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Women's Leadership in Sustainable Agriculture: Preserving Traditional Knowledge Through Home Gardens in Santa Maria Jacatepec, Oaxaca

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Abstract: Rural communities in Oaxaca face challenges such as food insecurity, economic instability, and the loss of traditional agricultural knowledge. Home gardens, once essential for food production and income generation, have declined due to migration, environmental degradation, and modern agricultural pressures. This study evaluated how community-driven models, supported by crowdfunding, can revitalize home gardens to improve food security, build community resilience, and promote economic empowerment. A mixed-methods approach, including household surveys, interviews, and focus groups, was used to assess the impact of these gardens. The results showed that over 70% of households experienced improved food security and reduced reliance on external food sources. Home garden production also led to a 20% reduction in food expenses, and the sale of surplus crops provided additional income, enhancing household economic stability. Women's involvement in agricultural decision-making increased, fostering empowerment within both family and community contexts. Traditional practices, such as seed saving and organic pest control, were maintained, contributing to the ecological sustainability of the gardens. Crowdfunding was an effective tool for financing home gardens, boosting community engagement and strengthening social bonds. The findings highlight the potential of integrating traditional knowledge with modern funding strategies to create resilient, sustainable agricultural systems in rural Oaxaca.

Keywords: home gardens; food security; community resilience; crowdfunding; rural development; SDGs

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1. Introduction

Home gardens have long been a cornerstone of small-scale agricultural systems in rural Mexico, particularly in Oaxaca, where they are crucial for food security, biodiversity conservation, and the preservation of traditional agricultural knowledge [1–3]. These biodiverse plots, typically located near homes, provide households with fresh food, medicinal plants, and small-scale livestock production [2]. Beyond their immediate contributions to household sustenance, home gardens play a vital role in promoting food sovereignty by enabling families to control their food production and maintain agricultural practices deeply rooted in local cultural traditions [4,5].

However, despite their numerous benefits, home gardens have been steadily declining across rural Mexico in recent decades [6]. One of the primary drivers of this decline is

rural-to-urban migration, particularly among younger generations seeking better economic opportunities [7,8]. This migration has disrupted the intergenerational transmission of traditional agricultural knowledge, weakening the continuity of home garden practices [9]. At the same time, the rise of industrial agriculture—favoring monoculture and large-scale production—has marginalized home gardens, pushing aside their more sustainable, biodiversity-friendly practices in favor of commercial crops [10]. Furthermore, environmental degradation and shifting land-use priorities have compounded these pressures, making it increasingly difficult for rural communities to maintain these once-essential systems [11].

In Oaxaca, women have historically been at the forefront of both household and agricultural activities, particularly in managing home gardens that provide essential food and medicinal plants for their families [12]. Despite their central role in ensuring household food security, women's contributions are often undervalued, seen as extensions of domestic responsibilities rather than formal agricultural work [13,14]. Traditionally, men have dominated public agricultural decision-making, while women's roles have remained confined to the private sphere, limiting their participation in community leadership and economic activities [15]. Yet, women's involvement in home gardens is not only essential for household sustenance but also for preserving agricultural biodiversity and transmitting traditional knowledge across generations [16]. Recognizing and overcoming these cultural and structural barriers is critical to unlocking the full potential of women's contributions to rural agricultural systems [17–19].

As home gardens decline and women continue to face barriers in agricultural leadership, innovative solutions are needed to revitalize these systems and promote equitable participation. One promising approach is social crowdfunding, which provides a decentralized and accessible means of financing community-driven projects, particularly in regions where traditional financial institutions are less accessible [20–23]. For indigenous and rural communities in Oaxaca, crowdfunding offers a valuable opportunity to secure resources for restoring home gardens, purchasing seeds, and improving infrastructure [24]. More than just a financial tool, crowdfunding connects local initiatives with broader networks of support, fostering social cohesion and collective ownership of agricultural projects [22]. By giving communities control over their development projects, crowdfunding empowers marginalized groups, allowing them to bypass institutional barriers and align agricultural initiatives with their cultural and ecological values [25,26].

This context of declining home gardens and marginalized communities highlights the case of Vega del Sol, a small area within the municipality of Santa María Jacatepec, which was classified as a priority attention zone due to its high levels of marginalization and socio-economic underdevelopment [27,28]. Approximately 30% of the population identifies as Afro-Mexican, adding to the region's rich cultural diversity [29]. However, despite this cultural richness, the community faces significant challenges: nearly 29% of the population lives in extreme poverty, a result of limited access to essential services, educational opportunities, and economic mobility [30]. The region's rugged terrain and relative isolation exacerbate these socio-economic issues, restricting access to markets, healthcare, and education, thereby contributing to the high levels of social vulnerability.

Vega del Sol serves as an ideal location for studying the complex interplay between cultural, environmental, and economic factors. This region provides a critical case study for examining the challenges and opportunities related to rural development, food security, and environmental conservation. In particular, the community's experience highlights the potential of home gardens not only as tools for subsistence and cultural preservation but also as a means to address socio-economic challenges through sustainable agricultural practices [31].

This study aims to address these gaps by exploring how community-driven initiatives, supported by crowdfunding, can revitalize home gardens in Oaxaca as a sustainable approach to improving food security, community resilience, and economic empowerment. The specific objectives are to assess the impact of home gardens on food security and household economic stability in rural communities, evaluate the effectiveness of crowdfunding

as a financial mechanism for sustaining home gardens, explore the role of women in agricultural decision-making within home garden projects, focusing on their contributions to community leadership and empowerment, and examine how traditional agricultural knowledge is preserved and transmitted through home gardens, and its role in sustaining rural livelihoods.

By focusing on these objectives, this research seeks to demonstrate the potential of home gardens as a sustainable solution to contemporary socio-economic and environmental challenges. The findings will contribute to broader discussions on sustainable development, with particular relevance to the Sustainable Development Goals (SDGs), including SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 5 (Gender Equality), and SDG 13 (Climate Action).

