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Value networks, consolidation, and risks of an agricultural territory

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ABSTRACT

Objective: Producer and marketer value networks in an agricultural land in Veracruz, Mexico were identified and characterized, to determine its consolidation level (primary, emergent, potential, or combined), as well as to detect risks and to establish an improvement proposal.

Design/Methodology/Approach: An area of the Altas Montañas Veracruz, Mexico was used for the experiment. Surveys were conducted with producers (n=131) and marketers (n=42) of agricultural produce. Socioeconomic, environmental, technical, commercial, and chain link variables were analyzed to detect risks, opportunities, and revaluations. The study was carried out with the RStudio v. 4.3.3 software.

Results: Six producer value networks and three marketer value networks were identified. Socioeconomic, environmental, commercial, and technological risks were detected. However, public health risks were different depending on the application of raw manure. Chayote and avocado have displaced other crops. The revaluation proposals for emergent and potential producer and marketer networks were focused on technical support (*i.e.*, commercialization and generational change).

Keywords: supply chain, value networks, risks, reevaluation, and local resources.

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INTRODUCTION

The increase of the world population is a major issue. In 1950, the population reached 2.5 billion; however, by 2022, this figure had grown to 8 billion. The world population is projected to reach 8.5 billion in 2030 and to increase further to 9.7 billion in 2050 and 10.4 billion by 2100 (ONU, 2019, 2023). Food demand has grown as a result of this situation and, consequently, the areas used for agriculture have also increased (Monjardín-Armenta *et al.*, 2017). Agricultural activities are related to environmental, economic, and social parameters (Blobel and Meyer-Ohlendorf, 2006). In Mexico, agriculture is part of the primary sector (Cardona Reséndiz *et al.*, 2018), contributing 4% of the gross domestic product (GDP) (INEGI, 2022). The GDP helps to understand the opportunities to produce

goods and services, benefiting the income, welfare, and life quality of the producers (INEGI, 2022; Rincón-Valdéz *et al.*, 2004). However, the biophysical effects of climate change impact food production (Blobel and Meyer-Ohlendorf, 2006). In addition, several socioeconomic factors, such as price and consumption change, influence crop productivity. These changes provide a comparative advantage to certain crops. Consequently, the decision to grow them depends on the adaptation strategies implemented in each region and agricultural system. Veracruz is characterized by its agricultural lands, where producers grow annual and perennial crops (INEGI, 2023; SIAP, 2022). Forty-eight percent of the Región Altas Montañas (RAM), one of ten strategic regions in Veracruz, is used for agricultural activities (INEGI, 2023; Rivera-Hernández, 2018; SIAP, 2022). Some local producers obtain their income from crops that are commercialized in the domestic and international markets. They supply raw materials for the agroindustry, including chayote, coffee, sugarcane, and banana leaf (Bada Carbajal *et al.*, 2010). Other local producers grow and sell food for rural populations (Beltran-Morales, 2022). The value networks identified in the region are links to the agrifood supply chain: producers and marketers carry out activities and use facilities and means of distribution, to guarantee the production of raw materials. In addition, they strengthen the development of crops, add value (cleaning, purification, etc.), and manufacture agricultural products for the final consumer. Producers and marketers carry out one or more activities within the value chain, including field production and packaging (Sánchez-Galván *et al.*, 2020), as well as technical support, phytosanitary and nutritional management, crop residue composting, shelf life, food safety, biosecurity, business transfer, marketing, and sales (Rosa and de Paredes, 2017). However, not all crops have the same structural maturity and operational level (Vargas-Canales *et al.*, 2020). The objective of this study was to identify and characterize producer and marketer value networks in an agricultural land in Veracruz, Mexico. The aim was to establish its consolidation level (primary, emergent, potential, or combined), as well as to detect risks and to develop an improvement proposal.

MATERIALS AND METHODS

The study area included the following municipalities of Veracruz: Alpatlahuac, Calcahualco, Coscomatepec, Fortín, Huatusco, and Ixhuatlán del Café (Figure 1). The region is located from 19° 07" to 18° 58' 39" N and from 97° 06" to 96° 57' 25" W, at 987 to 1,860 m.a.s.l. The climate is mainly temperate-semi-warm-humid (INEGI, 2000, 2024).

The crops grown in the area are: avocado (*Persea americana*), coffee (*Coffea arabica*), pumpkin (*Cucurbita pepo* L.), sugarcane (*Saccharum* spp.), chayote (*Sechium edule*), chilacayote (*Cucurbita ficifolia*), rocoto chili (*Capsicum pubescens*), plum (*Spondias* spp.), peach (*Prunus persica* L.), tomato (*Solanum lycopersicum* L.), prickly pear (*Opuntia ficus-indica*), potato (*Solanum tuberosum* L.), pear (*Pyrus communis*), Mexican husk tomato (*Physalis philadelphica*), and banana leaf (*Musa* sp.).

