# Homegarden Variation and Medicinal Plant Sharing among the Q'eqchi' Maya of Guatemala

AMANDA M. THIEL[1], AND
MARSHA B. QUINLAN[1]
[1] Department of Anthropology, Washington State University, Pullman, WA, USA
*Corresponding author; e-mail: mquinlan@wsu.edu

Q'eqchi' Maya villagers in Alta Verapaz, Guatemala, grow informal homegardens alongside field–based horticultural subsistence activities. Villagers cultivate 200 + homegarden plants that serve many functions including provisioning food and medicine. Semi–structured "plant walk" interviews with 31 informants and follow–up interviews with nine villagers informed on the presence of cultivated medicinal plants and residents' knowledge of plant names and uses. This research analyzes garden ethnobotanical data ethnographically to understand factors differentiating local herbal remedy availability and use. Hypotheses test medicinal plant presence in dooryard gardens in relation to socio–demographic and acculturation variables. Results show a high degree of intra–village sharing and variation in medicinal plant cultivation. Significant predictors of medicinal plants in homegardens are (1) distance from the main road ($p = 0.012$) and (2) presence of paid work within the home ($p = 0.002$) as opposed to paid work outside the home (wage labor). Home medicinal plant cultivation reflects Maya cultural esteem for collectivism (sharing) and site–specific ecological fit. By cultivating a variety of medicinal plants and sharing with kin and neighbors, villagers treat local illnesses in ecologically and culturally advantageous ways.

Los maya q'eqchi' de una aldea de Alta Verapaz, Guatemala, cultivan y manejan huertos familiares informales (con más de 200 plantas) junto con actividades agrícolas de subsistencia. Las entrevistas semiestructuradas—con 31 informantes en base a "caminatas botánicas" en los huertos, más nueve sin caminatas—reportaron la presencia de plantas medicinales cultivadas y el conocimiento sobre los nombres locales y usos específicos de las plantas. Este estudio analiza los datos etnobotánicos de los huertos para entender los factores que diferencian la disponibilidad y el uso de plantas medicinales locales. Se pone a prueba la hipótesis de que la presencia de plantas medicinales en huertos familiares se correlacionará con variables sociodemográficas y de aculturación. Los resultados indican un alto grado de intercambio de plantas medicinales dentro de la aldea y mucha variación en el cultivo de las mismas. Los predictores significativos de plantas medicinales en los huertos familiares son (1) la distancia del huerto familiar a la carretera principal ($p = 0.012$) y (2) la presencia de trabajo remunerado dentro del hogar ($p = 0.002$) en lugar de trabajo remunerado fuera del hogar (trabajo asalariado). En general, el cultivo casero de plantas medicinales refleja conceptos culturales mayas de colectivismo (el intercambio) y adecuaciones ecológicas específicas al sitio. Al cultivar una gran variedad de plantas medicinales y al compartirlas con vecinos y familiares, los aldeanos contribuyen a sus necesidades de salud de maneras ecológica y culturalmente adecuadas.

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## Introduction

Mayan homegardens, like most home or door–yard gardens, are multifunctional repositories of biocultural resources and heritage (Brownrigg 1985; Eyzaguirre and Linares 2004; Kumar and Nair 2006; Mariaca Méndez 2012). With disproportionate poverty and scanty local infrastructure, including a lack of rural modern medical services (Cosminsky 2016; CIA—World Factbook 2016), homegardening medicinal plants is crucial and botanical remedies are often the first line of defense in treating common illnesses (Adams and Hawkins 2007; Weller et al. 1997). Here, we contend that by cultivating a large variety of medicinal plants and by sharing with neighbors, family, and friends, Guatemalan Q'eqchi' Maya villagers of Santa Lucía contribute to their home healthcare needs in ecologically and culturally responsive ways. We further argue that homegarden medicinal plant cultivation reflects Maya cultural values of reciprocity and sharing and site–specific ecological fit.

Cultural and environmental changes from sociopolitical marginalization and globalization affect rural Guatemalans' ethnobotany and natural resource use patterns. The 1980s political–military regime's genocide and devaluation of indigenous cultural identity and practices (Comerford 1996) escalated Guatemala's trend toward Ladino–ization (loss of indigenous languages and lifeways) (Wilkinson 2004; Wilson 1995) that likely impacts healthcare today. Villagers report feeling a general loss of medical ethnobotanical knowledge—a concern echoed elsewhere in the region (Barrett 1995; Cosminsky 2016). Biomedicine's growing dominance further diminishes traditional healthcare (Cosminsky 2016). Yet, financial hardship, inaccessibility, and dissonance in cultural acceptability limit rural Guatemalans' biomedical options, even as nationwide biomedicine use ascends (Adams and Hawkins 2007; Cosminsky 2016). Home remedies remain the first treatment choice in healthcare practice (pers. obs.; Weller et al. 1997). How rural, indigenous Guatemalans care for their health with accessible local resources (e.g., homegarden medicinals) that they value as pharmacologically active may influence public health in Guatemala and abroad (Caceres 1996; Michel et al. 2007). Understanding the context of Maya cultivation and medicinal plant uses is necessary for cultural revitalization and successful integration of diverse healthcare models as Western biomedicine expands (Adams and Hawkins 2007; Caceres 1996) and local fears of ethnobotanical erosion increase (Cosminsky 2016).

