoyuca, 92100 Veracruz, Mexico; horacio.bautista@itsta.edu.mx
2 Department of Logistics and Supply Chain Management, Universidad Popular Autónoma del Estado de Puebla, Calle 21 Sur 1103, Barrio de Santiago, C.P. 72410 Puebla, 72410 Puebla, Mexico; joseluis.martinez01@upaep.mx (J.L.M.-F.); diana.sanchez@upaep.mx (D.S.-P.)
3 Directorate General, Tecnológico Nacional de México, Instituto Tecnológico Superior de Chicontepec, Calle Barrio Dos Caminos No. 22. Colonia Barrio Los Caminos, C.P. 72709, Chicontepec, 92709 Veracruz, Mexico
4 Department of Agro-industrial Engineering, Universidad Interserrana del Estado de Puebla-Ahuacatlán, Los Llanos Km 1 San Andrés Tlayehualancingo, C.P. 73330, Ahuacatlán, 73330 Puebla, Mexico; ireta.arely@colpos.mx
5 Graduate and Innovation Studies Division, Tecnológico Nacional de México, Instituto Tecnológico Superior de Misantla, Km 1,8 Carretera a Loma del Cojolite S/N. C.P. 93821, Misantla, 93821 Veracruz, Mexico; gfernandezl@itsm.edu.mx

* Correspondence: fabiola.sanchez@itsta.edu.mx; Tel.: +789-893-16-80 or +789-893-15-52

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Abstract: In order to define chain strategies for a backyard agricultural production system, this study identified agricultural products produced by high development priority communities with indigenous presence located in the Chontla and Tempoal municipalities in Veracruz, Mexico. The production system was integrated into a generic model decomposing the supply chain into hierarchical components. Data were collected through a face-to-face semistructured questionnaire based on statistical sampling of rural households, backyard producers, intermediaries, retailers, and wholesalers, as well as municipal authorities. The research was carried out from January 2017 to June 2018 and a computational program was designed to analyze the data. As a result, products were identified and their production destinations were quantified. Moreover, it revealed a backyard agricultural supply chain of five echelons with opportunities for improvement in areas such as unstructured agricultural processes and practices, inappropriate product storage and handling, and the lack of production records, and up to three intermediaries that sequentially drove up product cost in regional consumption centers. In this study, 20.9% of total production was destined for sale, 34.8% for self-consumption, and 44.2% was noncommercialized. Nopal, creole pumpkin, coriander, plum, passion fruit, and jobo were products with greater economic value for noncommercialized production. An improvement strategy would be to build inclusive agro-food chains through consolidated centers of backyard agricultural products.

Keywords: Inclusive agro-food chains; backyard agricultural profitability; short productive chains; high development priority communities; indigenous presence communities
1. Introduction

Backyard agriculture is an arrangement among nuclear family members that combines natural resources with economic, social, environmental, and cultural functions for food production [1]. In this respect, technical-economic interests do not guide backyard agricultural practice. It is instead a social practice that links housing and agricultural production with a peasant and indigenous identity [2]. Backyard production plays a fundamental role in the livelihoods of rural communities [3,4].

In Mexico, small agricultural producers contribute 1.6% to the gross domestic product. There are between 5.3 million and 5.4 million rural economic units, with 50.6% corresponding to the stratum of families with primary sale products less than 55,200 Mexican pesos (2721 USD) per year. Family income is complemented with nonagricultural activities on a smaller scale and with salaried labor services [5].

Backyard agriculture does not show potential economic growth due to the lack of developing human capital, low technological level, high vulnerability to weather conditions, and weak integration within productive chains [6]. Therefore, it is necessary to analyze the internal dynamics of rural family production units as a development strategy [7]. This implies studying the supply chain to identify the economic agents, besides studying the internal and external processes to define strategies that improve the productive competitiveness system [8,9]. In Mexico, a supply chain analysis of cranberry (*Vaccinium spp*) identified the need for innovation in marketing and generation of strategies to reach final consumers without intermediaries [10]. A supply chain analysis of Persian lime (*Citrus latifolia Tanaka*) in Veracruz determined behavior patterns related to agricultural practices in seasonal orchards and identified that intermediation and a lack of technology adoption were responsible for low orchard productivity [11]. A supply chain analysis of mezcal in Zacatecas demonstrated that its areas for opportunity were in commercialization and distribution processes [12].