2. Materials and Methods

2.1. Study Site Location

The study was conducted in La Chinantla, Oaxaca, one of the most biologically diverse regions in Mexico [32,33]. This region's extraordinary biodiversity has made it a focal point for conservation efforts and sustainable agricultural practices [31,34], which are critical for the livelihoods of indigenous and rural communities [34]. Agricultural activities, particularly the cultivation of traditional crops in home gardens, are closely linked to the cultural identity and environmental stewardship of the indigenous population, who rely on these practices for both subsistence and the preservation of their cultural heritage [31,34–36].

The specific study area focused on the ejido of Vega del Sol, located within La Chinantla in the municipality of Santa María Jacatepec (Figure 1). Vega del Sol is a rural community with a population of 1225 residents, composed of 658 women and 567 men. Among these, 6.29% of women and 2.78% of men are illiterate. Additionally, 96.41% of the population identifies as indigenous, with 72.73% speaking Chinantec as indigenous language, underscoring the community's deep-rooted cultural traditions that continue to shape everyday life [37]. Of the total population, 693 individuals fall within the working-age range of 15 to 59 years, playing a key role in supporting subsistence farming and local economic activities.

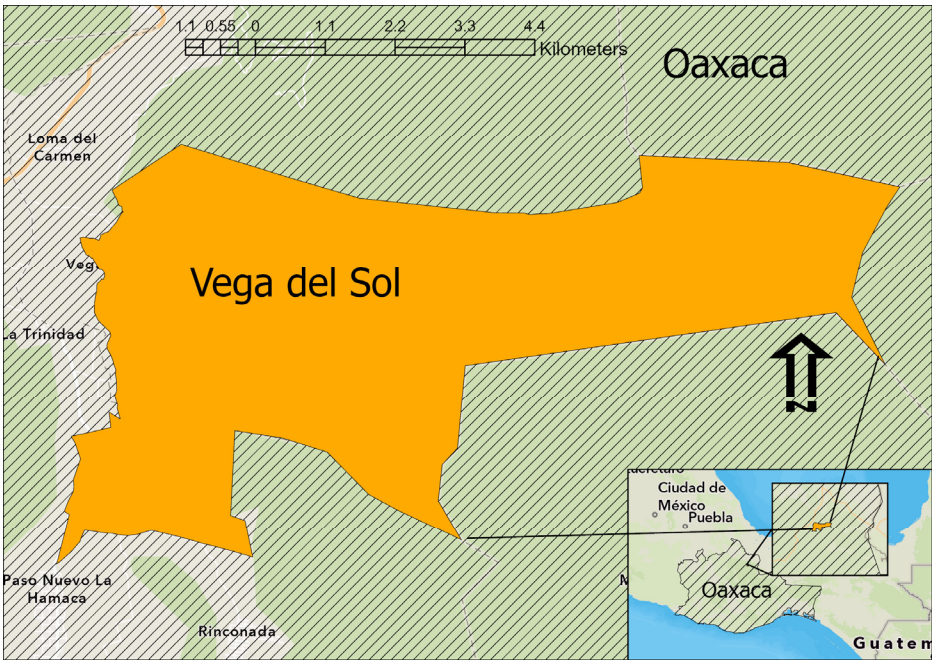


Figure 1. Geographical location of Vega del Sol in la Chinantla, Oaxaca.

2.2. Research Design

A mixed-methods approach was employed to address the research objective, integrating both quantitative and qualitative data to assess the revitalization of home gardens in

Oaxaca. The study, conducted from 2020 to 2022, focused on three primary areas: (a) food security and sustainability, (b) community resilience and empowerment, and (c) the preservation of traditional agricultural knowledge. A theoretical model (Figure 2) was developed to support the long-term sustainability and adaptability of home gardens, specifically through community-driven efforts and crowdfunding initiatives.

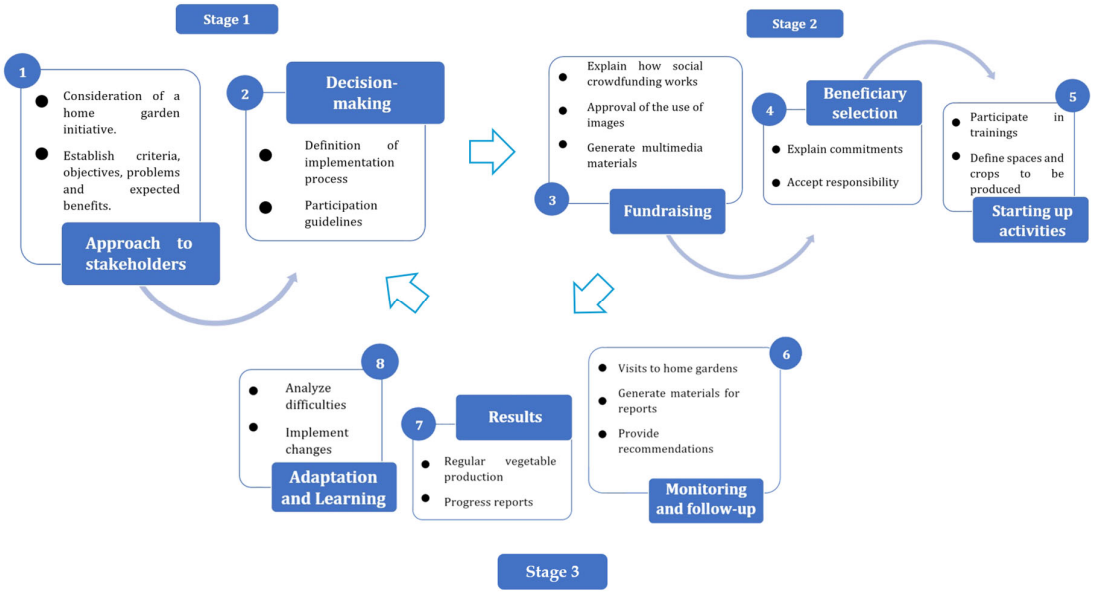


Figure 2. Theoretical model for home garden adoption.