Research method

The study was based on the value network focus proposed by Porter (1985), which includes inbound and outbound logistics, operations, marketing and sales, services,

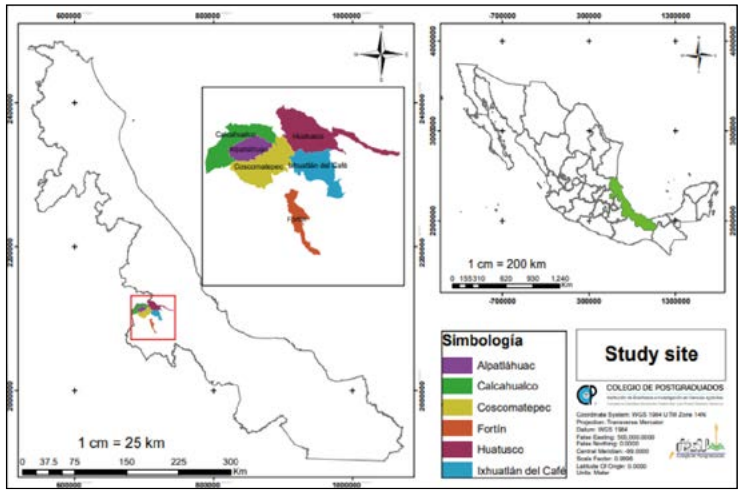

Figure 1. Location of the study area in the Región Altas Monañas, Veracruz, Mexico.

support, human resource management, procurement, technological development, and financial infrastructure. Sánchez-Sánchez *et al.* (2023) defined the primary, emergent, and potential value networks based on Porter (1985). Their aim was to integrate all the production-commercialization activities, determining their presence in the territory and their consolidation level (Table 1).

The ranges and acceptance criteria of value networks were developed following Sánchez-Sánchez *et al.* (2023). In addition, the consolidation level (primary, emergent, and potential) of the region was determined (Table 2), based on the assumption that value networks can include combined characteristics, depending on their structure and operational level.

Variables

Socioeconomic, environmental, commercial, technological, and link-type variables were analyzed. The main characteristics included gender, age, education, main activity, generation of local employment, land ownership, season and cause of manpower scarcity,

Table 1. Concepts and characteristics of value networks in an agricultural land.

Concept	Primary network	Emergent network	Potential network
Definition	The main source of income or business of a family.	An alternative and developing source of income, without a guaranteed or secure income for the families.	An experiment developed as future source of family income and whose main objective is to find out the future feasibility of this alternative.
Operations Post-harvest practices	High production volume, with an extended shelf life.	Low production volume, without an extended shelf life.	Small production volume, without an extended shelf life.
Marketing and sales Sale requirements	Food safety certificate.	No food safety certificate, no selection, no packaging according to product quality.	No food safety certificate. Product selected and packaged according to quality.

Table 2. Ranges and acceptance criteria of value networks, based on Sánchez- Sánchez *et al.* (2023).

Value network	Definition criteria	Acceptance range
Combined primary network	40% Primary-33% Emergent-27% Potential	45%-35-% Primary-38%-28% Emergent-32%-22% Potential
Combined emergent network	28% Primary-39% Emergent-33% Potential	28-26% Primary-39% Emergent-33% Potential
Combined potential-emergent network	21% Primary-45% Emergent-34% Potential	25%-16% Primary-50%-40% Emergent-39%-19% Potential
Primary network prevalence	50% Primary-30% Emergent-20% Potential	55%-45% Primary-35%-24% Emergent-25%-15% Potential
Transition to a consolidated primary network	65% Primary-25% Emergent-10 Potential	69%-59% Primary-26%-23% Emergent-15%-12% Potential
Consolidated primary network	75% Primary-18% Emergent-7% Potential	80%-70% Primary-22%-13% Emergent-11%-1% Potential

generational change, innovation adoption, type of target market (local, regional, domestic, international), post-harvest practices, seed use, and crop yield. Another major characteristic is the partnership advantages to find market niches that would add value to the product and sale. In addition, biosafety, food safety (certifications), technical support, and the presence of new pests were considered. The variables structured the producer and marketer surveys (Table 3).

Agricultural and commercialization risk variables that can impact the value networks were considered (Table 4).

Sample size

Agricultural producers and marketers were surveyed as links of the agrifood chain. Agricultural producers from RAM were identified to determine sample size, based on the

Table 3. Study variables used to identify and characterize value networks.