In the People’s Republic of China, there are agro-food supply chains made up of millions of small unstructured and nonorganized producers [13] that link grains, cereals, vegetables, and seasonal fruits with marketing scheme like convenience stores, supermarkets, discount stores, and hypermarkets [14]. In Brazil, families that adopt the role of small producers can grow exceptional agriculture economically and ecologically despite their circumstances [15].

In Madagascar, income stability of small-scale farmers was achieved through fresh food commercialization and minimal interference by intermediaries. They collectively met European supermarket quality requirements through microcontracts that offered intensive farm assistance and supervision programs [16].

In India, small-scale farmers are very much part of the agro-food supply chain. Their market is off-season vegetables and fruits that are linked to local cooperatives through purchasing agreements. Cooperatives organize the product collection and farmer training [17].

Our discussion is based on the hypothesis that a supply chain analysis of backyard agricultural production will contribute to the design of productive and operational strategies to strengthen local economies. This paper focuses on backyard agricultural production of the Chontla and Tempozal municipalities in Veracruz, Mexico, which have high development priority communities with indigenous presence [18]. In this sense, this paper aims to describe opportunities for improvement in the supply chain of backyard agricultural products in order to design productive and operational strategies that can contribute to strengthening local economies.

As a basis for this study, a generic model for agro-food supply chains proposed by Stringer and Hall in 2007 [19] was analyzed, and it was noted that they decomposed the supply chain into hierarchical components. This generic model helped to detect 8515 opportunity areas in agro-food chains in the United Kingdom. It was also referenced to propose improvement strategies for supply chains for game meat in South Africa [20], fresh mangoes in Indonesia [21], and the fishing industry in Denmark [22].

The following sections explain the development of this research. The Materials and Methods section describes the case study and provides clear details about the methodological design. The Results
section describes the supply chain of backyard agricultural products with improvement opportunities. It also shows projected annual production with its key performance indicator and includes proposed improvement suggestions. The salient elements of this study are summarized in the Discussion and Conclusion sections.

2. Materials and Methods

2.1. Methodology

This study is both exploratory and descriptive. We collected information from January 2017 to June 2018 to detect opportunities for improvement in the supply chain of backyard agricultural products of the Chontla and Tempoal municipalities in Veracruz, Mexico, which have high development priority communities with indigenous presence. The methodology used for carrying out this research is shown in Figure 1.

- **Data collection.** To identify the economic agents and supply chain echelons, face-to-face semistructured interviews were conducted with agricultural producers, intermediaries, agents, municipal authorities, wholesalers, and market owners. Also, a survey was designed to identify and quantify backyard agricultural products and their measurement units and production destinations. An opportunity sampling proposed by Hernández et al. [23] was carried out to collect backyard production information according to the operative capacity and economic resources linked to this study, taking advantage of monthly meetings held in the communities by municipal agents to discuss issues about their welfare.

- **Supply chain analysis and opportunity area identification.** They were defined with face-to-face semistructured interviews to integrate a generic model of the agro-food supply chain proposed by Stringer and Hall in 2007 [19], which analyzes the productive system through supply chain decomposition into hierarchical components (stages, operational steps, and unit operations).

- **Commercialization scheme definition.** A short productive chain proposed by Rodríguez and Riveros in 2016 [24] was analyzed, which evaluates criteria such as producer organizations, product differentiation, number of intermediaries, business formalization of purchasing and selling products, and social proximity between producers and final consumers.

- **Annual production projection.** Through surveys and statistical projection, we quantified the volume production destined for sale and self-consumption, and on-site food rot. Unit measurements were identified for each homegrown backyard agricultural product (tree, bucket, roll, quart, piece, grate, and litter) and converted to its equivalent weight in kilograms. The annualized economic value of production was calculated by multiplying the product weight by the harvest amount expected per year by sale price in the local market. To perform these calculations, a computational program designed in PHP 5.4.16 was used, including MySQL 5.5.32 as a database manager.