2.2.1. Household Surveys

Quantitative data were collected through structured household surveys (Figure A1) conducted with 30 households in Vega del Sol, selected using a non-probabilistic snowball sampling method. While the sample size may appear modest, it was deemed appropriate given the rural and isolated nature of the community, allowing for an in-depth exploration of household-level impacts. The survey included sections on demographics (age, gender, income), the use of home gardens, crop diversity, and their impact on food security. Additionally, it focused on agricultural practices, such as types of crops grown and methods used, to assess how home gardens contributed to household sustenance. Special attention was paid to the economic benefits of home gardens, including cost savings on food and any income generated from surplus produce. This approach provided a comprehensive understanding of both the socio-economic and food security dynamics in the community, helping to evaluate the viability and effectiveness of home garden initiatives in improving local livelihoods.

2.2.2. Interviews and Focus Groups

Qualitative data were collected through semi-structured interviews (Figure A2) with a total of 30 participants, consisting of community authorities and key stakeholders actively involved in home gardening. These interviews aimed to gather insights into traditional agricultural practices, gender roles, decision-making processes, and the challenges faced by women in taking on leadership roles within the agricultural sector. The selection of participants was purposeful, targeting individuals who held significant influence in the community or were directly engaged in managing home gardens.

Additionally, focus group discussions (FGDs) were conducted with women and community leaders to explore the cultural significance of home gardens and to assess the potential of crowdfunding as a tool for supporting community-driven agricultural projects. Participants were also asked to rate their perceptions of home gardens on a 5-point Likert scale, evaluating their contributions to food security, household resilience, and income generation [38].

2.2.3. Food Security and Economic Data

Food security was assessed using an adapted methodology [39,40], tailored to the local context incorporating 5-point Likert scales [38], to measure food availability and accessibility. Data on the economic benefits of home gardens included reductions in food expenses, income generation from surplus sales, and market participation, focusing on how home gardens provide economic relief for households. Key socioeconomic indicators such as income, savings from self-sufficiency, and local market involvement were measured to analyze the gardens' economic impact on household livelihoods.

2.2.4. Crowdfunding Experiment

An experimental component was integrated into the study to assess the viability of social crowdfunding as a tool for financing home garden initiatives. Social crowdfunding, in this context, involves raising funds by appealing to a broad audience, typically through online platforms, to support specific community-driven projects. The crowdfunding campaign was carefully designed in collaboration with community members, with the primary goal of generating financial resources for expanding or improving home gardens [24,41].

The process began with the creation of a narrative that highlighted the importance of home gardens for food security, sustainability, and community resilience. This narrative was shared with potential donors through digital platforms and local networks, emphasizing the specific financial goals and timelines set for the campaign. The strategy involved engaging the community directly, both in the design and promotion phases, to foster local ownership and ensure active participation.

The pilot crowdfunding campaign aimed to raise funds specifically for the establishment of 30 home gardens. Key metrics for assessing the success of the crowdfunding approach included the total funds raised, the level of community engagement, and external support from broader networks. This campaign provided a framework for evaluating the potential of social crowdfunding as an ongoing resource for supporting future agricultural initiatives.

Crowdfunding was intended to be a flexible and adaptable tool, capable of being used in the long term whenever additional funding was required. Its implementation in this study was aimed at determining not only its immediate financial viability but also its potential for sustained community engagement and donor involvement over time.

2.3. Data Analysis

Quantitative data from the household surveys were analyzed using Microsoft Excel 2021 to identify trends in food security, crop diversity, and economic impact. Key socioeconomic indicators, such as income from home gardens and savings from self-sufficiency, were analyzed to assess the economic benefits to households. Qualitative data from interviews and FGDs were analyzed thematically to highlight the role of women in agricultural decision-making, community participation, and the preservation of traditional agricultural knowledge.

3. Results and Discussion

3.1. Evaluation of the Conceptual Model for Home Garden Adoption and Community Engagement

The conceptual model for home garden adoption and community engagement (Figure 2) was implemented in a structured manner, divided into three distinct phases. This approach was designed to ensure the long-term sustainability and success of home gardens within the community of Vega del Sol. The model focused on fostering active participation, particularly among women, in decision-making processes. By doing so, it aimed to enhance the overall functionality of home gardens and strengthen community engagement, setting the foundation for the subsequent phases.

3.1.1. Stage One: Organizational Foundations

In the initial phase, the model laid the groundwork by assessing family structures and community dynamics [42,43]. This stage was critical in identifying the space each family could allocate for the gardens, which ranged in size from 15 to 30 square meters,

and understanding women's roles in decision-making. Traditionally, women have had limited involvement in agricultural decisions [44], but this phase established the importance of including them in the planning process [44–47]. A baseline of male and female beneficiaries' perceptions toward home gardens was generated (Table 1), highlighting the initial challenges women faced. Notably, of the 21 women participating, 38.10% rated their experience as "Bad" and "Very Bad", and 28.57% as "Regular". However, 33.33% perceived their involvement as "Good" or "Very Good", indicating that despite traditional barriers, many women saw the potential benefits of home gardens from the beginning [42]. These baseline perceptions were crucial in guiding gender inclusivity efforts and ensuring women's participation in the subsequent phases [12].

Table 1. Initial perception of home gardens based on gender.