Variables	Description
Social	Land ownership, crop, area, irrigation, rainfed agriculture, technical support. Age, gender, education, economic activity.
Economic	Local employment (number, week, month, year, and gender). New pests that impact the crop.
Environmental	Agrochemical, chemical, organic, and biological fertilizers. Biosafety: use of manure, raw manure, composts, manure origin.
Commercial	Markets (local, regional, domestic, and international). Direct sale, local intermediary, domestic central market, or supermarkets. Product presentation (bulk and box packaging, with or without refrigeration). Local, domestic, or international destination of the product. Domestic and international certifications (field and packaging).
Technological	Agronomical, nutrimental, health, harvest, and post-harvest management. Associated, extensive (≥ 1 ha), and backyard monocrop.
Links	Producers, suppliers, collectors, distributors (local, domestic, and international), consumers, manufacturers.

Table 4. Description of the potential risks faced by value networks.

Risks	Description
Public health	Food safety and biosafety
Socioeconomic	Oversupply: crop area increase, low quality, food safety, low prices, crop abandonment, lack of employment, and migration. Economic loss caused by pests.
Environmental	Soil, water, and air pollution caused by agrochemicals, fertilizers, and non-composted manure.
Technological	Lack of training, equipment, and infrastructure.
Economic	Commercialization (ban on exportation due to microbiological charges, residues, untreated water).
Preservation	Genotype displacement and loss of genetic abundance due to the use of uniform areas for monocrops. Higher phytosanitary risks.

Programa para el Bienestar, "Corte a junio 2022, beneficiarios del Programa Producción para el Bienestar 2022" (SADER, 2022) and the 2019, 2021, and 2022 Anuario Estadístico de la Producción Agrícola (SIAP, 2022). The Brenlla-Martínez (1997) formula was applied to the sample of n=1,131 agricultural producers. These authors suggest that a ≥107 ≥145 sample size of producers can obtain a 97% confidence level. The final sample consisted of n=131 producers. The marketer sample size was based on the economic census (INEGI, 2019), which was used to identify the wholesale traders and retailers (economic units) within the RAM (Figure 1). A sample of n=72 economic units resulted in a n=42 sample (Brenlla-Martínez, 1997), obtaining a 95% confidence level.

Statistical analysis

Google Forms was used to collect the data from the surveys applied to producers and marketers. The data were encoded with Excel. The encoding was established based on dichotomous-qualitative, polytomous-qualitative, ordinal-qualitative, and continuous-qualitative variables. After the encoding, the RStudio v. 4.3.3 statistical package was used to perform the cluster analysis. Clusters were developed using the similarity matrix, based on Gower's distance (Palacio *et al.*, 2020), and the fviz_nbclust function of the factoextra package was used to determine the optimal cluster number. Once the cluster number was established, the Ward rostering method was used to develop the scatter plot and to obtain the clusters based on value networks. Subsequently, Excel was used to identify value networks, considering range and acceptance criteria (Table 2). The risks of the value networks were determined using the distinctive characteristics of each network (Table 1). Finally, the Statistic package was used to analyze the main components, in order to reevaluate the emergent and potential networks.

RESULTS AND DISCUSSION

Based on the network characteristics described in Tables 1 and 2, as well as on the ranges and acceptance criteria, six agricultural value networks (Figure 2a) and three marketer value networks were identified (Figure 2b). Agricultural value networks were divided into primary (67%), emergent (17%), and potential-emergent (17%) networks; however, based on

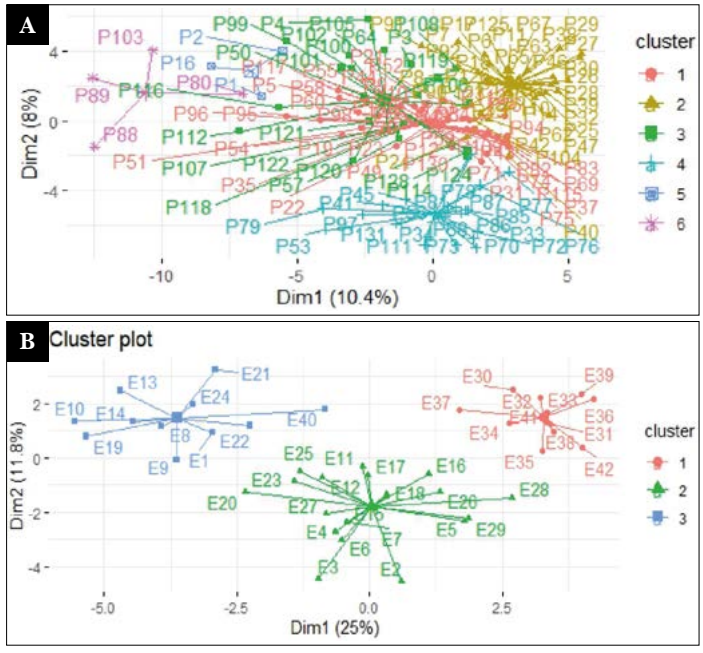

Figure 2. Value networks identified in the territory: A) agricultural value networks; B) marketer value networks.