- **Key performance indicator (KPI) design.** Backyard agricultural profitability (BAP) is the performance measurement of the backyard agricultural production system that expresses the proportion not sold due to noncommercialized (unused or rotted) products and could be an economic benefit for backyard producers and high development priority communities. BAP KPI can measure the performance of production within each product range. Therefore, backyard agricultural profitability is directly proportional to sales and inversely proportional to the economic value of noncommercialized (unused or rotted) products (Equation (1)). The higher the value of BAP KPI, the greater the economic benefit of production.

\[
BAP = \left( \frac{\text{sales}}{\text{noncommercialized}} \right) \times 100
\]
where BAP is backyard agricultural profitability, sales is the economic value of products sales, and noncommercialized refers to the economic value of noncommercialized products (Source: own elaboration).

![Diagram](image-url)

**Figure 1.** Methodology for supply chain analysis of backyard agricultural products. Source: own elaboration based on Stringer and Hall [19] a generic model of integrated food supply chain

### 2.2. Case Study

The Tempoal municipality is located in Veracruz, Mexico, in the Huasteca Alta region (98°23′17″ W, 21°31′21″ N). It has 636 rural localities and a total area of 1152 km², which represents 1.6% of the state, and a population of 38,774 [25]. Tempoal is characterized by a high marginalization degree (index from 0 to 100, 33.14), and its scope is rural with indigenous presence: Teenek or Huasteco (predominant), Nahuatl, Totonaca, Otomi, Zapoteco, Tlapapeco, Tepehua, and Mixe [18]. Of the total population, 19.8% live in extreme poverty and 51.9% in moderate poverty, 72.9% have an income below the welfare line, and 33.5% lack education. Tempoal has deficiencies in areas such as access to food (35.5%), essential housing services (68.8%), and social security (81.1%) [26]. Tempoal receives support from a government program named National Crusade Against Hunger [27].

The Chontla municipality is located in Veracruz, Mexico, in the Huasteca Baja region (97°55′26″ W, 21°17′40″ N). It has 138 rural localities and a total area of 390 km², which represents 0.54% of the state, and a population of 17,429 [25]. Chontla is characterized by a high marginalization degree (index from 0 to 100, 36.90), and its scope is rural with indigenous presence: Teenek or Huasteco (predominant), Nahuatl, Totonaca, and Mazateco [18].

Of the total population of the Chontla municipality, 21% live in extreme poverty and 50% in moderate poverty, 71.2% have an income below the welfare line, and 32.1% lack education. Chontla lacks access to social security (84.3%), essential housing services (81.3%), and food (36.8%) [26]. Chontla receives support from a government program named Zones Priority Development [27].

**Object of Study**

In the Chontla municipality, surveys were conducted in Arranca Estacas, Las Cruces, San Francisco, San Juan Otontepac, Tezitzal, and Xochitlan. In Tempoal, surveys were conducted in Agua Nueva, Dos Rayas, Ejido Armadillo, El Armadillo Congregación Buena Vista, El Cantarito, El Ranchito, El Sauce, Llano Grande, Tanchenche, and Zapotal.

Each is a community with high development priority, with a rural scope and indigenous presence, and each is part of a government program for marginalized community development because they have at least one form of social deprivation and insufficient income to satisfy their basic needs [18].

The initial sample size was calculated with maximum variance (95% confidence, 5% error, 50% heterogeneity). The target population of the survey was defined as the number of dwellings reported from the INEGI 2010 (National Institute of Statistic and Geography) census [25]: 4227 homes in Chontla.
and 10,193 homes in Tempoal. In Tempoal, 391 surveys were collected, and in Chontla, 370 surveys were collected.

3. Results

The focus of this study is agricultural activity, and, more specifically, backyard agriculture as a productive system. Although it is important, it is not the only activity or the only source of income for backyard producers.

Residents of the Tempoal municipality engage in agricultural and livestock activities; 58.82% of backyard producers surveyed are involved in agricultural activities, 14.71% in livestock activities, and 26.47% in both. The main reasons for involvement are family inheritance (42.2%), job alternative (24.5%), extra income (16.7%), self-consumption (12.7%), and others (3.9%).