Gender of the Beneficiary	Initial Perception	Counts	Percentage of Total (%)
Female (21)	Very bad	2	9.52
	Bad	6	28.57
	Regular	6	28.57
	Good	5	23.81
	Very good	2	9.52
Male (9)	Very bad	1	11.11
	Bad	1	11.11
	Regular	1	11.11
	Good	6	66.67
	Very good	0	0

3.1.2. Stage Two: Inclusive Planning and Strategy Development

During this phase, the model (Figure 3) emphasized active participation from all family members, particularly women. The participants who became directly involved were between the ages of 29 and 45, which facilitated the transmission of indigenous agricultural practices to younger generations. This active engagement helped ensure the preservation of traditional knowledge while integrating modern strategies. Women were involved in selecting crop varieties that would best suit local climatic conditions and meet household consumption needs [4,48].

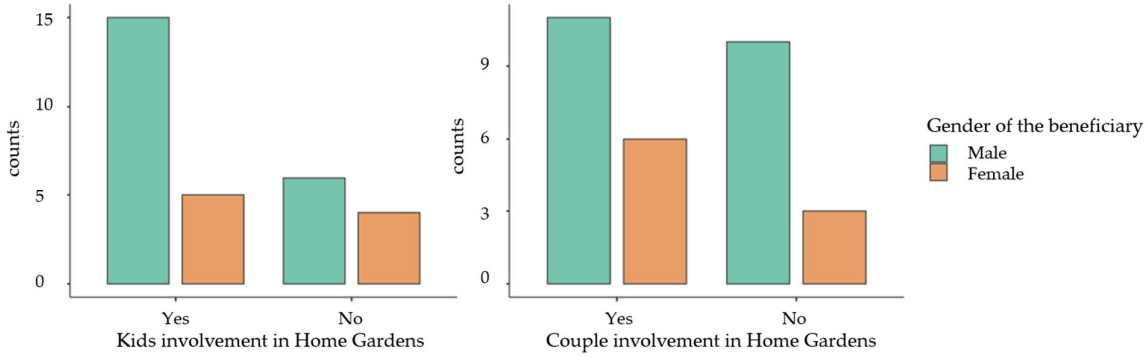


Figure 3. Participation and involvement of family members in home gardens.

In addition, financial strategies were developed to support long-term sustainability [24], with workshops on fundraising and financial management playing a pivotal role in the model's success [18,49,50]. The introduction of the crowdfunding component during this phase further strengthened community involvement, as it encouraged collective participation in raising funds for the development and expansion of home gardens [16,24,51].

3.1.3. Stage Three: Implementation and Community Empowerment

The final stage was focused on the actual implementation of home gardens. Women's roles in managing the gardens were strengthened and recognized by the community

(Figure 4), illustrating the shift in women's involvement from supportive tasks to taking leadership in decision-making processes at both the family and community levels. This empowerment of women not only enhanced their participation but also ensured that the gardens were effectively managed and sustained over time [52–54].

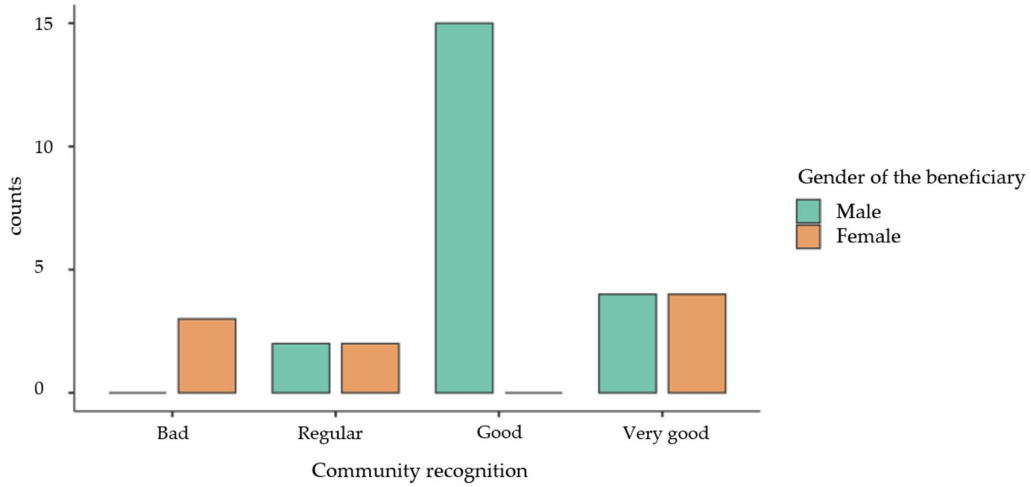


Figure 4. Recognition from the community for implementing home gardens.

The model incorporated a monitoring aspect to track the home garden activities and facilitated self-assessment, enabling participants to reflect on their progress, exchange experiences, and address challenges collectively. The community's ability to adapt and support each other played a crucial role in ensuring the long-term success of these gardens [19,47].

3.2. Impact of Home Gardens on Food Security and Economic Benefits

The analysis showed that 42.33% of households rated their access to food as "Good" and 23.33% rated it as "Very Good" highlighting the significant positive impact (70%) of home gardens on food security. Additionally, 46.67% of households reported that they experienced "Good" levels of savings due to home garden production, further reducing financial pressure from food expenses. These findings underscore the vital role that home gardens played in improving both food availability and economic stability for the surveyed households.

This shift allowed these families to reduce their reliance on external food sources. By providing consistent access to fresh, nutritious produce throughout the year, home gardens also strengthened household resilience, particularly during times of economic instability and fluctuating food prices [3,40].

Furthermore, improvements in food security were accompanied by notable economic benefits. A total of 76.67% of households (HH) reported successful crop harvests during the growing cycle, with many producing surplus vegetables that were sold in local markets. This not only supplemented household income but also strengthened the local food system, fostering sustainability and economic resilience within the community (Table 2).