their characteristics, no network has been fully (100%) identified as a consolidated primary value network (Figure 3a). Likewise, the marketer networks had various consolidation levels: primary (33%), emergent (34%), and potential (33%) (Figure 3b).

The diversity of crops of the agricultural networks can be linked with sustainability and diversification: they generate local employment and strengthen their presence in the territory. The networks are composed of the following crops: chayote (39%), avocado (14%), coffee (13%), peach (6%), plum (5%) and banana leaf (5%) (Figure 4a). Marketer networks receive their raw materials from the following crops: chayote (24%), avocado (12%), coffee (12%), banana leaf (16%), potato (10%), and rocoto chili (6%) (Figure 4b). Figure 4 shows that the crops identified in the value networks are connected with the area sown on the state: chayote (57%), avocado (50%), and banana leaf (47%) (SIAP, 2023).

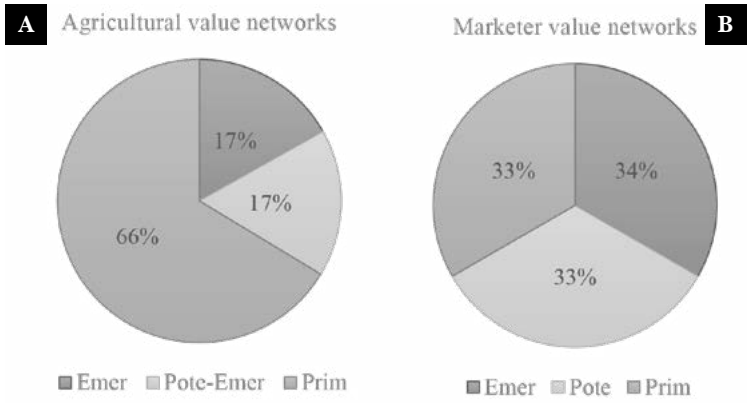

Figure 3. Percentage of the characteristics of the value networks in a part of the Altas Montañas territory, Veracruz, Mexico: A) agricultural value networks; B) marketer value networks.

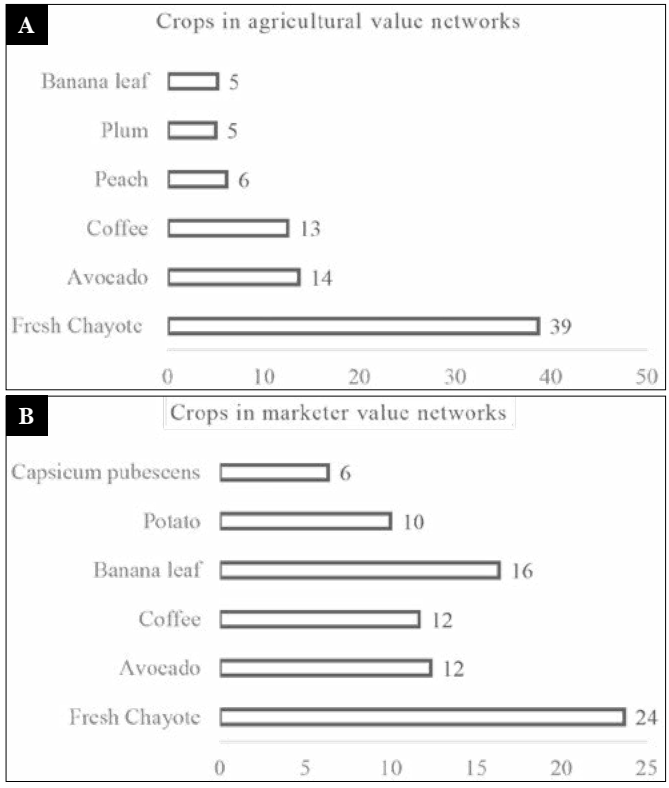

Figure 4. Representative crops of the agricultural value and marketer networks, highlighting their economic importance.