In the Chontla municipality, 75% of backyard producers surveyed are dedicated to agriculture, 15% to agricultural and livestock activities, 7% to agriculture and handicrafts, 1% to livestock, and 2% to all three. The main reasons for being involved in these activities are extra income (39%), self-consumption (14%), job alternative (16%), family inheritance (14%), and others (7%).

Livestock activities refers to the breeding and fattening of chickens, pigs, and sheep. Handicrafts refers to the embroidery of napkins and tablecloths.

Backyard producer income is complemented with nonagricultural activities on a smaller scale and salaried labor services. They are farmworkers who are hired by people who own large properties, and they also receive economic support from government programs.

3.1. Supply Chain Analysis

This study identified five echelons within the supply chain of backyard agricultural products: backyard production, product processing, manufacturing, commercialization, and consumption (Figure 2).

![Figure 2. Supply chain of backyard agricultural products in the Chontla and Tempoal municipalities. Source: own elaboration with information collected from semistructured interviews from January 2017 to June 2018.](image)

Products are harvested when the backyard producer needs to consume food (self-consumption) or has an opportunity to sell products (sales). This research defines noncommercialized products as products that are not used or wasted because they remained in the tree and fell due to overmaturity, as well as products that rotted during the storage, packaging, and commercialization process. Sometimes, noncommercialized products are used as fertilizer for the orchard.
Economic agents. There are four economic agents within the supply chain: backyard producer, local retailer, intermediaries, and the final consumer. Backyard producer refers to one or more family members individually and informally organized. Local retailers refer to local stores that provide main inputs and sell local products. Intermediaries refer to those who purchase backyard products and commercialize them.

Backyard agricultural production represents the first echelon within the supply chain. The backyard producer uses empirical techniques to carry out the cleaning and preparation of land for sowing and harvesting and manual techniques for product collection. The seeds and equipment for product collection (sacks, bags, buckets, and/or palm or wood baskets) are its main inputs. Local stores assume the input retailer’s role. Products transported to the second echelon are taken by the same producer or an intermediary, who buys the harvest directly from the orchard.

The producers’ houses or land are seen as warehouses and they are places where second echelon (product processing) activities are developed. To store and transport products between echelons, sacks, plastic bags, or rolls tied with yarn from local plants such as ixtle (Agave spp), izote (Yucca gigantea), and palm (Arecaceae) are used. Backyard producers perform visual inspections to separate defective or rotting products and classify products according to their size, shape, and color. Depending on the product, backyard producers or intermediaries transport the product to the next echelon (manufacturing or commercialization).

The manufacturing process is carried out in the warehouse and this adds extra value to the product. This process applies to some products, for example, creole chili (Capsicum spp.), which is subject to a drying process before storage. It is left to dry under the sun for several days. The creole chili is also dry-ground with sesame (Sesamum indicum) using traditional tools such as a handmill. Both products are packaged in average portions of 250 grams. Other products are sold per piece or are cut into small pieces and presented in a bag, such as creole pumpkin (Cucurbita maxima) and nopal (Opuntia ficus-indica). Cilantro (Coriandrum sativum) is commercialized in handfuls.

Intermediaries use their vehicles to transport products to the fourth echelon (commercialization). At the same time, backyard producers can move small quantities of products to the nearest town by mixed rural transport, which is defined as a truck that travels along gravel roads interconnected with localities with predefined morning or afternoon schedules.

Commercialization. Five key aspects define a commercialization scheme [24] in this study. (1) Backyard agricultural producers organize themselves individually and informally, and the products are sold by local stores, local markets, or different streets recognized as community or municipality markets. (2) Producers do not make presale contracts, generate production records, or establish service rules between the echelons of the supply chain. (3) Products that do not have third-party certification are offered. (4) Social proximity is close; affinity and sensitivity exist between producers and final consumers. (5) There are up to three intermediaries within the supply chain.