Additionally, home gardens helped reduce food expenses by an average of 19.72%, as families relied less on external food sources. For simplicity, this reduction was rounded to approximately 20% in the text. Surplus produce sold in local markets generated extra income, which further contributed to the economic stability of these households [39,40]. Table 3 shows a notable increase in the percentage of households generating income from surplus sales compared to the initial stages of implementation, where few families reported any economic benefit from home gardens. This additional income not only provided families with the means to invest in other household needs, such as education or healthcare but also created a buffer against economic uncertainties, ultimately improving livelihoods.

Table 2. Contribution of home gardens to household food security and economic stability.

Measure	Level	HH Count Over *	Percentage of Total (%)
Availability of goods	Bad	3	10
	Regular	7	23.33
	Good	13	42.33
	Very good	7	23.33
Access to Healthy food	Bad	3	10
	Regular	7	23.33
	Good	14	46.67
	Very good	6	20
Savings due to production	Very bad	4	13.33
	Bad	3	10
	Regular	9	30
	Good	14	46.67
Harvest obtained during the cycle	Yes	23	76.67
	No	7	23.33

* Number of households exhibiting the specified characteristics. n = 30 households.

Table 3. Relation of income and expenditure per family for food needs.

HH	ANIH * (MXN $)	MFEH * (MXN $)	MVEH * (MXN $)	IIH * (MXN $)	SFPI * (MXN $)	ISSL * (MXN $)	CIHI * (MXN $)
1	11,236	10,716	1530	1400	130	347	477
2	11,008	10,644	1479	1400	79	438	517
3	10,913	10,356	1492	1400	92	313	405
4	10,947	9804	1582	1400	182	427	609
5	10,800	9612	1384	1400	−16	136	120
6	10,410	9828	1600	1400	200	274	474
7	11,389	10,098	1331	1400	−69	256	187
8	10,397	10,788	1306	1400	−94	265	171
9	10,009	9750	1555	1400	155	-	155
10	10,156	9816	1393	1400	−7	153	146
11	11,068	10,188	1561	1400	161	266	427
12	9987	10,122	1444	1400	44	458	502
13	10,458	10,776	1338	1400	−62	-	−62
14	11,449	9804	1593	1400	193	-	193
15	11,192	9780	1413	1400	13	378	391
16	11,005	10,104	1491	1400	91	399	490
17	11,468	9936	1368	1400	−32	352	320
18	10,073	9810	1419	1400	19	308	327
19	10,009	10,596	1439	1400	39	-	39
20	11,034	10,512	1320	1400	−80	426	346
21	10,766	10,188	1465	1400	65	381	446
22	10,765	10,122	1516	1400	116	243	359
23	11,472	10,140	1457	1400	57	-	57
24	10,508	9984	1534	1400	134	428	562
25	10,867	9732	1357	1400	−43	425	382
26	10,004	10,614	1475	1400	75	257	332
27	10,265	9762	1339	1400	−61	-	−61
28	11,016	10,416	1412	1400	12	-	12
29	10,129	10,308	1436	1400	36	250	286
30	10,837	10,242	1507	1400	107	-	107

* ANIH = Average Net Income per Household; MFEH = Monthly Food Expenses per Household; MVEH = Monthly Vegetable expenses per Household; IIH = Initial investment per Home Garden; SFPI = Savings from production after Investment; ISSL = Income from Surplus Sales in Local Market; and CIHI = Contribution or improvement to Household income. Household income calculations are based on a family size of six people. Amounts are in Mexican pesos (MXN).

Furthermore, the practice of selling surplus produce strengthened local market participation, fostering stronger connections within the local economy. This dynamic reinforced community ties, as households became active contributors to the local food system. It also promoted sustainability through localized food production, reducing dependency on external food sources and encouraging circular economies within the community [2,55]. The economic benefits, combined with improved food security, highlight the holistic impact of home gardens on both household and community well-being, as shown in Table 3.

Crop diversity was also noted as a key factor, with households cultivating a variety of fruits (Table 4), vegetables, and medicinal plants. This diversity not only improved household nutrition but also reduced reliance on external food sources, further contributing to food security [38,41]. The inclusion of medicinal plants such as plants such as Blackberry herb (*Solanum nigrescens*) and Acuyo or hierba santa (*Piper auritum*) was particularly

important, as it allowed families to access natural remedies, which could in turn reduce healthcare costs and enhance overall well-being [56]. Additionally, the cultivation of a wide range of crops such as staple grains like corn (*Zea mays*) and beans (*Phaseolus* spp.) provides resilience against seasonal changes and climate variability, ensuring that households have a consistent food supply throughout the year. This diversity also fostered the preservation of local plant species such as sweet potato (*Ipomea batata*), cassava (*Manihot esculenta*), and chayote (*Sechium edule*) and agricultural knowledge, further promoting sustainable agricultural practices within the community.

Table 4. Identified crops at the community level for home gardens.