Plant cultivation and ethnobotanical patterns vary across southern Mexico and Central America (Barrett 1995; Hopkins and Stepp 2012; Lope–Alzina 2017). Variables affecting medicinal ethnobotanical patterns include demographic characteristics, which scholars have featured in ethnographic research among various communities. For example, ethnobotanical knowledge/practice relate to gender, age, and status (Browner 1991; Garro 1986; Lozada et al. 2006; Voeks and Leony 2004), with women and elders often preserving medical or ethnobotanical knowledge better than their counterparts. With little exception (see Wyndham 2010), education impacts ethnobotanical knowledge negatively (Heckler 2002; Srithi et al. 2009; Zent 2001), especially in combination with commercial occupations (Furusawa 2009; Quinlan and Quinlan 2007). Proximity to urban centers likewise diminishes ethnobotanical knowledge (Nolan 1998; Ososki et al. 2007; Reyes–Garcia et al. 2013), although conversely, it may increase valuation of traditional plant uses (Wayland 2004) and cultural identity, even across long–distance migrations (Medeiros et al. 2012). Ethnobotanical and ethnomedical knowledge vary widely, showing patterns of intracultural diversity as likely as consensus (Barrett 1995; Garro 1986; Hopkins and Stepp 2012; Quinlan and Quinlan 2007). Understanding patterns of ethnobotanical knowledge variation and sharing, "humanity's most widespread and ancient form of knowledge" (Reyes–Garcia et al. 2007:199)—including the contexts of knowledge situation and application, informs its preservation and revitalization.

## Hypotheses

This research explores possible predictors of Q'eqchi' variability in homegarden medicinal plant cultivation. We predict that homegarden contents reflect the inhabitants' needs, abilities, values, and considerations. Plants with important cultural roles (i.e., subsistence, healthcare) should be more common in homegardens than those without socio–economic functions (Mariaca Méndez 2012; Phillips and Gentry 1993). We expect residents' ages, life–stages, genders, educations, and acculturation levels to predict homegarden contents.

### Hypotheses on the Effects of Socio–Demographics and Acculturation

We test demographic variables for associations with medicinal plant presence in homegardens. Variables are age, members in household, generations in household, education level, presence of nearby extended family, religion, ethnicity, lot size, gender ratio, distance from the road, occupation, and material acculturation (two composite variables of electronics and other household goods). We selected variables to compare patterns here with findings among communities in similar and different geographical regions, per Reyes–Garcia et al. (2007), who called for comparative studies of ethnobotanical knowledge.

We consider education, religion, and lot size as independent variables, recognizing that they also reflect acculturation—e.g., more education requires more time away from home; evangelical church membership indicates acculturation, as Catholicism has been traditional for centuries, while evangelism is relatively new to Guatemala (Althoff 2014); and lot size may reflect economic acculturation.

*Hypothesis #1—Number of Household Members Will Correlate with the Number of Homegarden Medicinal Plant Species*

The higher the number of residents, the greater the need for a wide array of medicinal plants to treat conditions particular to individuals. Village household size varies between two and ten, averaging seven people. We expect that the more people in residence, the greater the household's need for a range of medicinal plant species.

*Hypothesis #2— Homegardens for Older Individuals' Families Will Contain More Medicinal Plants Than Homegardens with Younger Individuals In Residence*

With increased age and life experience, older villagers have had more opportunities to accumulate both knowledge and access to greater species diversity for home cultivation, especially the remedies they use for a range of life–stage medicinal applications (Finerman and Sackett 2003; Garro 1986). While Santa Lucía is modernizing in some respects, we predict that older villagers retain garden species that reflect cultural traditions, including medicinal plant use, more than do families with younger generations in residence.

*Hypothesis #3—Household Members' Age Range (Number of Generations) Will Correlate with the Number of Homegarden Medicinal Plants*

A family with young children may contain homegarden plants with common pediatric uses, and households with older residents may report plants for geriatric conditions (Finerman and Sackett 2003). Thus, the larger the household members' age range, the higher the need for a broad array of medicinal plants to treat age–related illnesses.

*Hypothesis #4—Women Will Report More Medicinal Plants Than Will Men*

Evidence from cross–cultural homegarden literature cites sexual divisions in homegarden care, management, and use (Kumar and Nair 2006; Mariaca Méndez 2012). We predict that women and men will emphasize different botanical use categories according to their respective gender–based roles in labor and social behavior (Wilson 1995; Zarger 2002). We predict that women report more medicinal plants as they are often the primary providers of home medicine and take pride in identifying with this role (Finerman and Sackett 2003; Voeks 2007; Wilson 1995). We predict Santa Lucía men will report more tree species, per observations of men carrying heavy loads of tree products such as firewood or palm thatching. This pattern would support Quinlan et al.'s (2016) findings that Dominican boys learn tree care more thoroughly, and sooner than girls, and Zarger's (2002) findings regarding the sexual division of labor in Belizean Q'eqchi' communities.

### *Hypothesis #5—Furthermost Homegardens from the Main Road (the Franja Transversal del Norte or FTN) Will Have More Medicinal Plants*

The main road (see Study Site) is a mostly paved strip, and the roadside and adjacent community features (churchyard, soccer field, community building, health clinic) are clear of most vegetation. We posit that the clearing effect will continue into villagers' lots. And residents living closer to the road have easier access to village shops and the merchandise that arrives via the main road, which is called Franja Transversal del Norte (FTN). They may thus rely on purchased goods more often than residents living further from the road, the latter of whom may rely more on home–grown plant resources.

### *Hypothesis #6—Homegardeners' Education Level Will Relate Inversely to the Number of Medicinal Plants*

The more years a villager spends in formal education, the more time they spend acquiring knowledge nonspecific to the village's natural surroundings (García 2006; Heckler 2002). Santa Lucía's school ends after middle school. To attend high school, a student must commute to a neighboring village. For specialized training programs and college, students must travel even further. The travel for continued education, plus accruing annual tuition, may detract from investing time and resources at home, including homegarden learning and maintenance.

### *Hypothesis #7—Villagers with a Commercial Occupation Outside the Home Will Have Fewer Medicinal Plants in Their Homegarden*

All villagers grow subsistence crops on plots of land outside the village. Some villagers also work in nearby schools, assist with health clinic activities, or own small shops in which they sell basic household items or foods, candy, and soda. As with education, commercial occupations require time and energy spent away from home and away from investment in homegardens.