One of the most significant differences between a traditional commercialization scheme and a short productive chain scheme is the number of intermediaries. To establish a short productive chain scheme, there must be only one intermediary within the chain. A short productive chain encourages the development of the market around the local agricultural products and improves the economic, social, and cultural conditions of the territories [24]. In this study, there are up to three intermediaries within the supply chain, which is why it is defined as a traditional scheme according to the commercialization process in the supply chain of backyard agricultural products of Chontla and Tempoal, Veracruz, Mexico.

The final consumer is the last echelon within the chain, who brings economic value when making a purchase. In this productive system, a formal statement of customer requirements does not exist, and there are no historical data for products. However, turning customer requirements into product features is an essential role of a supply chain. In this context, at least shelf life minimal features (fruit size, color, and shape) must be considered for designing customer specifications [28].
3.2. Improvement Opportunities

According to the information collected, this study identified four improvement opportunities: (1) inadequately defined processes, (2) inappropriate storage conditions, (3) intermediaries within the supply chain, and (4) lack of production records.

Inadequately defined processes. This occurs in the second echelon (product processing). Different packaging styles and several homegrown measurement units (tree, bucket, roll, quart, piece, and litter) can exist for the same product. Different product attributes are a challenge for designing production rules and matching them to local conditions and local producers’ needs [29]. In addition, this echelon presents heterogeneity in agricultural product quality because it depends on both subjective consumer perceptions and intrinsic product attributes [30]. Therefore, it is important to define production standards and processing practices to achieve quality and homogeneity of products.

Inappropriate storage conditions. Products can rot during storage (second and third echelon) due to perishability and seasonal characteristics, in addition to environmental conditions: temperatures between 24 °C and 26 °C in Tempoal and between 20 °C and 26 °C in Chontla [31]. Perishable products will change value over the interval between production and delivery to the customer. Products reach their peak value at harvest time, and product value deteriorates exponentially post-harvest until products are cooled. Backyard producers can maximize product value in the corresponding echelon by managing the process from picking through cooling [32].

Intermediaries. For a product to reach the final consumer, there are up to three intermediaries within the supply chain. Eliminating intermediaries tends to improve returns to producers. Commercialization through cooperatives promotes competitive market conditions for agricultural products, so it increases production because of economies of scale [33].

Lack of production records. The economic agents within the supply chain do not generate historical data about production levels or service/dispensal/sale operations, which does not allow assessment of the economic benefits of backyard agricultural production. To identify key aspects of sustainable agriculture and design indicators for monitoring its progress, producers must keep records of their agricultural practices and characteristics [34].

3.3. Annual Production Projection

In Mexico, the economic value of backyard agricultural products has not been documented. The National Agricultural Survey [35] shows data about main agricultural products corresponding to small- and medium-sized production units; backyard producers are not included. To enhance the local economy of a particular place and build self-reliant economies, it is necessary to identify the diversity of local products [36].

In this research, projected annual production demonstrates that there exists a great diversity of backyard agricultural products with high commercialization value. Among them, several vegetable crops stand out: nopal, creole pumpkin, coriander, and creole chili; as well as fruit: tamarind (Tamarindus indica); and exotic fruits: plum (Spondias purpurea L.), passion fruit (Passiflora edulis S.), jobo (Spondias Mombin), and litchi (Nephelium litchi camb.).

Backyard producers provide fresh, healthy, and affordable products to regional communities, and creating markets where people can buy products from local producers helps revitalize rural economies [37]. Hence, linking backyard agricultural producers with short productive chains is important in order to contribute to the development of high priority communities with indigenous presence.

Table 1 shows annualized production in tons and its respective economic value in the local market.
Table 1. Annualized production of backyard agricultural products, Chontla and Tempoal municipalities.