Category	Common Name	Scientific Name	Plant Number
Fruit trees	Citrus fruits (sweet lemon and sweet orange)	*Citrus* spp.	+++
	Citrus (sour orange)	*Citrus* sp.	++
	Mango	*Mangifera indica*	++
	Jinicuil	*Inga jinicuil*	++
	Guava	*Psidium guajava*	++
	Papaya	*Carica papaya*	+
	Soursop	*Annona muricata*	+
	Mamey	*Pouteria sapota*	+
	Anona	*Annona reticulata*	+
	Tamarind	*Tamarindus indica*	+
	Mexican avocado	*Persea* sp.	++
	Plum	*Spondia*	++
	Carambola	*Averrhoa carambola*	+
	Lychee	*Litchi chinensis*	+
	Pink Poma	*Syzygium jambos*	+
	White cocoa	*Theobroma bicolor*	+
	Cocoa	*Theobroma cacao*	+
	Purple plantain	*acuminata/balbisiana*	+
	Annatto	*Bixa orellana*	+
	Coffee	*Coffea arabica* *Coffea robusta*	+
	Posole leaf	*Calathea lutea*	+
	Jicara	*Crescentia cujete*	+
	Chikal	*Lagenaria siceraria*	+
Plants (edible or medicinal)	Blackberry herb	*Solanum nigrescens*	++
	Fitolaca	*Phytolacca icosandra*	+
	Smells at night	*Cestrum nocturnum*	+
	Quintonil, white quelite	*Amaranthus hybridus*	++
	Quelite de venado	*Ipomea* sp.	+
	Chipil or Chepil	*Crotalaria* sp.	++
	Purslane	*Portulaca oleracea*	+
	Chayote	*Sechium edule*	+
	Pumpkin	*Cucurbita moschata*	+
	Passion fruit or Palau	*Passiflora edulis*	+
	Watermelon	*Citrullus lanatus*	+
	Coconut	*Cocos nucifera*	+
	Tepejilote	*Chameadora tepijilote*	+
	Huasmole, Huele mole	*Renealmia alpinia*	+
	Nopal tres lobos or pitaya	*Hylocereus undatus*	+
	Tomato	*Solanum lycopersicon*	+
	Guaje	*Luecaena esculenta*	+
	Acuyo or hierba santa	*Piper auritum*	+
	Mint or spearmint	*Mentha viridis*	+
	Oregano orejón or vaporub plant	*Ocinum* sp.	++
	Chile	*Capsicum annuum*	+
	Chives	*Allium* sp.	+
	Epazote	*Dysphania ambrosioides*	+
	Basil	*Ocimum basilicum*	+
	Cilantro de monte or bull's coriander	*Eryngium foetidum*	+
	Cinnamon	*Cinnamomum verum*	+
	Coriander	*Coriandrum sativum*	+
Grains	Corn	*Zea mays*	+++
	Beans	*Phaseolus coccineus* *Phaseolus vulgaris*	+++
Roots	Malanga	*Colocasia esculenta*	++
	Sweet potato	*Ipomea batata*	++
	Cassava	*Manihot esculenta*	++
	Jicama	*Pachyrhizus erosus*	+

(+++) more than 20 plants per home garden, (++) between 6 and 19 plants per home garden, (+) one to 5 plants per home garden.

3.3. Role of Women in Agricultural Management and Decision-Making

The implementation model (Figure 2) was particularly effective in transforming the role of women within agricultural management. Prior to the initiative, women had limited involvement in agricultural decision-making, as these roles were typically reserved for men [52–54]. However, through the model's inclusive planning and training efforts, women became more actively involved in selecting crops, organizing garden maintenance, and managing finances related to surplus produce sales [18,52,57].

A notable shift in women's roles and perceptions was observed when comparing the initial perceptions in Table 1 to the final results in Table 5. Initially, Table 1 showed that 38.10% of 21 women rated their involvement in agricultural decision-making as "Bad" or "Very Bad", while only 33.33% viewed their participation as "Good" or "Very Good". However, after the implementation, Table 5 reveals a marked improvement: the percentage of women rating their involvement as "Bad and Very Bad" dropped to 4.76%, while those rating it as "Regular" increased to 38.10%. Notably, 57.14% of women now rated their involvement in agricultural management as "Good" or "Very Good", highlighting the success in empowering women.

Table 5. Final perception of home gardens based on gender.

Gender of the Beneficiary	Final Perception	Counts	Percentage of Total (%)
Female (21)	Bad	1	4.76
	Regular	8	38.10
	Good	10	47.62
	Very good	2	9.52
Male (9)	Bad	0	0
	Regular	1	11.11
	Good	3	33.33
	Very good	5	55.56

This shift in gender roles and increased engagement in decision-making contributed significantly to the women's sense of empowerment and their ability to lead agricultural initiatives, not only within the household but also at the community level [12]. The improved perception of women regarding their roles in home gardens demonstrates the model's effectiveness in fostering inclusive agricultural management and leadership.

Beyond the household, women also became more engaged in community meetings where key agricultural and development decisions were made. The model emphasized the importance of women's participation in these forums, ensuring that they had the opportunity to voice their opinions and contribute to collective decision-making processes [57]. As a result, women began to take on more visible leadership roles within the community, influencing broader agricultural policies and community planning efforts. Their involvement in these meetings not only expanded their influence but also strengthened community cohesion by ensuring that a wider range of perspectives was considered in the decision-making process as mentioned in similar studies related to gender [18,54].

This increased participation allowed women to advocate for resources, training, and support that aligned with their families' needs, particularly in terms of food security and sustainable agricultural practices. The ability to speak in community assemblies and influence agricultural policies is a critical step toward gender equity in the community. Furthermore, this engagement contributed to a more inclusive and resilient community structure, where women's contributions were recognized as vital to both the economic and social development of the community [12,45,52,58].

3.4. Preservation of Traditional Agricultural Knowledge

The initiative played a crucial role in preserving and transmitting traditional agricultural knowledge, particularly through the active participation of elder community members. One key practice passed down was seed saving. Elders shared techniques for selecting,

storing, and maintaining seeds from one season to the next, ensuring the availability of resilient, locally adapted varieties. This practice reduced dependence on external seed sources and contributed to maintaining biodiversity within the home gardens [59,60].

The involvement of both men and women in these seed recovery efforts was significant, as illustrated in Figure 5, which shows the participation of male and female household members in the recovery of local seeds and plants. The figure highlights that women played a crucial role in ensuring the continuity of these practices. This collaborative effort between genders emphasizes the collective responsibility to preserve biodiversity and maintain the resilience of home gardens.



Figure 5. Involvement of males and females in recovery of local seeds.

Women were particularly essential in integrating traditional seed-saving practices into modern agricultural activities, facilitating the transmission of knowledge to younger generations. This intergenerational transfer of knowledge not only helped to maintain the genetic diversity of crops but also contributed to the long-term ecological resilience of the community's agricultural systems [15,61,62]. Through their active participation, women helped safeguard both the cultural heritage and environmental sustainability of their home gardens.