Production and commercialization are links of the internal logistics chain of the value networks. Agricultural networks are mainly composed of raw material supply (67%) and internal raw material supply and procurement, added value, and sale of the produce (33%). The networks of marketers that buy and sell produce are deficient in raw material supply (66%), while the purchase and sale of raw material supply and agricultural produce accounted for the remaining deficiencies (34%). The agricultural and marketer networks face socioeconomic, environmental, technological, and commercialization risks, although they pose different public health and conservation risks (Figure 3). Agricultural networks involve public health and commercialization risks, as a consequence of the application of raw manure to the crops. Meanwhile, marketers are impacted by natural disasters (hail and drought) which ultimately hinder commercialization (low availability of raw material), increasing the produce preparation costs and limiting the fulfilments of agreements with domestic and foreign markets.

Regarding the strengthening of territorial development, base characteristics are used to develop proposals for the revaluation of local or endogenous produce in both value networks. In addition, they provide solutions for the scale and adaptation limitations for quality standards, following international commercialization standards, without losing their value for consumers. The risks identified the measures that must be taken as part of the proposal to reevaluate the value networks (Figure 3). The analysis of the main components (MC) revealed that the agricultural network variables were clustered in four MCs (Figure

4a) and the marketer networks were clustered in three MCs (Figure 4b). The (cumulative) explanatory variable for each link recorded 73.95% and 72.82% values. The analysis revealed that agricultural networks must improve their technical assistance, postharvest management, and sale requirements (Figure 5A). The agricultural value networks involved generational change for the proper establishment of the future of the crop and the network, through business succession and transference. Meanwhile, marketers must be trained in requirement compliance, postharvest practices, produce review, and professional capacity for the improvement of business operations (Figure 5B).

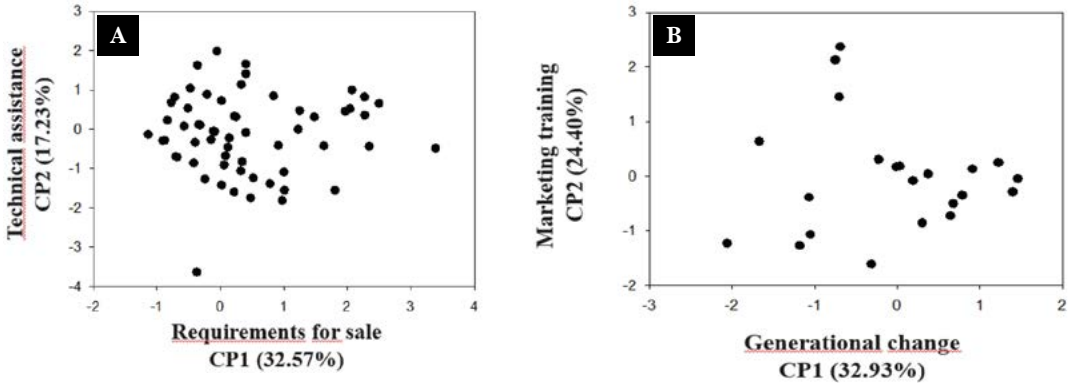

Figure 5. Principal component plots (A: plot of PC1 and PC2 of agricultural value networks; B: plot of PC1 and PC2 of value networks of agricultural marketers).

The six agricultural value networks and the three marketer networks have primary, emergent, and potential characteristics, with different consolidation percentages. According to Sánchez-Sánchez *et al.* (2023), a given territory can have value networks with various consolidation levels, generating a combination of distinctive characteristics. Agricultural value networks face public health risks related to the application of raw chicken manure to the crops that make up combined emergent, combined emergent potential, and consolidated primary value networks. This type of manure can expose the produce and the consumer to *Escherichia colli* and *Salmonella* sp. These findings match the results of Rosas-Martínez and Aguilar-Rivera (2022), who identified *Escherichia colli* and *Salmonella* sp. in pollinaza (chicken manure). Likewise, Nataren-Velazquez *et al.* (2020) reported a similar problem with the application of raw manure and fallen tree leaves in avocado (*Persea americana*) plantations. The marketer value networks (including the CommercializationPrimaryConsolidation network) face the risk of climate-related disasters, which impact the production and availability of raw material, as pointed out by Acevedo-Suárez *et al.* (2012), who detected the adverse effect of weather on production levels.

CONCLUSIONS

Six agricultural value networks and three marketer networks (with various consolidation levels) were identified in the territory. Neither type showed a single classification of

consolidated networks (*e.g.*, primary, emergent, or potential). Based on the percentage of distinguishing characteristics, the networks are dynamic and share features that classify them as combined and evolving networks. According to their consolidation level, the networks fulfill the following principles: input supply and product purchase and sales. Diverse risks were identified, but a social segment classification could facilitate their management.

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