<table>
<thead>
<tr>
<th>Product</th>
<th>Average Price 1,3</th>
<th>Expected Harvest</th>
<th>Annualized Value (USD) 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>T 2</td>
<td>Chontla</td>
</tr>
<tr>
<td>Plum</td>
<td>0.99</td>
<td>1</td>
<td>1.040</td>
</tr>
<tr>
<td>Nopal</td>
<td>1.97</td>
<td>2</td>
<td>2.666</td>
</tr>
<tr>
<td>Creole pumpkin</td>
<td>0.64</td>
<td>2</td>
<td>5.796</td>
</tr>
<tr>
<td>Coriander</td>
<td>2.46</td>
<td>4</td>
<td>0.489</td>
</tr>
<tr>
<td>Passion fruit</td>
<td>1.48</td>
<td>1</td>
<td>0.600</td>
</tr>
<tr>
<td>Jobo</td>
<td>0.99</td>
<td>1</td>
<td>0.780</td>
</tr>
<tr>
<td>Litchi</td>
<td>0.99</td>
<td>1</td>
<td>0.500</td>
</tr>
<tr>
<td>Tamarind</td>
<td>1.48</td>
<td>1</td>
<td>0.240</td>
</tr>
<tr>
<td>Creole chili</td>
<td>0.99</td>
<td>1</td>
<td>0.773</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td>27,057</td>
</tr>
</tbody>
</table>

Source: own elaboration with information collected from surveys from January 2017 to June 2018. 1 Average price per kilogram in the local market. 2 Tons per year expected. 3 1 USD = 20.2844 Mexican pesos. Average exchange rate during June 2018 [38].

Tables 2 and 3 show that 20.9% of production is destined for sale, 34.8% for self-consumption, and 44.2% is noncommercialized, the latter confirming the argument that almost half of all food produced is wasted before reaching the final consumer due to storage, packaging, and commercialization inefficiency [39].

Table 2. Production destinations of backyard agricultural products, Chontla municipality.

<table>
<thead>
<tr>
<th>Product</th>
<th>Self-Consumption 1</th>
<th>Sales 1</th>
<th>Noncommercialized 1,2</th>
<th>BAP KPI 3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nopal</td>
<td>3739</td>
<td>2303</td>
<td>4472</td>
<td>51.5</td>
</tr>
<tr>
<td>Creole pumpkin</td>
<td>2522</td>
<td>1590</td>
<td>3317</td>
<td>47.9</td>
</tr>
<tr>
<td>Coriander</td>
<td>1747</td>
<td>1027</td>
<td>2049</td>
<td>50.1</td>
</tr>
<tr>
<td>Plum</td>
<td>346</td>
<td>258</td>
<td>421</td>
<td>61.3</td>
</tr>
<tr>
<td>Passion fruit</td>
<td>305</td>
<td>222</td>
<td>360</td>
<td>61.6</td>
</tr>
<tr>
<td>Jobo</td>
<td>283</td>
<td>164</td>
<td>322</td>
<td>51.0</td>
</tr>
<tr>
<td>Creole chili</td>
<td>272</td>
<td>172</td>
<td>318</td>
<td>54.2</td>
</tr>
<tr>
<td>Litchi</td>
<td>177</td>
<td>133</td>
<td>182</td>
<td>73.0</td>
</tr>
<tr>
<td>Tamarind</td>
<td>117</td>
<td>83</td>
<td>155</td>
<td>53.4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>9509</td>
<td>5953</td>
<td>11,596</td>
<td>51.3</td>
</tr>
</tbody>
</table>

Source: own elaboration with information collected from surveys from January 2017 to June 2018. 1 USD annualized value. Average exchange rate during June 2018. 1 USD = 20.2844 Mexican pesos [38]. 2 Production unused due to not being harvested or rotting during storage, packaging, or commercialization. 3 BAP, backyard agricultural profitability; KPI, key performance indicator.

Table 3. Production destinations of backyard agricultural products, Tempoal municipality.