Moreover, the involvement of women in this process was essential. Women played a key role in ensuring that seed-saving traditions were integrated into modern agricultural practices and shared with younger generations, thereby contributing to both the cultural sustainability of the community and the ecological resilience of the home gardens.

Another significant contribution was the knowledge of organic pest control methods [63–65]. Elders passed down techniques to younger generations on how to use natural ingredients like herbs in biocompounds and companion planting to manage pests without relying on chemical pesticides. These organic practices promoted ecological balance and soil health in the home gardens, while also reducing costs for families by eliminating the need for expensive chemical treatments.

The use of biocompounds in home gardens, classified by the gender of the person responsible within the household, highlights the notable involvement of women in adopting and applying these organic methods (Figure 6). The data reveal that a significant proportion of women-led households were responsible for the use of biocompounds, illustrating their central role in implementing sustainable pest control practices. This gender-based analysis reflects how women's participation in agricultural management has expanded beyond traditional roles, contributing directly to the ecological health of the home gardens.

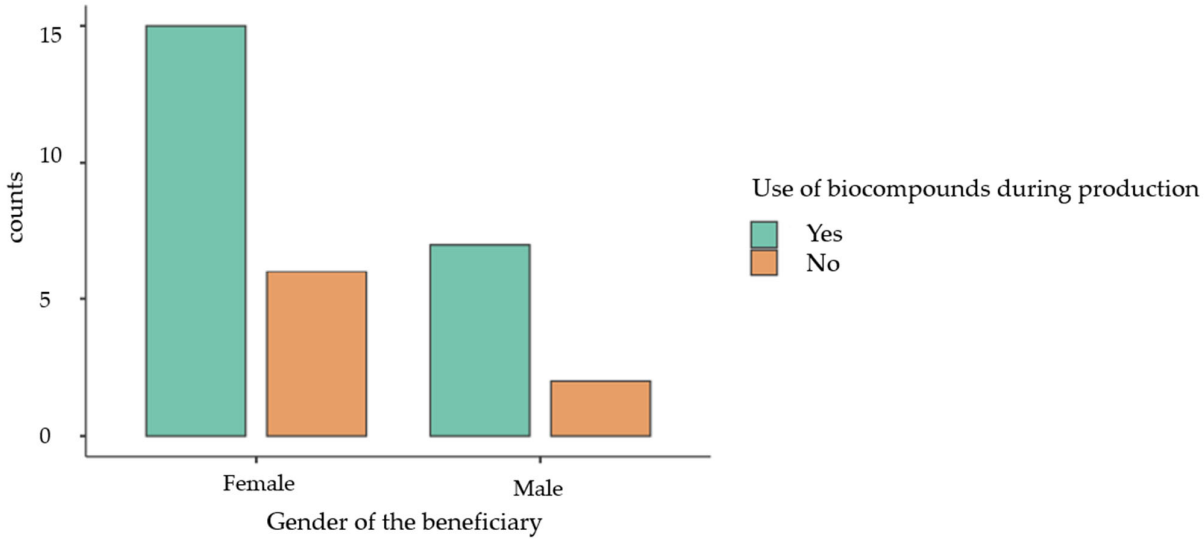


Figure 6. Inclusion of biocompounds in home gardens.

The widespread adoption of biocompounds underscores the importance of these organic methods [63,66,67] in maintaining soil quality and reducing pest infestations (Figure 6). Women, who were primarily responsible for daily garden activities, were integral in ensuring the success of these practices. Their involvement not only strengthened their leadership in agricultural decision-making but also fostered a more sustainable and cost-effective approach to pest management within the community [52,58].

3.5. Crowdfunding Experiment and Community Resilience

The pilot crowdfunding campaign was successful in raising sufficient funds to establish 30 home gardens [24]. It demonstrated that crowdfunding is a viable tool for financing community-led agricultural projects and increasing participation in local initiatives [68]. The community actively contributed both financially and through in-kind support, such as labor for garden construction and maintenance [51]. This collective involvement strengthened a sense of ownership, with the gardens being viewed as a shared community resource rather than individual family assets.

The campaign also fostered collective responsibility and resilience within the community [69]. Working together to raise funds and implement the gardens created trust and solidarity, as the shared goal of improving food security united participants in mutual support and collaboration [70]. By relying on internal resources and reducing dependence on external institutions, the crowdfunding initiative overcame traditional barriers to funding in rural communities [21,71].

Additionally, the campaign raised awareness of food security issues and attracted external supporters interested in sustainable agricultural practices [25,68]. This external involvement expanded the community's network and brought new resources, fostering connections with organizations interested in food sovereignty and sustainability [72].

Managing the funds and implementing the gardens promoted transparency and strengthened social bonds, as community members worked side-by-side, sharing knowledge and troubleshooting challenges. The success of this initiative not only improved food security and economic opportunities but also laid the foundation for future collaborative initiatives in the community.

4. Conclusions

This study demonstrates that home gardens play a critical role in enhancing food security, economic stability, and the preservation of traditional agricultural knowledge in rural Oaxaca. By integrating community-driven initiatives with modern crowdfunding mechanisms, the project empowered women to take on more active leadership roles in

agricultural decision-making, thus contributing to sustainable rural development. The increased involvement of women in managing home gardens not only improved household food production but also enhanced their influence on broader agricultural policies within the community, aligning with the objectives of SDG 5 (Gender Equality) by promoting greater inclusivity and equity.

The revitalization of home gardens resulted in notable improvements in household food security, with over 70% of households reporting improved access to fresh and nutritious produce, alongside a 20% reduction in food-related expenditures. Furthermore, the surplus production of crops offered families additional income streams, thus contributing to economic stability and resilience, in support of SDG 1 (No Poverty) and SDG 2 (Zero Hunger). The findings highlight the utility of crowdfunding as an effective financial mechanism for rural communities, enabling them to overcome traditional barriers to funding while fostering social cohesion and collective ownership of agricultural initiatives.