### *Hypothesis #8—Consumerism Will Relate Inversely to the Number of Medicinal Plants*

We calculate consumerism as an aggregate score based on possession of purchased material goods: electricity, electronics (i.e., refrigerator, stereo, computer, but *not* nearly ubiquitous cell phones), metal roofs (compared to thatch), and motorcycles. Villagers can only purchase these items outside the village, requiring the financial ability and interest to participate in a broader economy. Villagers with higher consumerism levels may trade traditional practices for new, commercial ones, including leaving behind medicinal plant cultivation in exchange for the purchase of commercial medicines.

## Cultural and Physical Setting

### Q'eqchi'

Q'eqchi' horticulturalists engage in local commerce and cultivate maize subsistence (*milpas*) and dooryard gardens (Grandia 2012; Maass 2005). They express their unique worldview and cultural values through subsistence and conservation activities (Maass 2005). For example, the Q'eqchi' value their relationship with the *tzuul taq'a*, or earth deity, and employ acts of reciprocity to ensure abundant harvests and personal wellbeing (Maass 2005; Wilson 1995). They uphold their values for mutual aid, sharing, and reciprocity by loaning each other corn, beans, coffee, and other items when needed (Centro Ak' Kutan 2007).

Similar to gender–roles across the Maya area (Anderson 2005; Mariaca Méndez 2012; Wilk 1991; Wilson 1995), Santa Lucía men predominantly do agricultural and other work outside the home, while women largely perform domestic tasks (e.g., food preparation, childcare, homegarden cultivation). We noticed that Santa Lucía men monitor homegarden activities and related decisions but are often not available to discuss these issues because of their daily schedule of production commitments outside the home.

## Study Site

We conducted this research in Santa Lucía Lachua—a lowland village in Alta Verapaz, Guatemala—during two field trips in 2016 and 2018. The region has a rainy and dry season, yet rainfall is abundant year–round (2,000 to 3,000 mm annually). The average temperature in the rainy season—the time of this research—is 25–30 °C and reaches 38 °C in the dry season. The limestone soil supports predominantly evergreen tropical rainforest (McKillop 2004) containing many different native palms, orchids, and bromeliads (Standley and Steyermark 1945).

Santa Lucía residents recount that Q'eqchi' Maya families founded the village in 1980 after fleeing conflict elsewhere and "searching for land" during Guatemala's 36–year civil war (pers. obs.; Skidmore and Smith 1992). Today, Santa Lucía is home to 700 people in 100 households. The village is mostly flat with palm–thatched, wooden plank homes in a rectangular grid—a typical layout in post–war Guatemala (Wilson 1995). A handful of homes have corrugated aluminum roofs and cement block foundations. Most households have a well on or near their lot but no running water. About three–quarters of village households have electricity. The village falls within neighboring Lake Lachua National Park's "area of influence" and sometimes receives visiting researchers, biologists, and conservation officials (Maass 2005).

Santa Lucía straddles a paved, two–lane road, the Franja Transversal del Norte (FTN), built across Guatemala's north in 1970 to promote agricultural and petroleum extraction (Solano 2012). While a relatively minor road by U.S. standards, its local impact is like that of a highway. Speedy traffic of trucks and buses carrying oil, crops, and passengers is standard along the FTN.

Santa Lucíans ride crowded minibuses along the FTN to visit nearby communities (for secondary school, larger stores, family, or medical services). Within Santa Lucía, residents walk the grid of dirt lanes to other homes and shops, and take narrow foot–trails to their subsistence gardens. Many younger men ride bicycles around Santa Lucía and to neighboring villages. Nearly 40% of households have motor bikes, which they use like the bicycles.

Surrounding the residential village is a rolling patchwork of *milpas*, traditional maize–prominent slash–and–burn gardens. In addition to subsistence plantings, villagers sometimes cultivate small garden sections for sale (e.g., cardamom, various fruits).

Santa Lucía has a two–room health center where a traveling nurse provides a half–day of immunizations or other services twice monthly. The nearest hospital is 19 km (11.8 mi), a drive of 30–40 min (almost always on a small bus, as residents do not own automobiles). Women generally travel to the hospital to give birth, as midwifery practice has all but disappeared in the village, a growing yet complicated phenomenon across Guatemala (Cosminsky 2016). Although studying lay medicines, our sample included one of Santa Lucía's three *curanderos* (folk healers). Villagers report varying levels of faith in *curanderos*' services.

Homegardens in Santa Lucía are the rectangular parcels of land upon which villagers live. Full lots measure 30 m by 60 m, though some are smaller from being divided. Various Spanish terms (e.g., *huerto*, *huerto familiar*, *traspatio*, *solar*) are typical in regional homegarden literature (Anderson 1996; Mariaca Méndez 2012), but in Santa Lucía, these terms only refer to raised beds for specific vegetables or culinary herbs. The local comprehensive term for households' beds plus their yards where residents pick cultivated and wild herbs, shrub and tree products, and raise domestic animals is *lote* or "lot." There is no corresponding Q'eqchi' term in this community, but Belizean Q'eqchi' use "*chi rix li k'abl*," meaning "around the house" (Zarger, pers. comm., January 2017). In this study, homegarden is synonymous with lot.

Almost all Santa Lucía villagers identify as Q'eqchi' Maya. A few residents have other Maya ethnicities (Kaqchikel, Pokomchi, Mam), and fewer identify as Ladino (Mestizo). Q'eqchi' is the predominant language, even among the few non–Q'eqchi'.

# Methods

Thiel conducted field research for this project in two periods. The initial research, during six weeks between June and August 2016, explored homegarden content and diversity. She conducted follow–up research during three weeks of June 2018 to explore ethnomedicine, the nature and extent of homegarden plant sharing, and to collect botanical vouchers.

These data come from a lengthy permission–seeking process, participant–observation, informal/unstructured interviews, semi–structured key–informant interviews, plant–walk interviews, voucher specimen and identification, and multiple regression analysis. Altogether, we include data from 40 individuals' interviews (11 men and 29 women between the ages of 20 and 70), with statistical analysis on a sample of 31.