<table>
<thead>
<tr>
<th>Product</th>
<th>Self-Consumption 1</th>
<th>Sales 1</th>
<th>Noncommercialized 1,2</th>
<th>BAP KPI 3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plum</td>
<td>5248</td>
<td>2855</td>
<td>7298</td>
<td>39.1</td>
</tr>
<tr>
<td>Passion fruit</td>
<td>714</td>
<td>387</td>
<td>940</td>
<td>41.2</td>
</tr>
<tr>
<td>Jobo</td>
<td>582</td>
<td>427</td>
<td>618</td>
<td>69.1</td>
</tr>
<tr>
<td>Litchi</td>
<td>246</td>
<td>111</td>
<td>259</td>
<td>42.9</td>
</tr>
<tr>
<td>Tamarind</td>
<td>206</td>
<td>127</td>
<td>241</td>
<td>52.7</td>
</tr>
<tr>
<td>Creole pumpkin</td>
<td>175</td>
<td>143</td>
<td>212</td>
<td>67.6</td>
</tr>
<tr>
<td>Coriander</td>
<td>40</td>
<td>21</td>
<td>58</td>
<td>36.0</td>
</tr>
<tr>
<td>Nopal</td>
<td>41</td>
<td>40</td>
<td>57</td>
<td>70.7</td>
</tr>
<tr>
<td>Creole chili</td>
<td>34</td>
<td>21</td>
<td>44</td>
<td>46.7</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>7286</td>
<td>4132</td>
<td>9727</td>
<td>42.5</td>
</tr>
</tbody>
</table>

Source: own elaboration with information collected from surveys from January 2017 to June 2018. 1 USD annualized value. Average exchange rate during June 2018. 1 USD = 20.2844 Mexican pesos [38]. 2 Production unused due to not being harvested or rotting during storage, packaging, or commercialization. 3 BAP, backyard agricultural profitability; KPI, key performance indicator.

Self-consumption, sales, and noncommercialized products constitute the total backyard agricultural production. These products are part of the diet of rural communities. In this study, self-consumption
is not seen as extra income for producers but rather as saving on food costs. Noncommercialized products could represent extra income for producers. Hence, the backyard agricultural profitability (BAP) indicator only considers the economic value of sales and noncommercialized products.

In Chontla backyards, the BAP indicator is 51.3%; exotic fruits (litchi, passion fruit, and plum) have the most significant BAP indicator, and crops (nopal, creole pumpkin, and coriander) have the most potential noncommercialized economic value (Table 2).

In Tempoal backyards, the BAP indicator is 42.5%; nopal, jobo, and creole pumpkin have the most significant BAP indicator, and exotic fruits (plum, passion fruit, and jobo) are the most economically wasteful due to noncommercialized products (Table 3).

Hence, it is important to define actions that can improve the BAP indicator and direct efforts toward converting noncommercialized production into an economic benefit for backyard producers and high development priority communities with indigenous presence. The European Commission [40] affirms that all economic agents must work together to quantify noncommercialized products at each echelon of the supply chain.

3.4. Improvement Strategies

This study proposes establishing inclusive agro-food chains to strengthen the local economies of high development priority communities with indigenous presence. According to the UN Food and Agriculture Organization (FAO) [41], inclusive strategies allow enhancement of agricultural food systems.

To link backyard agricultural producers to inclusive agro-food chains, each municipality should be segmented into microregions of rural agricultural production within a radius of less than 100 kilometers so it will be better distributed geographically [42]. To boost aggregate production, backyard agricultural producers must start an organizational process, working together with municipal authorities. Both of them should direct their efforts toward establishing a consolidated center of agricultural backyard products (CCABP) whose goal will be focused on noncommercialized backyard products in order to turn them into an economic benefit for producers.

The proposed CCABP would contribute to establishing a short productive chain (backyard producer–CCABP–final consumer), where the CCABP will serve as a support center for trade and development of high priority communities. The CCABP setup must be managed by an association made up of backyard producers with the aid of municipal authorities. In the long term, this proposal will tend to minimize the number of intermediaries.

The CCABP in the first phase should encourage short productive chains linking to local and regional markets, demonstration fairs, and local restaurants. Also, it should promote strategies for adding value to products, standardize backyard production and packaging techniques, and promote brand recognition of the CCABP-municipality to strengthen the trust bonds and social proximity between producers and consumers. Branding can be a competitive advantage that expresses local diversity and cultural heritage to promote unique products imbued with history and traditions [43].

In the second phase, the CCABP must generate a production data bank on the quantity and quality of each backyard product. This will allow determination of the optimal postharvest strategy for handling and marketing products to improve the backyard agricultural profitability KPI in subsequent years.