Moreover, the project facilitated the preservation of traditional agricultural practices, such as seed saving and organic pest control, which contributed not only to ecological sustainability but also to the safeguarding of cultural heritage. These practices, alongside the fostering of intergenerational knowledge exchange, reinforced the long-term resilience of home gardens, supporting the objectives of SDG 15 (Life on Land), which emphasizes biodiversity conservation through sustainable land-use practices.

While the study is focused on rural Oaxaca, the results offer valuable lessons with broader international implications. Rural and indigenous communities worldwide face similar challenges, such as food insecurity, environmental degradation, and the marginalization of women in agricultural leadership. The integration of traditional agricultural practices with crowdfunding presents a replicable model for addressing these global challenges. Communities in diverse settings could benefit from applying the strategies demonstrated in this study, making this research relevant not only in Mexico but also on an international scale. By implementing these strategies, communities across the globe can address contemporary socio-economic and environmental challenges while preserving cultural heritage and promoting resilience.

However, this study is not without limitations. Conducted as a pilot project in a geographically isolated and marginalized community, the scope and sample size were constrained, which limits the generalizability of the findings to other regions with differing socio-economic or environmental conditions. Additionally, the relatively short duration of the study limited the ability to assess the long-term sustainability of home gardens. Future research should address these limitations by undertaking larger-scale, longitudinal studies across diverse rural settings, incorporating a broader range of socio-economic and environmental variables to provide a more comprehensive understanding of the role of home gardens in achieving sustainable development goals.

In conclusion, this research highlights the transformative potential of home gardens in promoting food security, empowering women, and supporting sustainable agricultural practices. By leveraging community-driven initiatives and crowdfunding, rural communities worldwide can address contemporary socio-economic and environmental challenges, while preserving cultural heritage and fostering long-term resilience.

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Informed Consent Statement: The consent of the participants was obtained to carry out the study and gather information.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

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Appendix A

Household Survey: Home Gardens and Economic Benefits in Vega del Sol

Section 1: Demographics

1. **How many people live in your household?**
   ☐ 1–2 ☐ 3–5 ☐ 6–8 ☐ +8
2. **What is the gender of the head of the household?**
   ☐ Male ☐ Female
3. **What is the primary source of income for your household?**
   ☐ Agriculture ☐ Wage labor ☐ Business ☐ Remittances ☐ Other
4. **Average monthly household income (MXN):**
   ☐ 0–2000 ☐ 2000–5000 ☐ 5001–10,000 ☐ +10,000

Section 2: Home Garden Use

5. **Do you have a home garden?**
   ☐ Yes ☐ No
6. **How long have you had your home garden?**
   ☐ 0–1 year ☐ 1–3 years ☐ 3–5 years ☐ +5 years
7. **What types of crops do you grow?**
   ☐ Vegetables ☐ Fruits ☐ Medicinal plants ☐ Herbs ☐ Other
8. **What percentage of your food comes from the garden?**
   ☐ 0–25% ☐ 25–50% ☐ 50–75% ☐ +75%

Section 3: Economic Impact

9. **How much do you save on food due to the home garden (MXN/month)?**
   ☐ 0–500 ☐ 500–1000 ☐ 1000–2000 ☐ +2000
10. **Do you sell surplus produce?**
    ☐ Yes ☐ No
11. **If yes, how much additional income do you generate (MXN/month)?**
    ☐ 0–500 ☐ 500–1000 ☐ 1000–2000 ☐ +2000

Section 4: Household Resilience

12. **Has your home garden helped during times of food shortage?**
    ☐ Yes, significantly ☐ Yes, slightly ☐ No
13. **Has the home garden improved your household's financial stability?**
    ☐ Yes ☐ No ☐ Not sure

Figure A1. Format for Structured Household Surveys.

Focus Group Questionnaire: Home Gardens and Community Leadership

Section 1: Demographics

1. **Age:**
   ☐ 18–30 ☐ 31–45 ☐ 46–60 ☐ +60
2. **Gender:**
   ☐ Male ☐ Female
3. **Role in the Community:**
   ☐ Community leader ☐ Home Garden manager ☐ Other (specify) _____

Section 2: Home Gardens and Food Security

4. **How do home gardens contribute to your household's food security?**
5. **To what extent do home gardens reduce your household's need to buy food?**
   ☐ Very Bad ☐ Bad ☐ Regular ☐ Good ☐ Very Good
6. **How would you rate the impact of home gardens on the quality of food (e.g., diversity, freshness)?**
   ☐ Very Bad ☐ Bad ☐ Regular ☐ Good ☐ Very Good

Section 3: Economic Impact of Home Gardens

7. **Have you been able to sell surplus produce from your garden?**
   ☐ Yes ☐ No
8. **If yes, how much income do you generate from surplus sales in a typical growing cycle?**
9. **How would you rate the overall economic benefit of your home garden?**
   ☐ Very Bad ☐ Bad ☐ Regular ☐ Good ☐ Very Good

Section 4: Leadership and Decision-Making

10. **Has your role in managing a home garden increased your participation in household decision-making?**
    ☐ Yes ☐ No ☐ Not Sure
11. **How would you rate the involvement of women in agricultural decision-making within your community?**
    ☐ Very Bad ☐ Bad ☐ Regular ☐ Good ☐ Very Good

Section 5: Crowdfunding and Community Initiatives

12. **Are you familiar with crowdfunding as a tool to support agricultural projects?**
    ☐ Yes ☐ No
13. **How would you rate crowdfunding's potential to expand home garden initiatives in your community?**
    ☐ Very Bad ☐ Bad ☐ Regular ☐ Good ☐ Very Good

Figure A2. Questionnaire Format for Semi-Structured Focus Groups.

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