### Informed Consent

Washington State University's Institutional Review Board approved this research prior to conducting fieldwork. We followed the Code of Ethics of both the International Society of Ethnobiology (2006) and the Society for Latin American Ethnobiology (SOLAE 2015). We also followed local Q'eqchi' customs and obtained permission for our research from the village's governing council (*Consejo Comunitario de Desarollo)*, a process which Medinaceli (2018) discusses further. We obtained free, prior, and informed consent for each interview.

### Participant Observation and Informal Interviewing

Per anthropological tradition, our initial and ongoing methods included participant–observation (Bernard 2006) to achieve contextual understanding of Q'eqchi' life ways. We continued participant–observation through the duration of two field seasons (about nine weeks total in the village). Opportunities for participant–observation in ethnobotanical activities and conversations abound in this subsistence gardening community and provide a likely outlet for informal, conversational interviewing; for example, while visiting with residents Thiel asked about their gardens. She asked about planting procedures and certain plants' names and uses. She helped villagers with ethnobotanical chores like garden work as well as peeling and other food processing. As Thiel learned more about local plants and medicine through general discussions, she began to focus informal questions to prepare questions for ethnomedical interviews (details below).

### Plant Walk and Semi–Structured Interviews

Forty–one adult Santa Lucía residents (11 men and 30 women) participated in this research. Of the 41 interviews, we omitted one interview from analysis for reliability concerns, as the person (man) was not answering independently. We conducted two types of interviews: plant walks to discuss homegarden plants and related details, and ethnomedical interviews to probe villagers' ethnobiological remedies for local illnesses. We conducted 31 of the 40 total interviews in Spanish; the remaining nine were in Q'eqchi' with a local translator's assistance. The skewed sex ratio of our sample is due to availability. Most Santa Lucían men spend daylight hours working in their fields or wage labor, while women work in or near the home and are hence far more available for interviews.

Thirty–one villagers who reside in 26 homegarden–households participated in plant walk interviews (Martin 2004; Michel et al. 2007; Quinlan et al. 2016) to identify homegarden species. We selected household participants for plant walks via stratified convenience sampling (Bernard 2006) according to the distance and direction (north or south) of the lot from the main road that runs east to west, as well as by whether homegarden residents were willing to participate. The sampled homegardens represent 26% of Santa Lucía's 100 village homegardens. Plant walks lasted between a half hour and two hours, depending on the size and complexity of the garden and the interest level of the interviewee. Plant walks involved walking throughout an informant's lot, the informant or Thiel pointing to a plant, and the informant identifying it with its local Spanish, Q'eqchi', and any other name for each plant. For each plant identified via the plant walk, we asked of its local uses and probed for details regarding specific situations for use, parts, amounts, and preparations. We also obtained demographic information, GPS coordinates, pace–estimates of distance from the lot to the main road, and plant–sourcing for plants mentioned but not present.

The remaining nine participants contributed to semi–structured interviews about local illnesses, related treatments, and plant–sourcing. These interviews lasted between 20 and 90 min, depending on the interviewee's responses, depth of knowledge, and interest level.

### Data Analysis

Principally, we analyzed our homegarden interview data using multiple regression. Specifically, we used a Poisson, or log–linear model to examine the best predictors of the presence of medicinal plants because the total dependent variable count is relatively low. Log–linear models are apt for analyzing nominal/ordinal level data, such as ours. We bootstrapped the model to increase confidence in the p–values. All data were analyzed using the software STATA 13.1 (Glantz and Slinker 2001; Rose and Sullivan 1993).

Additionally, we analyzed interviews for reference to medicinal plant knowledge and use, especially in regard to variation, sourcing, and sharing of medicinal plants. We report on these qualitative findings to provide context and comparison with our quantitative analyses.

### Botanical Vouchers

During the 2018 research, key informants (plant walk interviewees who were especially knowledgeable and interested) helped us find botanical voucher specimens of the 100 most common species mentioned in interviews. We collected specimens on–site, noting growing conditions, growth habit, and ethnobotanical uses. We deposited vouchers in the University of San Carlos herbarium in Guatemala City. The herbarium director, Lic. Mario Véliz, assisted in voucher identification. The National Council for Protected Areas of Guatemala granted permission for voucher collection.

## Results

### General Findings

Table 1 summarizes our sample and data.

During plant walks, informants mentioned 209 useful ethnospecies, or locally distinguished plants (see Berlin 1973 or Hunn 1975). Of those 209 plants, informants reported 67 (32%) as having medicinal uses (what we herein call medicinal plants), sometimes in addition to culinary or

**Table 1.** Descriptive Statistics of the Homegarden Sample (n = 31 individuals in 26 households)

| Variable | Mean | Median | Minimum | Maximum | SD |
|---|---|---|---|---|---|
| $N_i$ Medicinal plants per garden | 4.0 | 3 | 0 | 12 | 3.5 |
| $N_i$ Illnesses treated per garden | 4.07 | 3 | 0 | 11 | 3.3 |
| Meters from garden to road | 210.96 | 88.2 | 0 | 742.5 | 254 |
| Age | 35.2 | 32.5 | 20 | 70 | 12.6 |
| Schooling | 4.2 | 3 | 0 | 4 | 1.5 |
| Consumer goods | 2.4 | 2 | 0 | 5 | 1.6 |
| Generations per household | 2.4 | 2 | 1 | 4 | .85 |
| Members per household | 5.3 | 5 | 1 | 14 | 2.6 |
| | **Proportion** | 1 | 0 | | |
| Household sex ratio | .69♀, .19♂,.12 = | ♀ bias (18) | ♂ bias (5) | ♀ = ♂ (3) | |
| Household ethnicity | .73: .23: .04 | Q'eqchi' (19) | Other Maya (6) | Ladino (1) | |
| Wages from outside home | .73 | Yes (19) | No (7) | | |
| At–home job | .538 | Yes (14) | No (12) | | |
| Household screens | .12: .42: .46 | PC + TV (3) | PC *or* TV (11) | Neither (12) | |
| Lot size | .846 | Full lot (22) | Partial lot (4) | | |
| Religion | .462 | Catholic (12) | Evangelical (14) | | |

other uses (details on the overlap of these categories below). A full list of ethnospecies and corresponding Latin names, where determined, appears in Electronic Supplementary Material (ESM) 1. Table 2 contains the 11 most frequently identified medicinal plants (plants with at least one medicinal use), which we discuss in detail elsewhere (Thiel and Quinlan 2020).