4. Discussion

Backyard agriculture has been studied as a family subsistence system, with agrobiodiversity and agroecological practices as its main strengths [3,44]. This research presents a case study of the Chontla and Tempoal municipalities in Veracruz, Mexico, and demonstrates that backyard agriculture can be seen as a productive system in which economic agents interact within a supply chain for the commercialization of their products.
The backyard agricultural production system under study presents a traditional marketing scheme due to the informal sales process and because there are up to three intermediaries within the production chain. To achieve the linking of backyard agricultural producers in agro-food chains, it is necessary to move from a traditional commercialization scheme to a short productive chain scheme [24]. However, in this research, the production of a single producer is not enough to link it to an agro-food chain. It is necessary to foster cooperation among backyard producers to promote aggregate production. The proposed CCABP would contribute to establishing short productive chains (backyard producer–CCABP–final consumer), where the CCABP will serve as a support center for trade and development of high priority communities. The CCABP setup must be managed by an association made up of backyard producers with the aid of municipal authorities. In the long term, this proposal will tend to minimize the number of intermediaries.

The goal of backyard production is self-consumption and sales [45]. This research highlights that destination is segmented into three portions: self-consumption, sales, and noncommercialized products. The self-consumption economic value demonstrates that backyard agricultural products are part of the diet of high development priority communities, coinciding with the argument that backyard production contributes to food access in upper-middle-income countries [4]. In this study, self-consumption is not seen as extra income for producers but rather as saving food costs.

Noncommercialized products refers to unused or wasted products that remained in the tree and fell due to overmaturaiton, as well as products that rotted during the storage, packaging, and commercialization process.

Direct sales between producers and final consumers represent personal relationships of trust [24] that are relevant for high-development communities. The purpose of this study is not to eliminate this relationship, but rather the CCABP proposal focuses on turning noncommercialized products into an extra income source for backyard producers.

Innovation and the dissemination of technology are important factors to achieve sustainable development of rural backyard farms [46]. This research holds that achieving sustainable development requires integrating backyard producers into a framework of cooperation, which promotes the linking of backyard agricultural producers into short productive chains.

One of the major problems of the Mexican countryside is scarce linkage with regional and national markets [47]; thus, this study proposes establishing short productive chains by setting up consolidated centers of backyard agricultural products. These centers would help to strengthen the backyard producers’ organization and promote commercialization of their products in local and regional markets, fairs, and restaurants, supporting the argument that there is a need to link food demand with the supply driven by backyard producers [48,49]. In the long term, an aggregated and consolidated center could contribute to improved product quality and will tend to minimize the number of intermediaries.

Agro-food supply chains have been studied with a single product approach, with producers organized formally [10–12]. In this research, an agro-food supply chain was studied for different products with similar characteristics (perishability and seasonality), with producers organized informally. This study proposes linking backyard agricultural producers into short productive chains as a strategy for economic strengthening of high-priority communities with indigenous presence, supporting the argument that mainstreaming underutilized traditional crops within a food system offers alternatives out of poverty besides developing a sustainable food system [50].

To analyze the impacts of the local food system, it is important to measure its performance [51]. This study defined a key performance indicator to measure backyard agricultural profitability (BAP), in which the average BAP indicator is 46%, which represents the portion of production that could be turned into extra income for backyard producers.

Climatic factors and the limited shelf life of products represent the biggest challenges of the proposed CCABP to guarantee the supply of backyard agricultural products.
5. Conclusions

A generic model for agro-food supply chain analysis allowed identifying improvement opportunities in the backyard agricultural production system of Chontla and Tempoal, Veracruz, Mexico, both high-development priority communities with indigenous presence.

The proposed productive and operational strategies include collecting backyard products, creating a data bank, and designing and monitoring the backyard agricultural supply chain through key performance indicators.

This study proposes taking advantage of available backyard production to establish inclusive agro-food chains in which aggregated production, backyard producer organizations, and municipal authorities are essential factors in strengthening the local economies of high-development priority communities with indigenous presence.

Inclusive strategies allow the agricultural food system to be enhanced, generating a link between production and consumption besides highlighting the diversity of local products. Future research should concentrate on preparing an economic feasibility study and designing an inclusive business model for consolidated centers of backyard agricultural products; also, the design of a logistics network for each municipality will be required.


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