Santa Lucía villagers use plants for various and overlapping purposes. For example, they consume *Citrus aurantium* L., *Citrus latifolia* Tan., *Psidium guajava* L., *Persea americana* Mill., and *Mangifera indica* L. fruits, and also use various parts of these plants for medicine (Thiel and Quinlan 2020). Villagers in 20 homegardens mention using avocado *(Persea americana)* as a food, but in four homegardens, villagers also report using it medicinally. Villagers in 16 homegardens report *Hibiscus rosa–sinensis* L. as an ornamental and as a fence delimiting the boundary between lots. However, three homegarden residents also mention it as a medicinal plant. On the other hand, Santa Lucía villagers use some plants exclusively as medicine: *Ruta chalepensis* L., *Opuntia cochinellifera* (L.) Mill, *Moringa oleifera* Lam., and *Cymbopogon winterianus* Jowitt ex Bor.

## Predictors of Medicinal Plants in Homegardens

To test hypotheses regarding predictors (see Table 1) of medicinal plant cultivation in Santa Lucía homegardens, we used a bootstrapped Poisson model in STATA 13.1 to analyze several demographic and acculturation variables. We used multiple regression on two to three variables (listed in Table 1) at a time to parse out the relationship among independent variables and the dependent variable. We performed exploratory analyses on two potential predictors (religion, ethnicity), which showed no significant effects; thus, we omitted them from discussion. Table 3 summarizes significant predictors. We then report on the results for each hypothesis.

The variables that proved significant in predicting the presence (or recognition) of medicinal plants in the bootstrapped model are the following: (1) work performed within the home and (2) distance from the road (see Table 3). In the original Poisson model, household members' age range is statistically significant in isolation but cannot be reliably added as a variable to the model due to small sample size and bivariate correlation between the number of household members and age range (see ESM 2 for bivariate correlations). We elaborate on this variable further in the Discussion.

### *Hypothesis #1—Number of Household Members Will Correlate with the Number of Medicinal Plants*

Data do not support this hypothesis, as the p–value is not statistically significant. Larger households do not have larger gardens.

### *Hypothesis #2— Homegardens for Older Individuals' Families Will Contain More Medicinal Plants Than Homegardens with Younger Individuals In Residence*

Data do not support hypothesis 2, as there is no statistical correlation between household members' age and the number of medicinal plants. Juana, the oldest informant (70 years old), mentioned just one medicinal plant. The two families with adults in their late 20 s to mid 30 s reported most medicinal plants in their homegardens.

### *Hypothesis #3—The Household Members' Age Range (Number of Generations) Will Correlate with the Number of Medicinal Plants*

The household members' age range—measured in the number of generations from one to four (under 18, 18–39, 40–55, older than 55 years)—does not correlate with the number of medicinal plants in the bootstrapped model. It does, however, correlate with the number of medicinal plants in the original Poisson model, but not in ways we expected. The two homegardens in which informants reported most medicinal plants ($>10$ species) are home to families with two generations and, overall, the two–generation families are those that report the most medicinal plants. Four–generation families—while expected to have the most medicinal plants due to a need for diverse medicinal treatments according to their residents' multiple life stages—have fewer medicinal plants than both two– and three–generation homes.

**Table 2.** The 11 most frequently mentioned medicinal plants and their uses, listed according to number of mentions as medicinal

| Latin name and family | Spanish name | Q'eqchi' name | English name | Growth habit | Plant part used medicinally | Illnesses treated locally | Number of homegardens in which reported as medicinal | Number of homegardens in which present | Voucher ID |
|---|---|---|---|---|---|---|---|---|---|
| *Citrus x aurantium* L., Rutaceae | naranja | chiin | bitter orange | tree | leaves | headache, stomachache, intestinal cramps, high blood pressure, vomiting, diarrhea, cough, fever | 7 | 14 | AT087/ 81,314 |
| *Ruta chalepensis* L., Rutaceae | ruda | ruda | rue | herb | aerial parts | *mal ojo*, vomiting, weepiness, for children's complaints | 5 | 5 | AT105/81606 |
| *Citrus latifolia* Yu. Tanaka, Rutacaeae | limón/ limón persa | lamunx/ lamux q'en | Persian lime | tree | leaves | fever, sore throat, cough, heart problems | 4 | 8 | AT017/79009 |
| *Mangifera indica* L., Anacardiaceae | mango | mank | mango | tree | leaves, bark | fever, kidney pain, unknown | 4 | 13 | AT013/ 78,924 |
| *Persea americana* Mill., Lauraceae | aguacate | oh/ó | avocado | tree | leaves, bark, pit | diarrhea, ulcers, skin problems, *mal ojo*, body pain, stomachache | 4 | 20 | AT001/78992 |

**Table 2.** (continued)

| Latin name and family | Spanish name | Q'eqchi' name | English name | Growth habit | Plant part used medicinally | Illnesses treated locally | Number of homegardens in which reported as medicinal | Number of homegardens in which present | Voucher ID |
|---|---|---|---|---|---|---|---|---|---|
| *Psidium guajava* L., Myrtaceae | guayaba | pata | guava | tree | leaves, bark | bites, stomachache, amoebas | 3 | 9 | AT025/79053 |
| *Opuntia cochinellifera* (L.) Mill, Cactaceae | nopal | persham | prickly pear | shrub | leaves | gastritis, diabetes | 3 | 3 | AT030/80924 |
| *Neurolaena lobata* (L.) R.Br. ex Cass, Asteraceae | tres punta | k'a mank | — | herb | leaves | *mal ojo*, fever, headache, stomachache, diabetes, gastritis | 3 | 4 | AT109/81406 |
| *Moringa oleifera* Lam., Moringaceae | moringa | — | moringa | tree | leaves | "for 300 illnesses", diabetes, nerves, gastritis, kidney infection, cancer | 3 | 3 | AT060/81194 |
| *Hibiscus rosa–sinensis* L., Malvaceae | clavel | clavel/ uutz'uuj | hibiscus | shrub | flowers, leaves, leaf buds | gastritis, ulcer, rashes, fever, swelling | 3 | 16 | AT104/ 81,436 |
| *Cymbopogon winterianus* Jowitt ex Bor, Poaceae | té de limón | — | lemon–grass | herb | aerial parts | cough, fever | 3 | 3 | AT044/80934 |

**TABLE 3.** BOOTSTRAPPED POISSON MODEL SHOWING EFFECTS OF SIGNIFICANT PREDICTORS ON NUMBER OF MEDICINAL PLANTS

| Variable | Coefficients | Standard error | P–value |
|---|---|---|---|
| (Constant) | –0.1768537 | 0.5651936 | 0.754 |
| Distance | 0.0012773 | 0.005076 | 0.012 |
| Work within the home | 0.8785233 | 0.2782722 | 0.002 |

Dependent variable: medicinal plants listed. Adjusted Pseudo R2 = 0.2665, N = 26

### *Hypothesis #4—Women Will Report More Medicinal Plants Than Will Men*

Confirmation of this hypothesis is tentative. A low sample size of informants in plant walks (males [n = 8], women [n = 23]) prohibits statistical analysis of this variable, so we rely on a qualitative assessment based on lists of plants mentioned. Women reported 49 medicinal plant species and men reported 35. Both men and women listed 18 plants in common, men listed 17 plants that women did not mention, and women listed 32 plants that men did not mention. Clearly, there is some divergence in the number of plants each sex mentioned. Overall, women tended to list more medicinal uses for fruit trees, and men listed more medicinal uses for other, non–fruiting tree species, although women reported more medicinal species overall. However, this result remains speculative, given sample size limitations.

### *Hypothesis #5—Furthermost Homegardens from the Main Road (the Franja Transversal del Norte or FTN) Will Have More Medicinal Plants*

Distance from the main road is a significant predictor of the presence of medicinal plants, but not in the expected, linear fashion. In Fig. 1, distance assumes a loosely quadratic fit with the number of medicinal plants so that homegardens in the 300–600 step range (approximately halfway to the village outskirts) from the FTN have the greatest number of medicinal plants. The number declines with increased distance.

### *Hypothesis #6—Homegardeners' Education Level Will Relate Inversely to the Number of Medicinal Plants*

Education level has no statistically significant correlation with the number of medicinal plants reported in Santa Lucía homegardens. However, there may not be enough range to show a pattern in medicinal plants listed based on education level, especially because of the female–skewed sample (which would show little variability since women typically do not surpass primary school).

### *Hypothesis #7—Villagers with a Commercial Occupation Outside the Home Will Have Fewer Medicinal Plants in Their Homegarden*

While villagers with a commercial occupation outside of the home do not have fewer medicinal

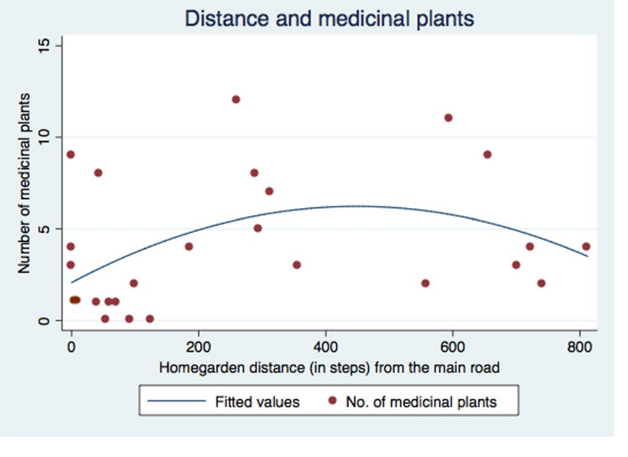


**Fig. 1.** The relationship between distance from the main road and the number of medicinal plants. (Note: there are two points at (x = 0, y = 1).)

plants in their homegardens, a reciprocal relationship holds. The six homegardens with the highest number of medicinal plants are all home to at least one household member who works for money *within* the home. This work includes running a maize grinder, owning a small shop, cheesemaking, selling fruit from one's trees, making and selling tortillas or tamales, and *curandero* (healing) services. Work *within* the home significantly predicts the number of medicinal plants.

### *Hypothesis #8—Consumerism Will Relate Inversely to the Number of Medicinal Plants*

As with education, consumerism (i.e., having electricity, a metal roof, a TV, a computer, or a motorcycle) has no statistically significant correlation with the number of medicinal plants reported in Santa Lucía homegardens.

### Variation and Sharing

Villagers identified 209 ethnospecies in homegardens; 67 of which they use medicinally. There was a large range in informants' mention of medicinal plants: three or more informants (10%) mentioned only 11 species (5.3%) as medicinal. On the other hand, two informants mentioned 56 species as medicinal. There appears to be significant variation in the cultivation of homegarden medicinal plants.

In addition to growing medicinal plants personally, villagers source medicinal plants from others' gardens. Seven villagers mention using plants they grow in combination with plants that grow in others' lots. For example, Juan (we use pseudonyms for all informants) identified *Citrus latifolia* leaves, which he grows in his lot, as useful for treating children's *frío* (chills, or a humorally cold condition). He uses these in combination with *Mangifera indica*, *Psidium guajava*, *Byrsonima crassifolia (L.) HBK*, and *Bixa orellana* L. leaves, four cultivated plants that he does not grow in his lot. Similarly, Marisol uses *Citrus aurantium* leaves from her garden as a treatment for high blood pressure, adding equal amounts of *Coffea arabica* L. and *Citrus x paradisi Macfad* leaves, two plants she does not grow.

In ethnomedical interviews, Martina and Juana, two unrelated informants, both reported asking their neighbors for *Cymbopogon winterianus* because they did not grow it themselves; Martina said she could pay for the plant or trade something for it, whereas Juana said her neighbor would gift it if needed. Two additional informants specifically mentioned that neighbors, friends, or family would share medicinal plants with them, either freely, by trade, or with cash. They emphasized the importance of sharing, regardless of financial or other returns, even if they also accepted small reciprocal favors.

## Discussion

### Indicators of Homegarden Medicinal Plants

Statistical analyses show that two variables—*working at home*, and *homegarden's distance from the main road*—significantly affect the number of medicinal plant species that Santa Lucía Q'eqchi' grow at home. Together, these two variables explain 26.65% of the variance in medicinal plant cultivation, which, in social science, indicates a "very promising" to "accurate" predictive model (Quinlan and Quinlan 2007:178). These variables make intuitive sense as we explain below.

First, the presence of a family member with at–home commercial work significantly predicts homegardening more medicinal plants. Residents earning money from home—by operating a maize grinder; harvesting fruit for sale; or making and selling tortillas, popsicles, or beverages—spend considerable time and energy near their homegardens. They can maintain their homegardens during down–times, potentially cultivating more species than if they were spending more time elsewhere working for wages or with kin. Furthermore, residents with at–home work potentially have extra income to invest in their gardens. Or gardening more plant species may reflect the self–motivation and resourcefulness that leads some to earn at home. Quinlan and Quinlan found a comparable result in Dominica that relates "bush" medical expertise to personality traits such as being "careful and exacting" and "leaders in their community" (2007:184). Home entrepreneurship and home medicinal plant cultivation may go hand in hand.

Second, distance from the road significantly predicts homegarden's medicinal abundance.

The Franja Transversal del Norte road transects the village center. Public resources—three small shops, two churches, a (usually unstaffed) health clinic, soccer pitch, community building, and an elementary school sit along the road on cleared lots with little vegetation. Whether by road construction, increased lot age, foot traffic, road pollution, or an aesthetic preference for open space, the business and house lots adjacent to the road remain bare, without local lush, jungle–like vegetation. Vegetation density increases the further one travels from the road.

Interestingly, homegarden medicinal plant content has a quadratic relationship with distance from the main road rather a linear one. The relative absence of vegetation on lots by the main road is apparent at first glance. Gardens' remedy richness in the middle–distance range likely reflects village ecology rather than plants relating to distance from the road, per se. Within this range (300–700 paces) are several lots with natural water from springs, creeks, or ponds. Even in this tropical village, where rain occurs daily throughout much of the year, local flora is more abundant in areas featuring water (residents do not water plants). Thus, medicinal plant species cultivation reflects a site–specific ecological fit: where water is more abundant, so too are plants, medicinal or otherwise. Additionally, three of the six homegardens with the most medicinal plants and the most household members are also lots with the most natural water. Future research should explore the potentially confounding effect of household size on medicinal plant cultivation, as we discuss below.

One variable we tested—the *number of household members* using the homegarden—was significant in the Poisson model but not in the bootstrapped one. Our small sample size or correlation with other variables likely affect this result. The odds of pathogen exposure or someone being sick or injured increases with household size, which would imply increasing household variety or quantity of homegarden medicinals. We suggest further research and a larger sample to clarify this variable's potential role in predicting Santa Lucía's medicinal plants.

Lastly, these data yield equivocal findings about gendered plant use differences in Santa Lucía. Yet, there is tentative support to assert gendered ethnobotanical domains (Mariaca Méndez 2012; Quinlan et al. 2016; Voeks 2007; Wayland 2001), though not always in predictable ways (Browner 1991; Pfeiffer and Butz 2005). Santa Lucía women identify more plants as medicinal and more uses for fruit trees than do men—presumably, they maintain these plants in homegardens. Men identify more non–fruiting tree species than women, reflecting local labor division in which men gather firewood and construction materials and women prepare food. Furthermore, women's medicinal plant reports tend to show consensus, while men have more unique mentions of medicinal plants, like Browner's (1991) findings in an indigenous community in Mexico. The study's small, female–skewing sample limits conclusions on this topic, but tentative observations warrant further research.

## Variation

Quantitative analysis reveals that village ecological characteristics account for some variation in homegardens' presence of medicinal plants. Looking at Fig. 1, there is a clear trend toward more homegarden medicinals growing in the wettest central–distance range between the road and Santa Lucia's outer edges. Therefore, the more variable a community's ecological characteristics, the more variety we expect to see in homegarden plants (medicinal or not). We expect variation to be the norm throughout Mesoamerica, as it is an exceptionally bioculturally diverse region (Azurdia and Leiva 2004; Maffi 2005; Montagnini 2006). Indeed, Santa Lucia's residents offered more unique mentions of medicinal plant species than consensual ones, a pattern of variation that scholars echo throughout the region (Barrett 1995; Hopkins and Stepp 2012; Quinlan and Quinlan 2007).

Other studies have found high variation in the distribution of ethnobotanical knowledge. In the nearby Yucatan peninsula, Hopkins and Stepp find a shared knowledge base, with up to 40–50% idiosyncratic knowledge, such that "a few plant names were shared by many people and numerous plant names are reported by a few people" (2012:253). Among 40 interviewed individuals, 84% of the remedies were only listed once. Barrett (1995:409) found Nicaraguan medicinal plant knowledge to be "dispersed widely, although unevenly" across ethnic, socioeconomic, geographic, and occupational lines. Of Barrett's 162 plant remedy reports, 23 species comprised 75% of treatments. Quinlan and Quinlan similarly find a highly uneven distribution of ethnobotanical knowledge in Dominica, concluding that "such a range of knowledge may itself be traditional" (2007:183). Contrasting with other ethnobotanical domains, intracultural variation appears normal in studies of medical ethnobotany knowledge.

Santa Lucía is not a typical Q'eqchi' village in some respects, which may increase homegardens' medicinal plants variation. While Santa Lucia's ethnicity is predominantly Q'eqchi' Maya, there are a few village Ladinos and a few with Kaqchikel, Pokomchi, and Mam Maya ethnicity. This slight cultural diversity may introduce different cultivation practices and floristic diversity, as Barrett (1995) found for an ethnically diverse region in Nicaragua. Ethnobotanical variation is further predictable with the village's semi–recent 1980 founding, as consensus appears to develop over time (Stepp 2016).

Our homegarden medicinal plants survey methods probe not for total ethnobotanical knowledge but for known cultivated, at–hand rainy–season resources. Had we resampled homegardens during the dry season or at a different point in time, we might have found additional homegarden medicinals and perhaps an increased variety from natural vegetation succession or other ecological or phenological factors (Anderson 1996; Stepp 2016). We nevertheless find high homegarden plant variability. Reviewing four decades of Yucatec Maya homegarden literature, Lope–Alzina (2017) concludes that variation—in garden composition, structure, and function—is the principal characteristic of homegardens and a major reason for their multifunctionality. Homegarden plant counts are highly variable, ranging from 28 to 347 species per Yucatec community (Lope–Alzina 2017). In X–Mejia, Campeche, villagers grow 73% of their medicinal herbs in homegardens (Cahuich–Campos et al. 2014) and medicinal plants form the greatest proportion of homegarden species' uses (26.8%) (González Jácome 2015).

With additional methods—such as freelisting local remedies—while this also probes active above total knowledge (Quinlan and Quinlan 2007:184)—we would expect to see more medicinal knowledge and variation thereof. Informants usually list cultivates growing in their homegardens *and* common wild plants or weeds growing close to home, as cross–culturally people often use the latter medicinally (Stepp and Moerman 2001). Accordingly, the *curandero* (healer) we interviewed had a distinct set of homegarden plants, including numerous plants he reported transplanting from uncultivated stands.

## Sharing

During homegarden plant walk interviews, villagers listed herbal–remedy concoction ingredients that they do not grow, but which they source from community, family or friends. Q'eqchi's extensive medicinal plant sharing means no household need grow every medicinal plant it may want; mirroring Finerman and Sackett's (2003) account of Andean Saraguro medicinal plant sharing, especially among female family members and close friends.

Practices of seeking and giving medicinal ingredients promote garden variation and an ethos of sharing, which varies across cultures (Herzog 2020). Q'eqchi' sharing ethics particularly contrast with individualistic cultures with full market economies that prioritize exchange over sharing. While scholars characterize Latin America as leaning "collectivist" (Triandis 2001), Maya cultures exemplify collectivism (Redfield 1941:357; Wilson 1995:250) by integrating members "from birth onward into strong, cohesive in–groups, often extended families" (Hofstede 1983; Hofstede and McCrae 2004:63). Maya, kinship connection "structures life and overwhelmingly dominates in matters of economic support and mutual aid" (Anderson 2005:160). Collective group units are paramount, and value relationships and cooperation over self–focused behavior (Oyserman and Lee 2008; Triandis 2001), as we find in Santa Lucía. Villagers grow medicinal plants for home healthcare and to share with family and friends according to Q'eqchi' philosophies of reciprocity and collective, communal well–being (Centro Ak' Kutan 2007; Hatse and De Ceuster 2004; Wilk 1991; Wilson 1995). The collectivist nature of Maya cultures likely operates upon a spectrum from remaining intact in isolated, homogenous communities to more individualistic in heterogeneous urban areas (Wilson 1995).

Although rural and remote, the FTN road's immediate proximity and Santa Lucia's market economy influence may contribute to community heterogeneity and incipient individualism. That villagers sometimes charge for medicinal plants complicates conclusions on sharing and collectivism, but could show collectivist out–group behaviors or villagers' increasing familiarity with commercial goods and cash–based economy. On the other hand, as its subsistence horticulture indicates, Santa Lucia's economy is not fully market–oriented. Its remote location, a national resurgence in Maya identity and pride, and social cohesion generated by its founders' refugee history and endurance through its "high degree of social cohesion, trust, and mutual aid" (Wilson 1995:245) may preserve collectivist tendencies.

Conclusions on this matter remain speculative and we suggest future exploration of the roles of collectivism and reciprocity on medicinal plant variation and sharing in Santa Lucía and other newer, refugee–founded communities. We know little about the influence of collectivism/individualism, reciprocity, and social networks on ethnobiological practices, but this vein of research could yield important insights into culture, cognition, and appropriate initiatives toward biodiversity conservation and cultural revitalization of salient knowledge.

## Conclusion

People's first healthcare choice are often home remedies from medicinal plants (Weller et al. 1997), a pattern that especially holds in rural, impoverished areas with few other medical options (Quinlan 2004; Vandebroek 2013), such as the community of Santa Lucía herein. By cultivating various medicinal plants, Santa Lucíans fill personal and community home–treatment needs in ecologically and culturally optimal contexts. Medicinal plant cultivation is distributed along two axes: the particular ecological characteristics of the homegarden surroundings and in–home entrepreneurial activities of the villagers. Villagers share the medicinal plants they grow with family and friends. Intracommunity sharing appears to be essential to the variation in medicinal plant cultivation in Santa Lucia's homegardens. Further research into how social networks' medicinal resource sharing influences ethnobotanical knowledge and practice would inform deeper understanding of cultural knowledge distribution, botanical resource conservation, and appropriate healthcare models in indigenous communities in Guatemala and beyond.

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